DEPARTMENT OF CHEMISTRY

Syllabus for

Undergraduate Programmes (Honours)

Under Credit Semester System

(Outcome Based Education with Effect from 2024 Admissions)

St Berchmans College
Founded 1922
AUTONOMOUS | College with Potential for Excellence | A+ in the Fifth Cycle of Reaccreditation by NAAC
Changanassery, Kerala, India 686101 | Affiliated to Mahatma Gandhi University, Kottayam

ACKNOWLEDGEMENT

I am pleased to present the newly designed syllabus for the Four-Year Undergraduate Programme in Chemistry, meticulously developed in alignment with the National Education Policy (NEP) of the Government of India. This innovative curriculum is crafted to provide a broad-based and inclusive educational experience, catering to the diverse academic interests and career aspirations of our students.

The NEP emphasizes the need for a multidisciplinary approach to education, encouraging the integration of various disciplines to foster a holistic learning environment. In response, our syllabus includes a wide range of courses spanning foundational, advanced, and interdisciplinary topics. This diverse offering allows students to pursue a major in Chemistry, combined major and minor options, or even double majors, with pathways specifically tailored for Bachelor of Science (BSc) in Chemistry, BSc Honours in Chemistry, and BSc Honours in Chemistry with research-oriented trajectories.

Our curriculum is designed to empower students with deep conceptual understanding and practical skills, preparing them not only for academic excellence but also for impactful contributions to society and industry. The inclusion of courses on emerging fields and advanced laboratory techniques ensures that our graduates are well-equipped to navigate the challenges of the 21st century.

I take this moment to express my gratitude to all who have diligently contributed to the development of the syllabus under the Four-Year Undergraduate Programme (FYUGP) framework. My appreciation extends to the college leadership and the curriculum revision committee for their efforts in organizing training sessions essential for the implementation of this curriculum. I would also like to acknowledge the contributions of the external Board of Studies members, including Dr. Mahesh Hariharan (Professor, Indian Institute of Science Education and Research, Thiruvananthapuram), Dr. Suneesh C. V. (Associate Professor, University of Kerala, Thiruvananthapuram), Dr. G. Anilkumar (Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam), Dr. Jubi John (Senior Scientist,National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram), and Mr. Davis Louis (Managing Director, Highrange Rubber & Coir Products (P) Ltd.). Special thanks to my colleagues within the department who have shown remarkable dedication and patience throughout the process of crafting the undergraduate syllabus for the FYUGP.

Dr. Renjith Thomas FRSC

Chairman of the Board of Studies in Chemistry

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PROGRAMME OUTCOMES

PO1: Develop in-depth conceptual knowledge and skills in the discipline for vertical growth and scholarly pursuits

PO2: Integrate and apply interdisciplinary knowledge incorporating historical, theoretical, scientific, technological, economic, philosophical, cultural, aesthetic and ethical perspectives to address complex challenges in diverse settings

PO3: Demonstrate communication skills promoting adaptability, collaboration and resilience in global and local contexts

PO4: Develop problem solving skills to transfer the knowledge of methods and systems of different disciplines for a sustainable and egalitarian world order

PO5: Cultivate research skills and innovative and critical thinking to contribute to societal development through the creation of sustainable solutions and advancements in the respective fields

PROGRAMME SPECIFIC OUTCOMES

PSO1: Integrate skill sets from various emerging fields to address complex scientific challenges and develop multidisciplinary expertise in chemical sciences.

PSO2: Enhance analytical and technical skills through advanced instrumentation techniques and data analysis, to foster expertise in the synthesis and characterization of diverse materials.

PSO3: Promote a deep understanding of the role of chemistry in societal, environmental, and economic contexts, to advocate sustainable development and good ethical practices.

PSO4: Develop effective communication and leadership qualities to disseminate scientific knowledge, attract collaborations across disciplines, and engage with diverse audiences.

PSO5: Encourage research and innovation by providing hands-on experience in cutting-edge laboratory techniques, prepare students for careers in research, academia, industry, and entrepreneurship with a strong emphasis on creativity and problem-solving skills.

OUTLINE OF DISCIPLINE SPECIFIC COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24CH1DSC100	Major	Foundation Course in Chemistry - I	5	75	4
SBU24CH1DSC101	Minor	General Chemistry	5	75	4
Semester II (Course Level: 100 - 199)					
SBU24CH2DSC100	Major	Foundation Course in Chemistry - II	5	75	4
SBU24CH2DSC101	Minor	Advanced Topics in Chemistry	5	75	4
Semester III (Course Level: 200 - 299)					
SBU24CH3DSC200	Major	Inorganic Chemistry - I	5	75	4
SBU24CH3DSC201	Major	Organic Chemistry - I	5	75	4
SBU24CH3DSC202	Minor	Advanced Physical Chemistry - I	5	75	4
SBU24CH3DSC203	Minor	Chemistry of Biomolecules	5	75	4
Semester IV (Course Level: 200 - 299)					
SBU24CH4DSC200	Major	Organic Chemistry - II	5	75	4
SBU24CH4DSC201	Major	Physical Chemistry - I	5	75	4
SBU24CH4DSC202	Minor	Advanced Physical Chemistry - II	5	75	4
SBU24CH4DSC203	Minor	Chemistry in Industry and Agriculture	5	75	4
BCH4DIN	Major	Internship	-	-	2
Semester V (Course Level: 300 - 399)					
SBU24CH5DSC300	Major	Inorganic Chemistry - II	5	75	4
SBU24CH5DSC301	Major	Physical Chemistry - II	5	75	4
Semester VI (Course Level: 300 - 399)					
SBU24CH6DSC300	Major	Inorganic Chemistry - III	5	75	4
SBU24CH6DSC301	Major	Organic Chemistry - III	6	90	4
SBU24CH6DSC302	Major	Theoretical Chemistry	4	60	4
Semester VII (Course Level: 400 - 499)					
SBU24CH7DSC400	Major	Spectrometric Identification of Organic Compounds	5	75	4
SBU24CH7DSC401	Major	Advanced Quantum Mechanics and Chemical Bonding	4	60	4
SBU24CH7DSC402	Major	Scientific Methods for Chemistry Research and Intellectual Property Rights	4	60	4
SBU24CH7DSC403	Major/ Minor	Advanced Topics in Physical Chemistry	4	60	4
SBU24CH7DSC404	Major/ Minor	Solid State Chemistry	4	60	4
SBU24CH7DSC405	Major/ Minor	Molecular Symmetry and Group Theory	4	60	4
Semester VIII (Course Level: 400 - 499)					
SBU24CH8DSC400	Major	Advanced Topics in Inorganic Chemistry	5	75	4
SBU24CH8DSC401	Major	Advanced Topics in Organic Chemistry	5	75	4

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH8DSC402	Major	Computational Chemistry	5	75	4
SBU24CH8DSC403	Major	Advanced Organic Reactions	4	60	4
SBU24CH8PRJ400	Major	Project			12

OUTLINE OF DISCIPLINE SPECIFIC ELECTIVE COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24CH3DSE200	Elective	Thermodynamics and Equilibrium	4	60	4
SBU24CH3DSE201	Elective	Instrumental Methods of Analysis	4	60	4
Semester IV (Course Level: 200 - 299)					
SBU24CH4DSE200	Elective	Materials Chemistry	4	60	4
SBU24CH4DSE201	Elective	Industrial Chemistry and Entrepreneurship	4	60	4
Semester V (Course Level: 300 - 399)					
SBU24CH5DSE300	Elective	Biochemistry	4	60	4
SBU24CH5DSE301	Elective	Advanced Coordination Chemistry and Organometallics	4	60	4
SBU24CH5DSE302	Elective	Green Chemistry: From Fundamentals to Frontiers	4	60	4
SBU24CH5DSE303	Elective	Medicinal Chemistry and Drug Design	4	60	4
SBU24CH5DSE304	Elective	Theoretical Spectroscopy and Kinetics	4	60	4
Semester VI (Course Level: 300 - 399)					
SBU24CH6DSE300	Elective	Forensic Chemistry	4	60	4
SBU24CH6DSE301	Elective	Chemistry of Polymeric Materials	4	60	4

OUTLINE OF MULTIDISCIPLINARY COURSES (MDC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24CH1MDC100	MDC	Cosmetic Chemistry	4	60	3
Semester II (Course Level: 100 - 199)					
SBU24CH2MDC100	MDC	Chemistry of Food	4	60	3
Semester III (Course Level: 200 - 299)					
SBU24CH3MDC200	MDC	Chemistry in Every Day Life	3	45	3

OUTLINE OF SKILL ENHANCEMENT COURSES (SEC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester IV (Course Level: 200 - 299)					
SBU24CH4SEC200	SEC	Dairy Chemistry	3	45	3
Semester V (Course Level: 300 - 399)					
SBU24CH5SEC300	SEC	Analytical Instrumentation for Chemists	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24CH6SEC300	SEC	Data Analysis and Digital Chemistry	3	45	3

OUTLINE OF VALUE ADDITION COURSES (VAC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24CH3VAC200	VAC	Exploring Natural Rubber Latex: From Sap to Final Products	3	45	3
Semester IV (Course Level: 300 - 399)					
SBU24CH4VAC200	VAC	Environmental Chemistry	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24CH6VAC300	VAC	Environmental Chemistry and Human Rights	3	45	3

OUTLINE OF SIGNATURE COURSES (SGC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester VII (Course Level: 400 - 499)					
SBU24CH8DSG400	SGC	Modern Instrumental Techniques and Statistical Thermodynamics	4	60	4
SBU24CH8DSG401	SGC	Advanced Chemical Bonding: Theoretical Insights and Practical Applications	4	60	4
SBU24CH8DSG402	SGC	Advanced Course on Biological Inorganic Chemistry	4	60	4

SEMESTER I

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH1DSC100	Major	Foundation Course in Chemistry - I	5	75	4
SBU24CH1DSC101	Minor	General Chemistry	5	75	4
SBU24CH1MDC100	MDC	Cosmetic Chemistry	4	60	3

SBU24CH1DSC100: FOUNDATION COURSE IN CHEMISTRY - I

Type of Course	DSC		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Mathematics, Physics and Chemistry at Class XII		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe periodic table of elements in detail	U
CO2	Analyse systematically the periodic trends observed among various chemical properties	An
CO3	Discuss the kinetic molecular theory of gases, vacancy theory of liquids and the significant properties of gases and liquids	U
CO4	Explain how to classify and name organic compounds along with basic concepts in organic chemistry, and to learn the preparation, properties, reactions and uses of alkanes in detail	U
CO5	Acquire basic laboratory skills and learn the techniques of acidimetry, alkalimetry and permanganometry	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	2	-	2	1	2	-	-	-
CO2	2	-	2	-	1	2	1	-	-	-
CO3	1	-	1	-	2	1	2	-	-	-
CO4	2	-	2	-	1	2	2	-	-	-
CO5	1	2	1	-	2	1	1	-	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva	Written Test	MCQ	
CO1	x	-	x	-	x	x
CO2	x	-	x	x	-	x
CO3	-	x	-	-	x	x
CO4	-	x	-	x		x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Laboratory Skills	Viva	Lab test	Record	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Periodic Table and Chemical Properties of Elements (15 Hrs)				
A brief history of periodic table, modern periodic law. Introduction to the periodic table: periods and groups, division of elements into s, p, d and f blocks; periodicity in chemical properties and its reason	1.1	1	2	Lecture
Sizes of atoms and ions: covalent, van der Waals and ionic radii, periodic trends in covalent, van der Waals and ionic radii; radii of cations and anions, isoelectronic ions	1.2	1	1	Lecture
Ionization energy: successive ionization energies, periodic trends and factors affecting ionization energy; enthalpy of atomization: periodic trends	1.3	2	2	Lecture
Electron affinity: periodic trends in electron affinity	1.4	2	1	Lecture
Electronegativity: Pauling, Allred and Rochow and Mulliken models for electronegativity. Factors affecting electronegativity; applications of electronegativity: partial ionic character of covalent bonds, enthalpy of formation, calculation of bond lengths	1.5	2	2	Lecture
Metallic character: periodic trends	1.6	2	2	Lecture
Terrestrial distribution of elements: Goldschmidt classification of elements; Effective nuclear charge: Screening effect, Slater's rules	1.7	2	2	Lecture
Problems based on the above topics (1.2 to 1.7)	1.8	1, 2	3	Interactive Problem Solving
Module 2: States of Matter: Gases and Liquids (15 Hrs)				
The kinetic molecular theory of gases: postulates. Kinetic gas equation: Boyle's law, Charels' law and Avogadro law from kinetic gas equation. The ideal gas equation, Graham's law of diffusion and Dalton's law of partial pressures	2.1	3	2	Lecture
Kinetic energy and temperature, Maxwell distribution of molecular velocities, effect of temperature on molecular velocities, Boltzmann factor.	2.2	3	1	Lecture
Types of molecular velocities: most probable velocity, average velocity and root mean square velocity	2.3	3	1	Lecture
The degrees of freedom among gaseous molecules: Translational, rotational and vibrational degrees of freedom; Normal modes of vibration in molecules; examples of CO_2 and H_2O	2.4	3	2	Lecture
The van der Waals equation of state: van der Waals constants	2.5	3	1	Lecture
Critical constants of gas: Critical temperature, pressure and volume with examples	2.6	3	1	Lecture
Vacancy theory of liquids, free volume in a liquid. Vapour pressure of liquids: heat of vaporization, Trouton's rule	2.7	3	1	Lecture

Surface tension: surface energy, effect of temperature on surface tension, cohesion and adhesion, interfacial tension, surface active agents	2.8	3	1	Lecture
Viscosity: coefficient of viscosity, fluidity, effect of temperature on viscosity, Reynolds number, Poisseuille equation	2.9	3	1	Lecture
Refraction: refractive index, specific refraction, molar refraction, specific rotation and optical activity	2.10	3	1	Lecture
Problems based on the above topics (2.1 to 2.10)	2.11	3	3	Interactive Problem Solving
Module 3: Introduction to Organic Chemistry and Alkanes (15 Hrs)				
Classification of organic compounds, introduction to function groups, IUPAC system of nomenclature	3.1	4	1	Lecture
Homolytic and heterolytic fission: notations for electron transfer, electrophiles and nucleophiles, structure and bonding in carbocations, carbenes, free radicals and carbanions	3.2	4	2	Lecture
Acidity and basicity: Arrhenius, Lowry-Bronsted and Lewis concepts; pK_a, pK_b and their significance in organic chemistry	3.3	4	1	Lecture
Structure of organic molecules: hybridization in alkanes, alkenes and alkynes	3.4	4	1	Lecture
Electronic displacements: Inductive effect, acidity and basicity of organic acids and bases. Electromeric effect; Hyperconjugation and applications; mesomeric effect; the concept of resonance; tautomerism; steric effect and steric inhibition of resonance	3.5	4	3	Lecture
Types of organic reactions: addition, substitution, elimination and rearrangements with examples (only basics)	3.6	4	1	Lecture
Alkanes: Natural sources of alkanes, composition of natural gas and petroleum, petroleum refining, cracking, knocking and anti-knocking agents, octane number and cetane number; Synthetic petrol: Fischer Tropsch and Bergius process. Compressed natural gas: composition and advantages	3.7	4	2	Lecture
Preparation of alkanes: Catalytic hydrogenation of alkenes and alkynes, reduction of haloalkanes, Wurtz synthesis, Corey-House alkane synthesis and Kolbe's electrolytic process	3.8	4	2	Lecture
Reactions of alkanes: free radical substitution reactions-halogenation, sulphonation and nitration; oxidation and aromatization	3.9	4	2	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co., Jalandhar, 2020
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2020
3. A. Bahl, B. S. Bahl, A text book of Organic Chemistry, S. Chand and Company Limited, 22nd Edition, 2016

Reference

1. M. Weller, T. Overton, J. Rourke, F. Armstrong, Inorganic Chemistry International Edition, Oxford University Press, 2018
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, O. K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, 5th Edition, Pearson Education, 2022
3. P. Atkins, J. Paula, J. Keeler, Physical Chemistry International Edition, Oxford University Press, 2018
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Edition, Oxford University Press, 2014
5. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th Edition, Pearson Education, 2010
6. K. S. Tewari, N. K. Vishnoi, A Textbook of Organic Chemistry, 4th Edition, S Chand and Company Ltd, 2022

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Basic Laboratory Techniques and Introduction to Volumetric analysis (6 Hrs)				
Students should be trained to handle: electronic analytical balance, weighing bottles, desiccators, funnels and filter paper, sintered-glass crucibles, pipets, burets, volumetric flasks and other necessary vessels	5.1	5	1	Practical
Laboratory notebook: maintaining a laboratory notebook, notebook format; safety in the laboratory: rules to be followed	5.2	5	1	Practical
Introduction to volumetric analysis: titration, indicators, equivalence points and end points.	5.3	5	1	Practical
Expressing concentrations: normality, molarity, molality, and parts per million	5.4	5	1	Practical
Preparation of solutions: standard solutions, primary and secondary standards, use of equivalent mass and molecular mass, training to prepare standard solutions	5.5	5	1	Practical
Types of volumetric analysis (only the basics): Acidimetry, alkalimetry, oxidation-reduction titrations, Iodimetry and Iodometry, precipitation titrations, complexometric titrations	5.6	5	1	Practical
From each of the following modules a minimum of three experiments are to be chosen. At least seven experiments should be done in the laboratory and recorded.				
Module 6: Experiments on Acidimetry and Alkalimetry (12 Hrs)				
Estimation of Hydrochloric acid using standard borax solution	6.1	5	12	Practical

Estimation of Sodium hydroxide using standard potassium hydrogen phthalate solution Estimation of Sulphuric acid (using oxalic acid crystals and sodium hydroxide solution) Estimation of Potassium carbonate (using sodium carbonate and hydrochloric acid) Estimation of Sodium hydroxide (using sodium carbonate and hydrochloric acid)				
Module 7: Experiments on Permanganometry (12 Hrs)				
Estimation of Sodium oxalate (using oxalic acid and potassium permanganate solution) Estimation of Oxalic acid (using Mohr's salt and potassium permanganate solution) Estimation of Mohr's salt (using Oxalic acid and potassium permanganate solution) Estimation of Fe (II) ions (using Mohr's salt and potassium permanganate solution) Estimation of Calcium Estimation of Fe (III) ions: reduction by zinc and sulphuric acid	7.1	5	12	Practical

Textbook

1. A. O. Thomas, Practical Chemistry, 8th Edition, Scientific Book Centre, 2000

Reference

1. Vogel, J. Bassett, G. H. Jeffrey, J. Mendam, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Higher Education, 1994
2. D. West, D. Skoog, F. Holler, S. Crouch, Fundamentals of Analytical Chemistry, 10th Edition, Brooks/Cole, 2021

Course designed by: Dr. Cyril Augustine V.

SBU24CH1DSC101: GENERAL CHEMISTRY

Type of Course	Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic Chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Summarize the characteristics of solids and identify the imperfections in crystals.	U
CO2	Explain the classification, preparation, properties and applications of colloids	U
CO3	Identify the classification, preparation and applications of nanomaterials and identify the role of green chemistry in sustainable development.	U
CO4	Provide the definition, structure, stability and isomerism in coordination complexes	A
CO5	To acquire basic lab skills and get hands-on experience in nanomaterial synthesis and inorganic preparation	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	1	-	-	-	-
CO2	1	-	1	-	-	1	-	-	-	-
CO3	1	-	1	-	-	1	-	-	-	-
CO4	-	2	1	-	2	1	-	-	1	2
CO5	-	2	2	-	2	1	-	-	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Exam 1	Exam 2	
CO1	-	x	-	x	-	x
CO2	-	x	-	-	x	x
CO3	x	-	x	x	-	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Lab involvement	Assignment	Laboratory report	Lab test	
CO1	-	-	-	-	-
CO2	-	-	-	-	-
CO3	-	-	-	-	-
CO4	-	-	-	-	-
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to the Solid State (9 Hrs)				
Difference between crystalline and amorphous solids- Characteristics of geometry, melting points, isotropy and anisotropy, size and shape of crystals and interfacial angles	1.1	1	1	Lecture/PPT
Close packing-HCP, CCP and packing efficiency, voids, radius ratio, Packing fraction, number of particles in unit cell, density of unit cell. Space lattice and unit cell, Bravais Lattices	1.2	1	3	Lecture/PPT
Classification and characteristics of crystals- Molecular crystal (water molecule), Covalent crystal (graphite and diamond), Ionic crystal (NaCl and CsCl) and Metallic crystal	1.3	1	3	Lecture/PPT
Imperfections in crystal. Point defects- the Schottky defects and the Frenkel defects	1.4	1	1	Lecture/PPT
Metal excess defects -The colour centres, Metal deficiency defects.	1.5	1	1	Lecture/PPT
Module 2: Introduction to the Colloidal State (6 Hrs)				
Colloids- Definition, Classification of Colloids, difference between lyophobic and lyophilic colloids	2.1	2	1	Lecture/PPT
Preparation of colloidal solutions- Mechanical dispersion, Electrical dispersion, peptization and condensation methods, Purification of colloidal solutions- Dialysis, Ultra-filtration	2.2	2	1	Lecture/PPT
General properties of colloidal systems-Tyndall effect and the Brownian movement, Electrokinetic properties – Electrophoresis and Electro-osmosis.	2.3	2	1	Lecture/PPT
Surfactants, Micelle formation, Critical Micelle Concentration	2.4	2	1	Lecture/PPT
Emulsions and Emulsifiers, Gels- Preparation and Classification	2.5	2	1	Lecture/PPT
Importance and applications of colloids	2.6	2	1	Lecture/PPT
Module 3: Fundamentals of Nano chemistry and Green Chemistry (15 Hrs)				
Nanomaterials-Definition, brief history, classification - 0D, ID, 2D and 3D nanomaterials	3.1	3	3	Lecture/PPT
Properties of nanomaterials	3.2	3	1	Lecture/PPT
General approach of nano synthesis – Top-down and bottom-up approach	3.3	3	1	Lecture/PPT
Physical and Chemical methods of preparation -Chemical vapour deposition, Chemical precipitation and Reduction methods**,** Fundamentals of sol-gel process.	3.4	3	2	Lecture/PPT
Applications of nanomaterials, Toxicity of nanomaterials	3.5	3	2	Lecture/PPT
Introduction to green chemistry, role of green chemistry in sustainable development	3.6	3	2	Lecture/PPT
Principles of green chemistry (brief idea only)	3.7	3	4	Lecture/PPT

Module 4: Introduction to Coordination Chemistry (15 Hrs)				
Coordination complexes- definition, ligands and coordination number	4.1	4	1	Lecture/PPT
Types of ligands-monodentate, bidentate and polydentate, chelating ligands	4.2	4	2	Lecture/PPT
Nomenclature of Coordination Compounds	4.3	4	3	Lecture/PPT
Effective Atomic Number Rule	4.4	4	1	Lecture/PPT
Factors affecting stability of a complex ion	4.5	4	1	Lecture/PPT
Geometry of Complexes with coordination number 4,5 and 6	4.6	4	1	Lecture/PPT
Isomerism in coordination complexes – Structural and stereoisomerism Structural isomerism- Ionisation isomerism, Coordination isomerism, Hydrate isomerism, Linkage isomerism	4.7	4	2	Lecture/PPT
Stereoisomerism-Geometrical and optical isomerism in complexes of coordination number 4 and 6	4.8	4	4	Lecture/PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Chemical Safety and Ethical Handling of Chemicals (10 Hrs)				
Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards	6.1	5	2	Lecture and demonstration
Flammable or explosive hazards	6.2	5	2	Lecture and demonstration
Disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals	6.3	5	2	Lecture and demonstration
Identification, verification and segregation of laboratory waste, incineration and transportation of hazardous chemicals	6.4	5	2	Lecture and demonstration
Lab safety, working of fire extinguisher and first aid	6.5	5	2	Lecture and demonstration
Module 7: Synthesis of Nanomaterials and Application of Green Approach in Chemical Synthesis (10Hrs)				
Synthesis of ZnO nanoparticles by Wet Chemical Precipitation	7.1	5	10	Practical
Synthesis of zero valent iron nanoparticles ($Fe^{3+)}$ by Wet Chemical Precipitation				
Synthesis of ZnS nanoparticles				
Green synthesis of bis (dimethylglyoxamato) nickel (II) complex using nickel carbonate and sodium salt of dimethylglyoxime				
Module 8: Inorganic Preparation (10 Hrs)				
(a) Tetramminecopper(II)sulphate (b) Potassium trioxalatochromate(III) (c) Prussian Blue (d) Potassium trioxalato aluminate (III) (e) Bis thiourea copper (I) sulphate	8.1	5	10	Practical

(f) Cuprous Chloride, Cu_2Cl_2 (g) Manganese (III) phosphate, $MnPO_4.H_2O$ (f) Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum				
At least three feasible inorganic preparations should be carried out and recorded.				

Textbooks

1. B. R. Puri, M.S. Pathania, L. R. Sharma, Principles of Physical Chemistry, 48 th Edition, Vishal Publishing Co., 2020.
2. G. Raj, Advanced Physical Chemistry, 39th Edition, Krishan Prakashan, 2014
3. T. Pradeep, A Textbook of Nanoscience and Nanotechnology, McGraw Hill Education, 2017.
4. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co., Jalandhar, 2020
5. J. Vogel, G.H. Bassett, J. Jeffrey, J. Mendam, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Higher Education, 1994

Reference

1. J.H. Clark, and D. J. Macquarrie, Handbook of Green Chemistry and Technology, Wiley-Blackwell, 2002.
2. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edition., Pearson Education, 2006.
3. P.T. Anastas and T.C. Williamson, Green Chemistry: Frontiers in Benign Chemical Syntheses and Processes, Oxford University Press, New York, 1999.
4. G.A. Ozin, A.C. Arsenault and L. Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, 2nd Edn, 2008.
5. V. S. Muralidharan, A. Subramania, Nano Science and Technology, CRC Press, 2008.
6. J. Klabunde, R. M. Richards, Nanoscale Materials in Chemistry, 2nd Edn., Wiley Interscience, 2009
7. D. West, D. Skoog, F. Holler, S. Crouch, Fundamentals of Analytical Chemistry, 10th Edition, Brooks/Cole, 2021
8. J. Vogel, G.H. Bassett, J. Jeffrey, J. Mendam, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Higher Education, 1994
9. A. O. Thomas, Practical Chemistry, 8th Edition, Scientific Book Centre, 2000

Course designed by: Dr Renchu Scaria

SBU24CH1MDC100: COSMETIC CHEMISTRY

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)	Basic knowledge of cosmetic products.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Formulate and evaluate ingredients in cosmetic products	E
CO2	Know the key components used in different cosmeceutical products.	U
CO3	Recognize the role of ingredients and herbs used in cosmeceutical products.	A
CO4	Applying the green chemistry principle to cosmetic science	A
CO5	Demonstrate skills in designing and preparing cosmetic products, incorporating environmentally conscious and sustainable practices.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	1	-	1	-
CO2	1	-	-	-	-	1	1	-	-	-
CO3	1	1	1	-	-	1	1	-	1	-
CO4	1	1	-	-	-	1	1	-	1	-
CO5	1	2	1	-	-	1	1	-	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Exam 1	Exam 2	
CO1	-	-	x	x	-	x
CO2	x	-	-	x	-	x
CO3	-	x	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Lab involvement	Viva voce	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Cosmetic Chemistry (6 Hrs)				
Definition of cosmetics as per Indian and EU regulations, Evolution of cosmeceuticals from cosmetics, cosmetics as quasi and OTC drugs.	1.1	1	1	Lecture/Power point presentation
Skin: Basic structure and function. Sun protection: Classification of Sunscreens and SPF. Mechanism of sunscreen	1.2	1	2	Lecture/Power point presentation
Principles of formulation and building blocks of skin care products: Face wash, cleansing creams, toner, Night and massage creams, Moisturizing, vanishing and foundation creams, Pigmented foundation creams, hand creams, hand and body cream, all-purpose creams and their advantages and disadvantages.	1.3	1,2	3	Lecture/Power point presentation
Module 2: Chemistry of Skin Care Cosmetics (6 Hrs)				
Face Serums: Benefits and usage. Different types with composition- Anti aging, Skin brightening, Acne fighting, Hydrating, Exfoliating, Reparative and renewing face serums.	2.1	2,3	2	Lecture/Power point presentation
Common products for make-up i. Moisturiser ii. Primer iii. Concealer iv. Foundation v. Highlighter vi. Contour vi. Blusher vii. Setting powder viii. Eye shadow ix. Eye liner x. Mascara xi. Lipstick xii. Setting spray. Basic understanding of ingredients of each product.	2.2	2,3	3	Lecture/Power point presentation
Coloured Make-up Preparations: Lipstick- Introduction. Ingredients of lipstick, Formulation. Manufacture of lipsticks.	2.3	2,3	1	Lecture/Power point presentation
Module 3: Eye and Nail Care Cosmetics (6 Hrs)				
Under eye darkness- Composition of under eye cream	3.1	2,3	2	Lecture/Power point presentation
Eye make-up: Chemistry of Mascara, Eye shadow, Eyeliner, Eyebrow pencil. Application of false eye lashes method.	3.2	2,3	2	Lecture/Power point presentation
Chemistry of nail care cosmetics: Introduction	3.3	2	2	Lecture/Power point presentation
Module 4: Hair Care Cosmetics (6 Hrs)				
Hair: Basic structure of hair. Hair growth cycle. Cosmetic problems associated with Hair.	4.1	2,3	2	Lecture/Power point presentation

Principles of formulation and building blocks of Hair care products like conditioning shampoo, hair conditioner, anti-dandruff shampoo. Hair oils. Natural Dyes and Chemical Dyes Chemistry, formulation and side effects of Para-phenylene diamine-based hair dye.	4.2	2,3	3	Lecture/Power point presentation
Study of side effects of cosmetic ingredients & products	4.3	2,3	1	Lecture/Power point presentation
Module 5: Green Cosmetics (6 Hrs)				
Definition, Composition of Green cosmetics, need of switch to green cosmetics, Future perspectives	5.1	4	1	Lecture/Power point presentation
Green skin care products - Formulation	5.2	4	2	Lecture/Power point presentation
Green Hair care products – Formulation	5.3	4	1	Lecture/Power point presentation
Aromatherapy	5.4	4	1	Lecture/Power point presentation
Floral Cosmetics	5.5	4	1	Lecture/Power point presentation
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Frank Dreher, Elsa Jungman, Kazutami Sakamoto, Howard Maibach, Handbook of Cosmetic Science and Technology, 5th Edition, CRC Press, 2022.
2. Nema R.K., Textbook of Cosmetics, 2ndEdition, CBS Publishers, 2017.
3. Kazutami Sakamoto, Robert Y. Lochhead, Yuji Yamashita, Cosmetic Science and Technology, Theoretical Principles and Applications, Elsevier, 2017.
4. Amol A Kulkarni, Vikram Gharge, Cosmetic Science, First Edition, Nirali Prakashan, 2017.

Reference

1. John Knowlton and Steven Pearce, Handbook of Cosmetic Science & Technology, Elsevier Science, 1993
2. Heather A.E. Benson, Michael S. Roberts, Vania Rodrigues Leite-Silva, Kenneth Walters, Cosmetic Formulation Principles and Practice, CRC Press, 2019.
3. Wilkinson, John Bernard, and Raymond Jack Moore, Harry's Cosmeticology. Vol. 749, Chemical Publishing, 1982.

Practical

Designing of Cosmetic Products

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Preparation of Commercial Cosmetic Products (15 Hrs)				
Basic lab safety protocols 1. Preparation of soap 2. Preparation of lipstick/lip glow balm 3. Preparation of hair shampoo	7.1	5	15	Demonstration Lab work

4. Preparation of face serums 5. Preparation of moisturiser 6. Preparation of perfume ***(Any four preparation)***				
Module 8: Green cosmetic product synthesis (15 Hrs)				
1. Preparation of natural face wash 2. Preparation of natural facial scrub 3. Preparation of natural cleansing lotion 4. Preparation of natural sunscreen lotion 5. Preparation of natural hair conditioner for all hair types 6. Preparation of natural hair dye ***(Any four preparation)***	8.1	5	15	Demonstration Lab work

Textbooks

1. Pavani Anumukonda, Shweta Bhutada, A Practical Manual of Cosmetic Formulations, First Edition, Nirali Prakashan, 2020.
2. Beckett, Arnold Heyworth, and John Bedford Stenlake, Practical Pharmaceutical Chemistry: Part II, Fourth edition, A&C Black, 1988.
3. Jeffery, G. H. Vogel's Textbook of Quantitative Chemical Analysis 5th Edn. 2022.

Reference

1. Sethi, Prabhu Dayal. Quantitative analysis of drugs in pharmaceutical formulations. CBS, 2008.
2. Sharma, P. P. Cosmetics: Formulation, Manufacturing & Quality Control, 6th Edition Vandana Publications, 2018.
3. Butler, Hilda, ed. Poucher's perfumes, cosmetics and soaps. Springer Science & Business Media, 2013.

Course designed by: Dr Ajith James Jose

SEMESTER II

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH2DSC100	Major	Foundation Course in Chemistry - II	5	75	4
SBU24CH2DSC101	Minor	Advanced Topics in Chemistry	5	75	4
SBU24CH2MDC100	MDC	Chemistry of Food	4	60	3

SBU24CH2DSC100: FOUNDATION COURSE IN CHEMISTRY - II

Type of Course	DSC		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	**75**
Pre-requisite (if any)	Mathematics, Physics and Chemistry at Class XII and successful completion of Foundation Course in Chemistry I		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe different types of chemical bonds and the related theories	U
CO2	Explain the fundamentals of thermodynamics	U
CO3	Describe the concept of isomerism in organic chemistry	U
CO4	Explain the preparation, properties, reactions and applications of cycloalkanes	U
CO5	Illustrate the techniques of dichrometry and complexometry	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	1	2	-	-	-
CO2	2	-	1	-	1	2	1	-	-	-
CO3	2	-	2	-	2	1	2	-	-	-
CO4	2	-	2	-	1	2	2	-	-	-
CO5	1	2	1	-	2	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva	Written Test	MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	-	x
CO3	-	x	x	x	x	x
CO4	-	x	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Laboratory Skills	Viva	Lab test	Record	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Chemical Bonding (15 Hrs)				
Ionic bond: nature and factors influencing ionic bonds	1.1	1	1	Lecture
Covalent and co-ordinate bonds: polarity in covalent bonds, polarization of ions, Fajan's rules, percentage of ionic character, dipole moment and molecular structure	1.2	1	1	Lecture
VSEPR theory, notion of hybridization with examples (sp, sp^2, sp^3, sp^3d and sp^3d^2), structures of H_2O, NH_3, XeF_2, XeF_4, SF_4, ClF_3, IF_7, $[I_3]^-$ and $[SO_4]^{2-}$	1.3	1	3	Lecture
Valence bond theory (VBT), its applications and limitations, VBT of hydrogen molecule (derivation not expected)	1.4	1	1	Lecture
Molecular orbital theory (MOT): Linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, application to hydrogen molecule ion (derivation not expected)	1.5	1	2	Lecture
Applications of MO theory to homo- and hetero-diatomic molecules (H_2, Li_2, B_2, C_2, N_2, O_2, F_2, CO, NO and HF), bond order, bond strength and bond energy	1.6	1	3	Lecture
Metallic Bond: Free electron, valence bond and band models (derivations not expected)	1.7	1	1	Lecture
Hydrogen Bonding: Types, consequences and significance	1.8	1	1	Lecture
Lattice energy of ionic compounds: Born-Lande equation, Born-Haber cycle and its applications, solubility and stability of ionic compounds on the basis of lattice energy	1.9	1	2	Lecture
Module 2: Introduction to Thermodynamics (15 Hrs)				
Basics of thermodynamics: Systems (isolated, closed and open systems), surroundings, homogeneous and heterogeneous systems, phase, macroscopic properties	2.1	2	1	Lecture
State of a system and state variables, thermodynamic equilibrium, extensive and intensive properties; thermodynamic processes: isothermal, adiabatic, isobaric, cyclic, reversible and irreversible processes; state functions and path functions	2.2	2	1	Lecture
First law of thermodynamics: work, energy, exothermic and endothermic processes, internal energy; statement and explanation of the first law; Heat transactions: calorimetry, heat capacity: heat capacity at constant volume	2.3	2	2	Lecture
Enthalpy: definition, variation of enthalpy with temperature, heat capacity at constant pressure, relation between heat capacities C_p and C_v. Enthalpies of vaporization and fusion	2.4	2	1	Lecture
Expansion of an ideal gas and changes in thermodynamic properties: basic expressions and physical significance through problems (derivations are not expected)	2.5	2	1	Lecture

Zeroth law of thermodynamics, absolute scale of temperature	2.6	2	1	Lecture
Introduction to thermochemistry: concept of the standard enthalpy changes of reactions through problems; Hess's law and applications	2.7	2	2	Lecture
Bond energy: concept and applications	2.8	2	1	Lecture
Basic concepts of entropy, Helmholtz free energy (A), and Gibbs free energy (G)	2.9	2	1	Lecture
Second and third laws of thermodynamics: brief description with significance, Problems based on the above topics, 2.3 to 2.9	2.10	2	4	Lecture
Module 3: Isomerism and Cycloalkanes (15 Hrs)				
Introduction to isomerism: Classification (Constitutional and stereoisomerism). Constitutional isomerism: Chain, position, functional isomerism, metamerism and tautomerism; Stereoisomerism: geometrical and optical isomerism	3.1	3	1	Lecture
Geometrical isomerism: Examples of 3-hexene, butenedioic acid; geometrical isomerism in cyclic compounds	3.2	3	1	Lecture
Optical isomerism: optical activity, specific rotation, plane of symmetry and chirality, chiral carbon atoms, enantiomers, optical isomers of lactic acid and tartaric acid	3.3	3	1	Lecture
Racemic mixture, diastereomers, meso compounds; optical activity without chiral carbons: allenes and biphenyls; resolution of racemic mixtures; racemisation	3.4	3	1	Lecture
Syn-anti isomerism: Examples from oximes, diazo compounds and cycloalkanes	3.5	3	1	Lecture
Absolute configuration: Cahn-Ingold-Prelog system, examples; E-Z system	3.6	3	1	Lecture
Fischer, Newman and Sawhorse projection formulae and their inter-conversions	3.7	3	1	Lecture
Conformational isomers: examples of ethane, propane and butane	3.8	3	1	Lecture
Cycloalkanes: methods of preparation, reactions (substitution and ring opening reactions)	3.9	4	3	Lecture
Stability of cycloalkanes: Baeyer strain theory, Sachse-Mohr theory, molecular orbital theory	3.10	4	2	Lecture
Conformations of cyclohexane and its derivatives: equatorial and axial hydrogens, examples of cyclohexane and methyl cyclohexanes	3.11	4	2	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co., Jalandhar, 2020

2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2020
3. A. Bahl, B. S. Bahl, A text book of Organic Chemistry, S. Chand and Company Limited, 22nd Edition, 2016

Reference

1. M. Weller, T. Overton, J. Rourke, F. Armstrong, Inorganic Chemistry International Edition, Oxford University Press, 2018
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, O. K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, 5th Edition, Pearson Education, 2022
3. P. Atkins, J. Paula, J. Keeler, Physical Chemistry International Edition, Oxford University Press, 2018
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Edition, Oxford University Press, 2014
5. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th Edition, Pearson Education, 2010
6. K. S. Tewari, N. K. Vishnoi, A Textbook of Organic Chemistry, 4th Edition, S Chand And Company Ltd, 2022

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
From the following modules a minimum of three experiments are to be chosen. At least seven experiments should be done in the laboratory and recorded.				
Module 5: Experiments on Dichrometry (15 Hrs)				
Estimation of Fe (II) ions using internal indicator Estimation of Fe (II) ions using external indicator Estimation of Fe (III) ions using internal indicator Estimation of Fe (III) ions using external indicator: reduction with stannous chloride Estimation of Chromium (using ferrous ammonium sulphate and potassium dichromate solution)	5.1	5	15	Practical
Module 6: Experiments on Complexometry (15 Hrs)				
Estimation of Zinc Estimation of Magnesium Estimation of Copper Estimation of Calcium and Magnesium Estimation of Nickel	6.1	5	15	Practical

Textbook

1. A. O. Thomas, Practical Chemistry, 8th Edition, Scientific Book Centre, 2000

Reference

1. D. West, D. Skoog, F. Holler, S. Crouch, Fundamentals of Analytical Chemistry, 10th Edition, Brooks/Cole, 2021
2. Vogel, J. Bassett, G. H. Jeffrey, J. Mendam, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Higher Education, 1994

Course designed by: Dr. Cyril Augustine V.

SBU24CH2DSC101: ADVANCED TOPICS IN CHEMISTRY

Type of Course	Minor		
Course Level	100 – 199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	General Chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Summarize the characteristics of aromatic compounds and classify compounds as aromatic, antiaromatic and non-aromatics	U
CO2	Identify the separation and purification techniques of organic compounds	U
CO3	Apply the fundamental principle of IR and UV spectroscopy to analysis of functional groups	A
CO4	Analyse simple organic compounds and their mixtures.	A
CO5	To acquire hands-on experience in the preparation of organic molecules	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	1	-	-	-	-
CO2	-	2	1	-	-	1	-	-	-	-
CO3	-	2	1	-	2	1	-	-	2	2
CO4	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written test	MCQ	
CO1	x	x	x	x	x	x
CO2	-	x	x	x	-	x
CO3	-	x	x	x	x	x
CO4	-	-	x	x	-	-
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	MCQ	Viva	Lab test	Record	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Aromaticity (15Hrs)				
Aromaticity: Definition, Huckel's Rule	1.1	1	2	Lecture/PPT
Benzenoid aromatic compounds – benzene, naphthalene, anthracene	1.2	1	2	Lecture/PPT
Non-benzenoid aromatic compounds -cyclopropenyl cation, tropylium cation Heterocyclic aromatic compounds -pyridine, pyrrole and furan	1.3	1	3	Lecture/PPT
Non-aromatic and antiaromatic compounds	1.4	1	1	Lecture/PPT
Fused ring aromatic compounds	1.5	1	1	Lecture/PPT
Ring activating and deactivating groups with examples	1.6	1	2	Lecture/PPT
Aromatic electrophilic substitution reactions- Fridel Crafts alkylation, acylation, nitration, sulphonation and halogenation	1.7	1	4	Lecture/PPT
Module 2: Separation and Purification of Organic Compounds (15Hrs)				
Purification of Organic Compounds- crystallisation, sublimation, distillation and extraction with a solvent	2.1	2	4	Lecture/PPT
Column chromatography - principle, types of adsorbents, preparation of the column, elution, recovery of substances and applications	2.2	2	3	Lecture/PPT
Thin layer chromatography - principle, choice of adsorbent and solvent, preparation of chromatoplates, R_f-values, factors affecting the R_f -values, Significance of R_f values.	2.3	2	5	Lecture/PPT
Paper chromatography - principle, solvents used, development of chromatogram, ascending, descending and radial paper chromatography	2.4	2	3	Lecture/PPT
Module 3: Introduction to spectroscopic methods (15Hrs)				
Electromagnetic Spectrum, Fundamentals of Spectroscopy.	3.1	3	2	Lecture/PPT
Ultraviolet (UV) absorption spectroscopy, absorption laws (Beer-Lambert law), molar absorptivity	3.2	3	2	Lecture/PPT
Energy levels and origin of spectra, types of electronic transitions, effect of conjugation and solvent, concept of chromophore and auxochrome.	3.3	3	2	Lecture/PPT
Presentation and analysis of UV spectra, UV-visible spectra of simple organic molecules	3.4	3	2	Lecture/PPT
Infra-Red (IR) absorption spectroscopy- molecular vibrations, Hooke's Law, selection rules	3.5	3	2	Lecture/PPT
Intensity and position of IR bands, measurement of IR spectrum	3.6	3	2	Lecture/PPT
Finger print region, characteristic absorptions of various functional groups	3.7	3	1	Lecture/PPT
Interpretation of IR spectra of simple organic compounds	3.8	3	2	Lecture/PPT

Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

Practical

Course Content	Unit	CO	Hour	Transaction Mechanism
Module 5: Application of Chromatography in Analysis (10 Hrs)				
Chromatography - preparation of TLC plate and calculation of R_f value of simple organic compounds or mixtures.	5.1	4	2	Practical
Paper chromatographic separation of $Fe^{3+,}$ Al^{3+}, and Cr^{3+}	5.2	4	2	Practical
Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.	5.3	4	2	Practical
Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.	5.4	4	2	Practical
Chromatographic separation of the active ingredients of plants, flowers and juices by TLC	5.5	4	2	Practical
A minimum of three separation should be carried and recorded				
Module 6: Identification of functional groups and application of IR and UV spectra in the analysis (10 Hrs)				
Qualitative Analysis – Microanalysis and Semi microanalysis (Introduction) Identification of functional group present in the given organic compound (a) alcohol/phenol (b) acid (c) amines (d) aldehydes (e) ketones (f) esters	6.1	4	5	Practical
Identification of organic functional groups by analysis of given UV spectra of the following compounds (acetone, acetaldehyde, 2-propanol, acetic acid, benzoic acid, ester, amines, phenol) Analysis of the given IR spectra of compounds (acetone, acetaldehyde, 2-propanol, acetic acid, benzoic acid, ester, amines, phenol)	6.2	4	5	Practical
A minimum of four organic functional groups should be analysed and recorded (analysis must be done using experiments and IR and UV spectra)				
Module 7: Organic Preparations (10 Hrs)				
Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done. (a) Bromination of Phenol/Aniline (b) Benzoylation of amines/phenols	7.1	5	10	Practical

(c) 2,4 dinitrophenylhydrazone of aldehyde/ketone (d) Nitration of salicylic acid (e) Nitration of nitrobenzene (f) Nitration of urea				
A minimum of three organic preparation should be carried and recorded				

Textbooks

1. S.C. Sharma, M.K. Jain, Modern Organic Chemistry, Vishal Publishing Company, New Delhi, 2014
2. A. Bahl, B. S. Bahl, A text book of Organic Chemistry, S. Chand and Company Limited, 22nd Edition, 2016
3. G. R. Chatwal, S. K. Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House, 2011
4. Vogel, J. Bassett, G. H. Jeffrey, J. Mendam, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Higher Education, 1994

Reference

1. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Edition, Oxford University Press, 2014
2. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th Edition, Pearson Education, 2010
3. A. Bahl, B. S. Bahl, A text book of Organic Chemistry, S. Chand and Company Limited, 22nd Edition, 2016
4. K. S. Tewari, N. K. Vishnoi, A Textbook of Organic Chemistry, 4th Edition, S Chand And Company Ltd, 2022
5. D. West, D. Skoog, F. Holler, S. Crouch, Fundamentals of Analytical Chemistry, 10th Edition, Brooks/Cole, 2021
6. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edn., Pearson Education, New Delhi, 2006
7. G. D Christian, Analytical Chemistry, 6th Edn., New York, John Wiley, 2004
8. S. M. Khopkar, Basic Concepts of Analytical Chemistry, New Age, International Publisher, 2009
9. Vogel, J. Bassett, G. H. Jeffrey, J. Mendam, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Higher Education, 1994
10. A. O. Thomas, Practical Chemistry, 8th Edition, Scientific Book Centre, 2000

Course designed by: Dr Renchu Scaria

SBU24CH2MDC100: CHEMISTRY OF FOOD

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Summarize the chemical composition of various food components, such as proteins, carbohydrates, lipids, vitamins, and minerals.	U
CO2	Explain the relationship between chemical reactions, food additives, and food preservation methods.	U
CO3	Illustrate principles of food chemistry to predict the behaviour of food during processing, storage, and cooking.	A
CO4	Develop proficiency skills with respect to food and dietary practices.	U
CO5	Apply the principles of food chemistry to conduct simple laboratory experiments.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	1	1	-	-	-
CO2	1	-	2	-	-	1	1	-	-	-
CO3	1	-	1	-	-	1	1	-	-	-
CO4	1	-	2	-	-	1	1	-	-	-
CO5	2	1	1	-	2	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Assignment	Written test	MCQ	
CO1	x	x	-	x	x	x
CO2	x	-	x	x	x	x
CO3	x	-	x	x	-	x
CO4	x	-	x	x	-	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab Involvement	MCQ	Viva	Lab test	Record	
CO1	-	-	-	-		-
CO2	-	-	-	-		-
CO3	-	-	-	-		-
CO4	-	-	-	-		-
CO5	x	x	x	x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Chemistry of Food (15 Hrs)				
Carbohydrates: Classification with examples. Biological importance of carbohydrates. Starch and cellulose, Applications of cellulose.	1.1	1	2	Lecture
Lipids- Classification – Oils, fats and waxes: biological functions and examples. Trans fats. Extraction and refining of vegetable oils. Common fatty acids present in oils and fats. Biological functions of phospholipids and glycolipids.	1.2	1	3	Lecture
Amino acids and Proteins: Essential and non-essential amino acids. Proteins: Effects of food processing: changes occurring in chemical, functional & nutritional properties of proteins. Protein deficiency.	1.3	1	3	Lecture
Enzymes- Enzymes involved in food digestion. Importance of enzymes in food industry.	1.4	1	2	Lecture
Vitamins- Biological functions and deficiency diseases of Vitamins A, B, C, D, E and K.	1.5	1	2	Lecture
Minerals- Nutritional aspects of minerals, Essential mineral elements. Deficiency of following minerals– calcium, iron, iodine, sodium and potassium.	1.6	1	3	Lecture
Module 2: Food Additives (15 Hrs)				
Food additives – definition. Food preservatives – Natural food preservatives, traditional food preservation methods, artificial preservative agents, modern food preservation techniques.	2.1	2	2	Lecture
Artificial sweeteners, Fragrances, Flavouring Agents– Vegetables, fruit and spice flavours. Flavour enhancers. Monosodium glutamate.	2.2	2	3	Lecture
Emulsifiers- Role, Types with examples.	2.3	2	1	Lecture
Commonly used permitted and non-permitted food colours (structures not required). Uses and abuses of these substances in food beverages. Quality assurance of food colourants.	2.4	2	2	Lecture
Fast foods and junk foods & their health effects – Soft drinks and their health effects.	2.5	3	1	Lecture
Antioxidants: Types of antioxidants, natural sources of antioxidants, Safety concerns of antioxidants.	2.6	3	2	Lecture
Gelling Agents, Leavening agents, Stabilisers, and Thickeners, Dietary Supplements.	2.7	3	2	Lecture
Safety concerns of food preservatives. FSSAI, Food Safety and Standards Act, Societal Role of Food Chemists.	2.8	4	2	Lecture
Module 3: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. Sreelakshmi, Food Science, New Age, 2018.
2. Swaminathan M., Food Science and Experimental foods, Ganesh and Company, 2005.
3. N. Agarwal, A. Srivastava, Food Chemistry, Anu Books, 2023.

Reference

1. S. Roday, Food Science and Nutrition, 3rd Edition, Oxford University Press, 2018.
2. H. D. Belitz, W. Grosch, P. Schieberle, Food Chemistry, 4th Edn, Springer, 2009.
3. T. Coultate, Food: The Chemistry of Its Components, 6th Edition, RSC. 2015.
4. T. A. M. Msagati, Chemistry of Food Additives and Preservatives, John Wiley & Sons, 2013.
5. V. Kontogiorgos, Introduction to Food Chemistry, Springer, 2021.
6. C. M. Weaver, J. R. Daniel, The Food Chemistry Laboratory, CRC Press, 2005.
7. A. V. Ramani, Food Chemistry, MJP Publishers, 2011.
8. S. Damodaran, K. L. Parkin, Fennema's Food Chemistry, 5th Edition, CRC Press 2017.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 4: Food Chemistry Practical (30 Hrs)				
1. Preparation of various value added food products. 2. To find out the moisture content from a given food sample by Lab oven method. 3. Determination of threshold concentrations of primary tastes. 4. Qualitative tests for the presence of carbohydrates in food samples. 5. Qualitative test for the presence of proteins in food samples. 6. Qualitative test for the presence of sugar in given food sample. 7. Qualitative test for the presence of lactose in milk sample. 8. Determination of acid value of given oil or fat sample. 9. Qualitative test for the presence of fat in milk powder. 10. Determination of vitamin C in food sample. 11. Tests for common food adulterants in chilli powder. 12. Tests for common food adulterants in turmeric. 13. Tests for common food adulterants in milk. 14. Tests for common food adulterants in cooking oil. 15. Determination of RM value of oil and fat.	4.1	5	30	Lab work

A minimum of six experiments must be done and recorded.

Reference

1. C. M. Weaver, J. R. Daniel, The Food Chemistry Laboratory, CRC Press, 2005.
2. I. Bevier, Food and Nutrition Laboratory Manual, Forgotten Books, 2018.
3. S. Sehgal, A Laboratory Manual of Food Analysis, International Publishing, 2016.
4. S. S. Nielsen, Food Analysis Laboratory Manual, 3rd Edn, Springer, 2019.

5. D. D. Miller, C K Yeung, Food Chemistry: A Laboratory Manual, Wiley, 2022.

Course Designed by: Dr. Jinesh M. Kuthanapillil

SEMESTER III

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH3DSC200	Major	Inorganic Chemistry - I	5	75	4
SBU24CH3DSC201	Major	Organic Chemistry - I	5	75	4
SBU24CH3DSC202	Minor	Advanced Physical Chemistry - I	5	75	4
SBU24CH3DSC203	Minor	Chemistry of Biomolecules	5	75	4
SBU24CH3DSE200	Elective	Thermodynamics and Equilibrium	4	60	4
SBU24CH3DSE201	Elective	Instrumental Methods of Analysis	4	60	4
SBU24CH3MDC200	MDC	Chemistry in Every Day Life	3	45	3
SBU24CH3VAC200	VAC	Exploring Natural Rubber Latex: From Sap to Final Products	3	45	3

SBU24CH3DSC200: INORGANIC CHEMISTRY - I

Type of Course	Major		
Course Level	200- 299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Foundations of Chemistry- I		

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyze general group trends of s - block elements.	An
CO2	Distinguish acids and bases based on various acid- base concepts	U
CO3	Differentiate different types of nuclear reactions and identify its applications in various fields.	A
CO4	Illustrate the various theories of bonding in coordination compounds.	An
CO5	Use basic inorganic chemistry concepts for preparation and quantitative analysis.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	1	-	-	1	1	-	-	-
CO2	-	-	1	-	-	1	1	-	-	-
CO3	-	-	1	-	-	1	1	-	-	-
CO4	-	-	1	-	-	1	1	-	1	-
CO5	-	-	1	-	2	1	1	-	-	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written Test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	-	x
CO3	-	x	x	x	x	x
CO4	x	-	x	x	-	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	MCQ	Viva voce	Lab test	Record	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Characteristic and Distinctive Properties of s Block Elements (12 Hrs)				
Hydrogen: occurrence of hydrogen, isotopes of hydrogen, hydrides - ionic or salt like hydrides, molecular or covalent hydrides and metallic or interstitial hydrides. Heavy water: manufacture and properties.	1.1	1	2	Lecture
Chemistry of s - block elements: inert pair effect, relative stability of different oxidation states, diagonal relationship-diagonal relationship between beryllium and aluminium, diagonal relationship of lithium with magnesium, anomalous behaviour of first member of each group.	1.2	1	2	Lecture
Allotropy and catenation.	1.3	1	2	Lecture
Alkali metals: Li, Na, K, Rb and Cs - occurrence, comparative study of elements-trends in ionization potential, electropositive character, oxidation state, reducing character, and characteristic flame colouration, oxides, halides, hydroxides and carbonates. Exceptional property of lithium.	1.4	1	3	Lecture
Alkaline earth metals: Be, Mg, Ca, Sr and Ba - occurrence and comparative study of the elements-trends in ionization potential, electropositive character, oxidation state, and characteristic flame colouration, oxides, hydroxides, halides, sulphates and carbonates. Basic beryllium acetate and nitrate. Exceptional property of beryllium.	1.5	1	3	Lecture
Module 2: Acids and Bases (3 Hrs)				
Arrhenius concept, Bronsted-Lowry's concept and Lux Flood concept.	2.1	2	1	Lecture
Lewis's concept, group characteristics of Lewis acids, solvent levelling and differentiating effects	2.2	2	2	Lecture
Module 3: Nuclear Chemistry (15 Hrs)				
The nucleus: structure of the nucleus, subatomic particles, forces in the nucleus, mesons.	3.1	3	1	Lecture
Radiochemistry: natural and induced radioactivity; radioactive decay α-decay, β-decay, γ-decay, neutron emission, positron emission, electron capture.	3.2	3	1	Lecture
Decay constant, half-life period, units of radioactivity.	3.3	3	1	Lecture
Stability of nucleus - n/p ratio, binding energy; radioactive elements.	3.4	3	1	Lecture
Mass defect: energy produced during common nuclear reactions.	3.5	3	1	Lecture
Nuclear models-shell model, liquid drop model (basic idea).	3.6	3	2	Lecture
Geiger-Nuttal rule, radioactive displacement law, radioactive series.	3.7	3	1	Lecture

Nuclear reactions: types of nuclear reactions - spallation, nuclear fission, and nuclear fusion reactions.	3.8	3	1	Lecture
Nuclear fission-theory of nuclear fission; chain reaction and critical mass.	3.9	3	1	Lecture
Nuclear reactors - fast breeder reactors, fuels used in nuclear reactors, separation of isotopes, moderators, coolants; nuclear fusion.	3.10	3	1	Lecture
Atom bomb, neutron bomb and hydrogen bomb (principles).	3.11	3	1	Lecture
Applications: energy tapping, radio carbon dating, neutron activation analysis, isotopic labelling studies, nuclear medicine.	3.12	3	2	Lecture
Principles of counting technique such as GM counter, proportional, ionization and scintillation counters. Cloud chamber (Basic concepts).	3.13	3	1	Lecture
Module 4: Coordination Chemistry - 1 (15 Hrs)				
Werner's theory; coordination number and oxidation state. Valence bond theory; geometries of tetrahedral and square planar and octahedral, inner orbital and outer orbital complexes. Merits and demerits of VBT. Nomenclature of coordination compounds.	4.1	4	3	Lecture
Crystal filed theory, splitting of d-orbitals in octahedral, tetrahedral, and square-planar complexes.	4.2	4	3	Lecture
Spectrochemical series-strong and weak field ligands, CFSE, pairing energy, low spin and high spin complexes.	4.3	4	2	Lecture
Stability of complexes; factors affecting the stability of metal complexes. Chelate effect and macrocyclic effect.	4.4	4	2	Lecture
Crystal field splitting in tetragonally distorted octahedral geometry, Jahn-Teller distortion in Cu (II) complexes.	4.5	4	2	Lecture
Theoretical failure of crystal field theory, evidence for metal ligand covalency, Nephelauxetic effect, MO theory, MO diagram of complexes of octahedral symmetry (sigma bonding only)	4.6	4	3	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Vikas Publishing Co., Jalandhar, 2013
2. R. Gopal, Inorganic Chemistry for Undergraduates, Universities press, India Pvt. Ltd., 2009.
3. P. L. Soni, Text Book of Inorganic Chemistry, S. Chand and Sons, 2007

Reference

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edn. Pearson Education, 2006.
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edn, Chapman & Hall, 2002
3. D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 3rd Edn., Oxford University Press, New Delhi, 2004

4. F.A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., Wiley Interscience, 1999
5. R. Gopalan, Elements of Nuclear Chemistry, Vikas Publishing House, 1999
6. S. Glasstone, Sourcebook on Atomic Energy, 3rd Edn., Krieger Publishing Company, 1979.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Gravimetry (20 Hrs)				
Determination of water of crystallisation in barium chloride/copper sulphate.	6.1	5	20	Lab work (A minimum of three experiments must be done and recorded)
Estimation of sulphate as barium sulphate	6.2	5		
Estimation of barium as barium sulphate	6.3	5		
Estimation of Fe as Fe_2O_3	6.4	5		
Estimation of nickel as dimethyl glyoxime complex	6.5	5		
Estimation of copper as CuSCN	6.6	5		
Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate)	6.7	5		
Module 7: Synthesis of nano materials (10 Hrs)				
Synthesis of ZnO nanoparticles by wet chemical precipitation	7.1	5	10	Lab work
Synthesis of zero valent iron nanoparticles ($Fe^{3+)}$ by wet chemical precipitation	7.2	5		
Synthesis of ZnS nanoparticles	7.3	5		

Reference

1. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999
2. A. I. Vogel, A Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, 3rdEdn., Longman, 1971
3. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, Vogel's Text Book of Quantitative Chemical Analysis, 5thEdn., Longman Scientific and Technical, 1989
4. V. S. Muralidharan, A. Subramania, Nano Science and Technology, CRC Press, 2008.
5. J. Klabunde, R. M. Richards, Nanoscale Materials in Chemistry, 2nd Edn., Wiley Inter science, 2009

Course designed by: Dr Subin Joseph

SBU24CH3DSC201: ORGANIC CHEMISTRY - I

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	IUPAC Nomenclature, Basic organic chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand organic reaction intermediates, their roles, and mechanisms in molecular transformations.	U
CO2	Grasp aromaticity, electrophilic substitutions, and their impacts on reaction orientation in aromatic compounds.	U
CO3	Learn the synthesis and reactions of haloalkanes focusing on their mechanisms.	U
CO4	Study the organic chemistry of unsaturated compounds concentrating on their mechanism and synthetic applications.	A
CO5	Develop practical skills in organic compound analysis and laboratory techniques.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		-	-	-	1	1	-	-	-
CO2	1		-	-	-	1	1	-	-	-
CO3	1	1	-	-	-	1	1	-	-	-
CO4	1	1	-	-	-	1	1	-	-	-
CO5	1	2	-	1	2	1	-	1	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written Test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	x	x
CO3	x	-	x	x	-	x
CO4	x	-	x	x	-	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	MCQ	Viva voce	Lab test	Record	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Reaction Intermediates				
Introduction to organic intermediates, characteristic features of intermediates, general methods of determination of intermediates	1.1	1	1	Lecture
Carbocations: Structure, stability (aliphatic, aromatic and cyclic), preparation of carbocations. Non classical carbocations- structure and bonding	1.2	1	3	Lecture
Carbocation rearrangements: Hydride shift, Methide Shift in Wagner-Meerwin rearrangement, Pinacol-pinacolone rearrangement, Dienone-Phenol rearrangement	1.3	1	3	Lecture
Carbanions: Structure, stability (aliphatic, aromatic)	1.4	1	1	Lecture
Grignard Reagents and Gilman Reagents	1.5	1	1	Lecture
Carbenes: Structure, properties, types (singlet and triplet), Carbene Insertion Reactions	1.6	1	2	Lecture
Nitrenes: Structure, properties, aziridine formation, Hoffmann and Curtius rearrangement	1.7		2	Lecture
Free radicals: Structure, stability, Generation: Homolytic cleavage in bromination of methane. Stability of Allylic and benzylic radicals	1.8	1	1	Lecture
Arynes: Benzynes- structure and bonding, Diels-Alder reaction with benzyne to form adducts	1.9	1	1	Lecture
Module 2: Organic chemistry of aromatic compounds				
Concept of aromaticity: antiaromaticity and non-aromaticity. NMR evidence of aromaticity.	2.1	2	2	Lecture
Huckel's rule: application to benzenoid; benzene, naphthalene and non-benzenoid compounds; cyclopropenyl cation, cyclopentadienyl anion and tropylium cation.	2.2	2	2	Lecture
Aromatic behaviour of five membered heterocyclics like pyridine, pyrrole and furan, azulene, fulvene, calicene.	2.3	2	2	Lecture
Aromaticity of polycyclic compounds: anthracene and chrysene. Introduction to homoaromatic behavior.	2.4	2	1	Lecture
General mechanism of electrophilic substitution, mechanism of halogenation, nitration, Friedel-Craft's alkylation, and acylation. Applications	2.5	2	2	Lecture
Orientation of aromatic substitution: ortho, para and meta directing groups. Ring activating and deactivating groups with examples. Orientation of groups like -OH, amino, methoxy, nitro, carbonyls, acids, halogens and styrene	2.6	2	3	Lecture
Aromatic nucleophilic substitutions: The addition - elimination and the elimination - addition mechanisms of nucleophilic aromatic substitution reactions. Synthetic applications.	2.7	2	3	Lecture

Module 3: Haloalkanes, Alkenes, alkynes				
Preparation of alkyl halides: from alcohols, halogenation of alkanes, the addition of hydrogen halides to alkenes, Darzens process, Hunsdicker, and Finkelstein reactions. Preparation of vinyl and allyl halides.	3.1	3	1	Lecture
Reactions of alkyl halides: Nucleophilic substitution reactions- SN^2 and SN^1 mechanisms. Effect of solvent, substrate, nucleophile and nucleofuge on nucleophilic substitution reactions. Relative reactivity of alkyl halides vs. allyl and vinyl halides.	3.2	3	3	Lecture
Alkenes and alkynes: general methods of preparation	3.3	4	1	Lecture
Regioselectivity using Hoffmann and Saytzeff rules, E1, E2, E1CB, Saytzeff and Hofmann eliminations.	3.4	4	2	Lecture
Reactions of alkenes: cis-addition (alkaline KMnO4) and trans-addition (halogens), addition of hydrogen halides and water, Markonikov's rule, free radical additions-peroxide effect/Kharasch effect	3.5	4	2	Lecture
Addition reactions: oxy mercuration - demercuration, hydroboration, ozonolysis. Syn hydroxylation, epoxidation and Simmons-Smith reaction.	3.6	4	2	Lecture
Dienes: stability of dienes (conjugated, isolated and cumulative dienes). General methods of preparation, 1,2 - and 1,4 – additions with mechanism.	3.7	4	1	Lecture
Alkynes: Preparation from CaC2, conversion into higher alkynes by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides.	3.8	4	1	Lecture
Reactions: acidity of alkynes- metal salt formation and alkylation of terminal alkynes, reaction with Tollens reagent and Fehlings solution	3.9	4	1	Lecture
Reactions: ozonolysis and hydroboration/oxidation Reduction (cis and trans).	3.10	4	1	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. K. S. Tewari, N.K. Vishnoi, A Textbook of Organic Chemistry, 4th Edn., Vikas Publishing House, 2017
2. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, 3rd Edn., Vishal Publishing Company, 2017

Reference

1. P. Sykes, A Guide to Mechanism in Organic Chemistry, 6th Edn., Pearson Education, 2004
2. P. S. Kalsi, Organic Reactions and Their Mechanisms, 8th Edn., New Age International, 2014
3. J. March, Advanced Organic Chemistry, 6th Edn., John Wiley & Sons, 2007
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Edn., Oxford University Press, 2012
5. R. T. Morrison, R. N. Boyd, Organic Chemistry, 6th Edn., Prentice Hall, 2004

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Test for aromaticity	5.1	5	1	Lab work
Test for saturation and un saturation	5.2	5	1	Lab work
Test for elements (N, S, X)	5.3	5	2	Lab work
Module 6				
Test for functional groups- OH, COOH (mono and di), X (nucleus and side chain), CHO, ketone, ester, carbohydrates,	6.1	5	3	Lab work
Test for functional groups- amine (primary, sec and tert), amide, anilide, nitro	6.2	5	3	Lab work
Module 7				
Systematic analysis of the above-mentioned organic compounds	7.1	5	15	Lab work

Reference

1. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999
2. Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell Vogel's Textbook of Practical Organic Chemistry, 5thEdn., Longman Scientific & Technical, 1989
3. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4thEdn., Pearson Education, 2009
4. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry: Qualitative Analysis, Universities Press, 2000

Course designed by: Dr Renjith Thomas

SBU24CH3DSC202: ADVANCED PHYSICAL CHEMISTRY - I

Type of Course	Minor for Physical/Mathematical Science		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the factors determining the rate of chemical reactions and derive integrated rate equations.	U
CO2	Determine the factors affecting electrical properties of electrolytes and find the titration endpoint.	A
CO3	Differentiate between types of adsorptions and adsorption isotherms.	An
CO4	Distinguish between different types of surfactants and colloids and identify their everyday applications. Apply phase rule to solve related problems.	A
CO5	Students performing the experiments will be capable of handling the conductivity meter, pH meter and potentiometer and verification of Debye-Huckel-Onsager equation.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	-	-	1	-	-	-	-
CO2	-	-	-	-	-	1	-	-	-	-
CO3	-	-	-	-	-	1	-	-	-	-
CO4	-	-	-	-	-	1	-	-	-	-
CO5	-	1	-	-	1	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Assignment	Written Test	MCQ	
CO1	x	x	-	x	x	x
CO2	x	x	-	x	x	x
CO3	x	-	x	x	-	x
CO4	x	x	-	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva voce	Lab test	Laboratory report	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Chemical Kinetics (5 Hrs)				
Rate of a reaction, rate law and rate constant, units of rate constant.	1.1	1	1	Lecture/PPT
Effect of temperature on reactions rates, threshold energy, activation energy, Arrhenius equation	1.2	2	1	Lecture/PPT
Collision theory of bimolecular gas phase reactions, activated complex theory of bimolecular gaseous reactions -basic concepts	1.3	3	1	Lecture/PPT
Eyring equation-(no derivation required), Lindemann's theory of unimolecular gaseous reactions.	1.4	2,4	1	Lecture/PPT
Equilibrium approximation, steady state approximation, kinetics of opposing and consecutive reactions.	1.5	3,5	1	Lecture/PPT
Module 2: Thermodynamics and Equilibria (15 Hrs)				
Statement of second law of thermodynamics and their equivalence. Concept of entropy – Definition and physical significance.	2.1	1	1	Lecture/PPT
Entropy as a function of volume and temperature, Entropy as a function of pressure and temperature. Entropy as a criterion of spontaneity and equilibrium. Entropy changes in various physical processes	2.2	1,2	2	Lecture/PPT
Auxiliary state function - Helmholtz free energy and Gibbs free energy and their significance. Gibbs-Helmholtz equation, dependence of Gibbs free energy change on temperature, volume and pressure.	2.3	2,3	2	Lecture/PPT
Gibbs free energy as a criterion of spontaneity and equilibrium. Third law of thermodynamics-statement and determination of absolute entropies of substances.	2.4	3	2	Lecture/PPT
Nernst distribution law–conditions for the validity of the distribution law – application of Nernst Distribution Law in the study of complex ions.	2.5	4	2	Lecture/PPT
Binary Liquid Systems – Solubility of Partially miscible liquids – different types Phenol- water system - miscibility temperature and critical solution temperature.	2.6	4,5	2	Lecture/PPT
Gibb's Phase rule – definition of terms giving examples. Phase diagram of one component system – water, Two component systems	2.7	2,4	2	Lecture/PPT
Simple Eutectic Systems – Examples, Phase diagram of Naphthalene - Biphenyl System – Cooling Curve, Eutectic Point.	2.8	2,5	2	Lecture/PPT
Module 3: Electrochemistry (15 Hrs)				
Faraday's laws of electrolysis, electrochemical equivalent and chemical equivalent, Specific conductance, equivalent conductance and molar conductance	3.1	1	2	Lecture/PPT

Variation of conductance with dilution - Kohlrausch's law	3.2	2	2	Lecture/PPT
Conductometric Titrations – Theory involving strong acid- strong base, strong acid-weak base, weak acid-strong base titration, and advantages.	3.3	3	2	Lecture/PPT
Debye Huckel Theory of Strong Electrolytes – ionic atmosphere, asymmetry effect, electrophoretic effect, viscous effect, Wein effect, Debye Falkenhagen Effect (derivation not required)	3.4	1,3	3	Lecture/PPT
Ionic strength. Galvanic cells - Cell and electrode potentials, Reference electrodes – Standard hydrogen electrode and calomel electrode; Indicator electrodes-metal-metal ion electrodes, Quinhydron electrode and Redox electrodes	3.5	1,4	2	Lecture/PPT
Potentiometric titrations – Theory and Advantages - acid-base and redox reactions	3.6	3,4	2	Lecture/PPT
Thermodynamics of cell reactions – determination of ΔH, ΔS, ΔG, ΔH°, ΔS° and ΔG° of cell reactions, Nernst equation, Standard EMF and Equilibrium constant.	3.7	4	2	Lecture/PPT
Module 4: Chemistry of Surfaces (10 Hrs)				
Adsorption – Difference between Chemical and Physical adsorption- Langmuir adsorption isotherm, BET equation (derivation not required)	4.1	1	2	Lecture/PPT
Gibbs adsorption isotherm (postulates and application). Reactions at surfaces -Langmuir - Hinshelwood mechanism	4.2	2	1	Lecture/PPT
Mechanism of heterogeneous catalysis – enzyme catalysis – Michaelis Menten theory	4.3	3	1	Lecture/PPT
Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples.	4.4	2,3	2	Lecture/PPT
Surfactants - examples of anionic, cationic, non-ionic and amphoteric surfactants.	4.5	4	2	Lecture/PPT
Micelles - structure, CMC. Emulsions – micro and macroemulsions, emulsification by surfactants, Importance and applications of colloids.	4.6	1,5	2	Lecture/PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R Puri, L. R Sharma, M. S. Pathania, Principles of Physical Chemistry, 60th edition, Vishal Publishing Company, 2020.
2. Gurdeep Raj, Advanced Physical Chemistry, 39th Edition, Krishan Prakashan, 2014.

Reference

1. K. J. Laidler, Chemical Kinetics, 3rd Edition, Pearson Education, 2004.
2. J. I. Steinfeld, J. J. Francisco, and W. L. Hase. Chemical Kinetics and Dynamics. Upper Saddle River, N. J. Prentice-Hall, 1998.
3. P. Atkins, J. de Paula, Atkin's Physical Chemistry, 11th Edition, Oxford University Press, 2018.

4. S. W. Benson, Thermochemical Kinetics: Methods for the Estimation of Thermochemical Data and Rate Parameters. 2nd Edition, New York: Wiley, 1976.
5. S. Glasstone, D. Lewis, Elements of Physical Chemistry, 2nd Revised Edition, Palgrave Macmillan., 1963.
6. R. A. Huggins, Advanced Batteries: Materials Science Aspects. Springer, 2008.
7. G. A. Prentice, Chapter 3 in Electrochemical Engineering Principles. Prentice Hall, 1990.
A. W. Adamson, A. P. Gast, Physical Chemistry of Surfaces, 6th Edition, John Wiley, 1997.
8. D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 7th Edition, Cengage Learning, 2017.
1. P. W. Atkins, Physical Chemistry, 9th Edition, Oxford University Press, 2009.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Conductometry (14Hrs)				
Determination of cell constant	6.1	1	2	Lab work
Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.	6.2	1,2	2	Lab work
Perform the following conductometric titrations: (i) Strong acid against strong base (ii) Weak acid against strong base (iii) Weak acid against weak base (iv) Strong acid against weak base (v) Mixture of acids against strong base	6.3	3	10	Lab work
Module 7: Potentiometry (6 Hrs)				
Potentiometric titration – Fe^{2+} vs. $Cr_2O_7^{2-}$	7.1	2	2	Lab work
Potentiometric titration – Fe^{2+} vs. MnO_4^-	7.2	2	2	Lab work
Determination of pH by potentiometric method	7.3	2	3	Lab work
Module 8: Electrochemistry (9 Hrs)				
Verification of Debye- Huckel Onsager equation	8.1	2,5	3	Lab work
Determination of solubility of silver chloride, lead sulphate	8.2	2,3	3	Lab work
Verification of Kohlrausch Law.	8.3	4	3	Lab work

Reference

1. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press, 2009
2. J. B. Yadav, Advanced Practical Physical Chemistry, 29th Edn., Krishna Prakashan Media Pvt. Ltd., 2010.
3. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999
4. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press, 2009
5. R. C. Das, B. Behera, Experiments in Physical Chemistry, Tata McGraw-Hill, 1983.
6. K. K. Sharma, An Introduction of Practical Chemistry, Vikas Publishing House, New Delhi, 2003

Course designed by: Dr Sam John

SBU24CH3DSC203: CHEMISTRY OF BIOMOLECULES

Type of Course	Minor for Biological Science		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic Chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the inorganic molecules in living beings along with their function.	U
CO2	Comprehend the toxic effects of metals in human body	U
CO3	Learn the chemistry of organic molecules in living beings along with their function.	U
CO4	Comprehend some important biomolecules with their functions.	R
CO5	Analyse certain biomolecules using specific reactions	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	1	-	-	1	-	-	-	-
CO2	-	-	2	-	-	1	-	-	-	-
CO3	-	-	1	-	-	1	-	-	-	-
CO4	-	-	1	-	-	1	-	-	-	-
CO5	-	1	-	-	1	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Assignment	Written test	MCQ	
CO1	x	x	-	x	-	x
CO2	x	x	-	x	-	x
CO3	x	x	-	x	x	x
CO4	x	x	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	MCQ	Viva	Lab Test	Record	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Bioinorganic Chemistry (15 Hrs)				
Bioinorganic chemistry: Elements of life – essential, major, trace and ultra-trace elements. Role of metal ions (specially Na^+, K^+, Mg^{2+}, Ca^{2+}, $Fe^{3+/2+}$, $Cu^{2+/+}$, and Zn^{2+}).	1.1	1	3	Lecture
Metal ion transport across biological membrane Na^+ ion pump, ionophores. (basics only)	1.2	1	3	Lecture
Biological functions of haemoglobin and myoglobin, cytochromes and ferredoxins and carbonic anhydrase (structure and mechanism not needed).	1.3	1	4	Lecture
Biological nitrogen fixation. Photosynthesis (basic level only)	1.4	1	3	Lecture
Toxic metal ions (Hg, Cd, As and Pb) and their effects, chelation therapy (examples only), Pt and Au complexes as drugs (examples only).	1.5	1	2	Lecture
Module 2: Bio organic chemistry (15 Hrs)				
Carbohydrates: Classification with examples. Biological importance of carbohydrates. Structure of starch and cellulose (structure elucidation not expected). Applications of cellulose.	2.1	2	3	Lecture
Amino acids: classification, essential and non-essential amino acids, Zwitterions, isoelectric point.	2.2	2	3	Lecture
Peptides: Peptide bond. Synthesis of dipeptides (any one example). Proteins: Classification of proteins. Functions.	2.3	2	3	Lecture
Enzymes: nomenclature, characteristics and classification; active site, mechanism of enzyme action (lock and key and induced fit model), coenzymes and cofactors, enzyme inhibitors.	2.4	2	3	Lecture
Nucleic acids: nucleosides and nucleotides. Composition of RNA and DNA, complementary base- pairings, features of DNA double helix (Watson - Crick Model).	2.5	2	3	Lecture
Module 3: Advanced Bio-organic compounds (15 Hrs)				
Steroids: Importance, cholesterol- significance (structure not required). HDL & LDL, bile acid.	3.1	3	3	Lecture
Carotenoids: carotenes, lycopene (only structure and brief function).	3.2	3	3	Lecture
Hormones: Introduction. Steroid hormones, peptide hormones and amine hormones (examples, endocrine gland and biological functions, structure not required). Artificial hormones (elementary study only).	3.3	3	3	Lecture
Vitamins: Classifications. Water soluble vitamins. Biological functions of thiamine, riboflavin, nicotinic acid, pyridoxine, pantothenic acid. Vitamin B12, Vitamin C and	3.4	4	3	Lecture

biotin. Fat soluble vitamins: biological functions of vitamin A, D, E, K (structure not required).				
Oils and fats; phospholipids and glycolipids; Biological function	3.5	4	3	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Vikas
2. Publishing Co., Jalandhar, 2013.
3. G. R. Chatwal, S. K. Anand, Instrumental Methods of Chemical Analysis, Himalaya
4. Publishing House, 2011.
5. R. Gopalan, P. S. Subramanian, K. Rengarajan, Elements of Analytical Chemistry, S.
6. Chand Publishers, 2003.

Reference

1. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, Fundamentals of Analytical Chemistry, 9th Edition, Brooks/Cole, 2013.
2. H. Kaur Chromatography, Published by Pragati Prakashan, 2021

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Spot tests and analysis of biological molecules (30 Hrs)				
Tests for reducing sugar	5.1	5	4	Lab work
Tests for non-reducing sugar	5.2	5	4	Lab work
Tests for proteins	5.3	5	4	Lab work
Tests for starch	5.4	5	4	Lab work
Iodine value/saponification value/acid value of oils	5.5	5	14	Lab work

Reference

1. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999.
2. D. West, D. Skoog, F. Holler, S. Crouch, Fundamentals of Analytical Chemistry, 10th Edition, Brooks/Cole, 2021.
3. A I Vogel, J. Bassett, G. H. Jeffrey, J. Mendam, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Higher Education, 1994.
4. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry: Qualitative Analysis, Universities Press, 2000.

Course designed by: Capt James Baben George

SBU24CH3DSE200: THERMODYNAMICS AND EQUILIBRIUM

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Basic foundation level thermodynamics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply the laws of thermodynamics in physical and chemical processes in ideal and real systems	A
CO2	Determine the properties of real systems based on thermodynamic principles	A
CO3	Describe the relationship between free energy and equilibrium, equilibrium constants and principles governing equilibrium	U
CO4	Explain the concept of acids and bases, their strengths and interpret acid-base titrations	U
CO5	Interpret the properties of different types of electrolytes and their applications	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	1	-	2	-	-	1	-
CO2	2	-	1	1	-	2	-	-	1	-
CO3	2	-	1	1	-	2	-	-	1	-
CO4	2	-	1	1	-	1	-	-	1	-
CO5	2	-	1	1	-	1	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Problem based assignment	Seminar	Written test	MCQ	
CO1	x	x	-	x	x	x
CO2	x	x	-	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Thermodynamics (30 Hrs)				
Calculations of q, w, U and H for reversible, irreversible and free expansion of ideal gases under isothermal and adiabatic conditions	1.1	1	2	Lecture

Comparison of isothermal and adiabatic expansions	1.2	1	1	Lecture
Joule-Thomson effect: inversion temperature, Joule-Thomson coefficient	1.3	1	2	Lecture
Determination of enthalpies of reaction, Kirchhoff equations, (integrated Kirchhoff equation), flame temperature, explosion temperature	1.4	1	2	Lecture
Carnot cycle, Carnot's theorem, efficiency of heat engine	1.5	1	2	Lecture
Entropy changes for reversible and irreversible processes, entropy change accompanying changes of phase	1.6	1, 2	2	Lecture
Entropy changes of an ideal gas with change in pressure, volume and temperature, entropy change in isothermal, isobaric and isochoric process	1.7	1	3	Lecture
Gibbs and Helmholtz free energy, variation of free energy change with temperature and pressure	1.8	1	2	Lecture
Maxwell relations	1.9	1	1	Lecture
Criteria for reversible and irreversible process	1.10	1, 2	1	Lecture
Gibbs-Helmholtz equation	1.11	1	1	Lecture
Partial molar properties, chemical potential, Gibbs-Duhem equation	1.12	2	2	Lecture
Chemical potential of a mixture of ideal gases in terms of partial pressure, molar concentration and mole fraction	1.13	1	2	Lecture
Clausius - Clapeyron equation, applications	1.14	1	1	Lecture
Third law of thermodynamics, Nernst heat theorem, thermodynamic probability, residual entropy	1.15	1, 2	2	Lecture
Problems based on theory (unit 1.1 – 1.16)	1.16	1, 2	4	Collaborative learning
Module 2: Chemical Equilibrium (10 Hrs)				
Standard free energy change, Standard free energy of formation of compounds	2.1	3	1	Lecture
Law of mass action, equilibrium constant	2.2	3	1	Lecture
Derivation of law of chemical equilibrium, derivation of relations between K_p, K_c and K_x	2.3	3	2	Lecture
Pressure dependence of equilibrium constants, derivation of van't Hoff equation	2.4	3	2	Lecture
Le Chatlier's principle and applications	2.5	3	2	Lecture
Problems based on theory (unit 2.1 – 2.6)	2.6	3	2	Collaborative learning
Module 3: Ionic Equilibrium (20 Hrs)				
Arrhenius and Lowry-Bronsted concepts of acids and bases, strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization	3.1	4	2	Lecture
Effect of solvents on the strength of acids and bases, levelling effect	3.2	4	1	Lecture
Ionization of weak acids and bases, dissociation constant, dissociation constants of polybasic acids, relative strengths of weak acids and bases	3.3	4	2	Lecture
Ionic product of water, pH and pOH, common ion effect	3.4	4	2	Lecture
Buffer solutions, buffer capacity, buffer range, buffer action, Hendersson - Hasselbalch equation, applications of buffers	3.5	5	2	Lecture

Salt hydrolysis: calculation of hydrolysis constant, degree of hydrolysis and pH for different salts	3.6	5	3	Lecture
Solubility product, relation between solubility product and molar solubility of sparingly soluble salts	3.7	5	1	Lecture
Applications of solubility product principle	3.8	5	1	Lecture
Theory of acid - base indicators, action of phenolphthalein and methyl orange, pH range of indicators	3.9	4	2	Lecture
Titration curves of strong acid against strong base and weak acid with strong base, mathematical treatment of acid base titrations	3.10	4	2	Lecture
Problems based on theory (unit 3.1 – 3.10)	3.11	4, 5	2	Collaborative learning
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, M. S. Pathania, L. R. Sharma, Principles of Physical Chemistry, 48th Edn., Vishal Publishing Co., 2020
2. K. L. Kapoor, A Textbook of Physical Chemistry: Thermodynamics and Chemical Equilibrium, Vol. 2, 5th Edn., McGraw Hill Education, 2015

Reference

1. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics: Classical, Statistical and Irreversible, Pearson Education, 2013
2. P. Atkins, J. de Paula, Atkin's Physical Chemistry, 11th Edn., Oxford University Press, 2018
3. T. Engel, P. Reid, Physical Chemistry, 3rd Edn., Pearson, 2013

Course designed by: Dr. Bejoy Francis

SBU24CH3DSE201: INSTRUMENTAL METHODS OF ANALYSIS

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the basic concepts of instrumental methods of analysis	U
CO2	Illustrate the basic principles and instrumentation of various chromatographic techniques.	U
CO3	Explain the basic principles, instrumentation and applications of various thermal and radiochemical methods of analysis.	U
CO4	Describe basic principles, instrumentation, and applications of various spectroscopic techniques for surface analysis.	A
CO5	Discuss basic principles, instrumentation, and applications of various microscopic techniques for surface analysis.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	-	-	1	1	-	-	-
CO2	1	2	2	-	-	1	1	-	-	-
CO3	1	1	1	-	-	1	1	-	-	-
CO4	-	2	1	-	-	1	1	-	-	-
CO5	-	2	1	-	-	1	1	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Assignment	Written test	MCQ	
CO1	x	-	-	x	x	x
CO2	x	-	-	x	x	x
CO3	x	x	-	x	x	x
CO4	x	x	-	x	x	x
CO5	x	x	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Instrumental Methods (15 Hrs)				
Electrical and nonelectrical data domains- detectors, sensors-active and passive sensors, transducers-piezoelectric, pyroelectric, photoelectric, pneumatic and thermal transducers. Seebeck effect.	1.1	1	4	Lecture

Criteria for selecting instrumental methods - precision, sensitivity, selectivity and detection limits.	1.2	1	3	Lecture
Signals and noise: S/N ratio, sources of noise-chemical noise and instrumental noise, thermal noise or Johnson noise, shot noise, flickr noise, environmental noise. Hardware methods for enhancing S/N ratio- shielding and grounding, analog filtering and modulation method. Computer averaging method for enhancing S/N ratio.	1.3	1	3	Lecture
Electronics: Transistors, Field effect transistors (FET)- Junction field effect transistors (JFET) and Metal oxide semiconductor field effect transisitors (MOSFET). Advantages and applications of FET. Integrated chips (ICs)- Monolithic and hybrid ICs, advantages and disadvantages of ICs, Operational amplifiers (OPAMs), mathematical and non-mathematical applications of OPAMPs.	1.4	1	5	Lecture
Module 2: Chromatography (15 Hrs)				
Chromatography - Principle of differential migration. Classification of chromatographic methods.	2.1	2	1	Lecture
Adsorption and partition column chromatography: principle, methodology, materials for stationary phases, and applications.	2.2	2	3	Lecture
Thin layer chromatography (TLC): Basic principle, methodology, R_f value, applications.	2.3	2	2	Lecture
Paper chromatography (PC): Introduction, basic principle, methodology, R_f value, applications.	2.4	2	1	Lecture
Gas chromatography (GC)- Introduction, basic principle, instrumentation, and applications.	2.5	2	2	Lecture
Liquid Chromatography: Introduction, basic principle, methodology, applications.	2.6	2	2	Lecture
High performance Liquid chromatography (HPLC)- Introduction, theory, instrumentation, advantages and applications.	2.7	2	2	Lecture
Ion exchange chromatography (IEC)- Introduction, methodology, ion exchange resins, mechanism of the ion exchange process, factors affecting ion exchange, and applications.	2.8	2	2	Lecture
Module 3: **Thermal and Radiochemical Methods of Analysis (15 Hrs)**				
Thermogravimetric Analysis (TGA)- Principle, TGA instrumentation, Thermogravimetric Curves, interpretation of TGA curves, analytical applications of thermogravimetry.	3.1	3	3	Lecture
Differential Thermal Analysis (DTA)-Principle, methodology, instrumentation, advantages and limitations, analytical applications of DTA.	3.2	3	2	Lecture
Differential Scanning Calorimetry (DSC)- DSC instrumentation, applications of DSC.	3.3	3	2	Lecture
Thermograms of above techniques, information from thermograms, factors affecting thermograms and	3.4	3	2	Lecture

applications of thermograms for qualitative/quantitative analysis.				
Thermometric titrations – theory, applications.	3.5	3	1	Lecture
Radiochemical Methods: Radioactive Isotopes, Neutron Activation Analysis (NAA), General Principles, Instrumentation, Destructive and Non-destructive Neutron Activation Methods, Applications.	3.6	3	3	Lecture
Isotope dilution methods: Principle, methodology and applications	3.7	3	2	Lecture
Module 4: Surface Study Techniques –Basic Instrumentation and Applications (15 Hrs)				
Spectroscopic Methods: Principle, basic instrumentation and applications of Ion scattering spectroscopy (ISS), Secondary ion mass spectroscopy (SIMS), Electron spectroscopy for chemical analysis (ESCA), Auger electron spectroscopy (AES), Atomic absorption spectroscopy (AAS).	4.1	4	8	Lecture
Microscopic Methods: Principle, basic instrumentation and applications of Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning Probe Microscopes: Scanning tunneling microscopy (STM) and Atomic force microscopy (AFM).	4.2	5	7	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. K. Sharma, Instrumental Methods of Chemical Analysis Vol. 1 & Vol. 2, Krishna Prakashan, 2023.
2. G. D. Christian, J. E. O'Reilly, Instrumental Analysis, Allyn and Bacon, Inc., 1986.
3. M. E. Brown, Introduction to Thermal Analysis: Techniques and Applications, Springer, 2001.

Reference

1. D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 7th Edn, Cengage Learning, 2017.
2. F. A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, 1997.
3. H. H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, Instrumental Methods of Analysis, 7th Edition, CBS Publishers and Distributors, 2018.
4. J. H. Kennedy, Analytical Chemistry: Principles, Saunders College Pub., 1990.
5. F. W. Fifield, D. Kealey, Principles and Practice of Analytical Chemistry, Blackwell Science, 2000.
6. P. J. Haines (Ed.), Principles of Thermal Analysis and Calorimetry, RSC Paperbacks, 2002.
7. P. Gabbott (Ed.), Principles and Applications of Thermal Analysis, Blackwell Publishing, 2008.
8. R. F. Speyer, Thermal Analysis of Materials, CRC Press, 1993.

Course Designed by: Dr. Jinesh M. Kuthanapillil

SBU24CH3MDC200: CHEMISTRY IN EVERYDAY LIFE

Type of Course	MDC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Differentiate between different types of soaps, detergents and other household cleansing agents	U
CO2	To get a basic understanding on different classes of drugs	U
CO3	Generate basic knowledge on different types of fertilizers, pesticides and plant growth hormones	U
CO4	Understand the principle of water purification	U
CO5	Get an idea on how chemistry influences sports and processes taking place in kitchen	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	1	-	2	1	-	1	-
CO2	1	-	1	1	-	2	1	-	1	-
CO3	1	-	1	1	-	1	1	-	1	-
CO4	1	-	1	1	-	2	1	-	1	-
CO5	1	-	1	1	-	1	1	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva	Written test	MCQ	
CO1	x	-	x	x	x	x
CO2	-	-	x	x	x	x
CO3	x	-	x	x	x	x
CO4	x	x	x	x	-	x
CO5	-	x	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Chemistry of Cleansing Agents (9 Hrs)				
Introduction. Types of soaps - Toilet soaps, washing soaps. Liquid soap. TFM and grades of soaps. Cleansing action of soap. Synthetic surfactants and their mode of actions.	1.1	1	2	Lecture/presentation
Introduction. Types of detergents - anionic, cationic, non-ionic and amphoteric detergents. Common detergent additives. Enzymes used in commercial detergents.	1.2	1	3	Lecture/presentation

Laundry detergents - organic and inorganic builders, inert fillers, fluorescers, foam. Comparison between soaps and detergents. Environmental aspects.				
Bleach - chlorine, sodium perborate, Washing in machines - solid and liquid laundry detergents - compositions, surfactants and their potentiation.	1.3	1	2	Lecture/presentation
Dry cleaning and its effect on the environment, other household cleaning agents (Disinfectants, Sanitizers).	1.4	1	2	Lecture/presentation
Module 2: Understanding Drugs: History, types and path to abuse (6 Hrs)				
Definition – History of drugs, Classification of drugs - Analgesics, Antipyretics, Antihistamines, Antacids, Antibiotics and Psychotropic drugs - Tranquilizers, Antidepressants and Stimulants with examples (structure and synthesis not required, only examples for each category and their mode of action). Drug addiction and abuse.	2.1	2	6	Lecture/presentation
Module 3: Chemistry in Crop Production: Fertilizers, Hormones and Pesticides (9 Hrs)				
Fertilizers – classification- straight, mixed, complex, solid and liquid fertilizers, NPK fertilizers. Manufacture of ammonium salts, urea and superphosphates, biofertilizers - rhizobium, azospirillum and azotobacter.	3.1	3	3	Lecture/presentation
Plant growth hormones- Definition, functions of auxin, gibberellins, cytokinin, abscisic acid and ethylene.	3.2	3	2	Lecture/presentation
Pesticides: – classification, organic and inorganic pesticides with simple examples. Insecticides: use of Insecticides: DDT and BHC. Herbicides - function of 2,4 -D and 2,4,5 – T (only basic idea like structure, properties and their use) (no synthesis/preparation method required)	3.3	3	2	Lecture/presentation
Fungicides- inorganic and organic- Bordeaux mixture. Biopesticides. Excessive use of pesticides – environmental hazards. Artificial growth hormones, pheromone trap and natural pest control.	3.4	3	2	Lecture/presentation
Module 4: Clean Water Chemistry: Chlorination and Waste Water Remediation (9 Hrs)				
Chlorination of swimming pools. Effect of pH. Measuring the amount of chlorine in water. Super chlorination.	4.1	4	1	Lecture/presentation
Water quality index (colour, temperature, pH, dissolved oxygen, BOD, COD), Effluents (definition).	4.2	4	2	Lecture/presentation
Types and characteristics of industrial waste water (Alkaline contamination, cooling & radioactive contaminants, organic pollution, oil or grease contamination, acid or contamination by heavy metals, toxic contaminants and contamination by cleaning agents.	4.3	4	2	Lecture/presentation
Aerobic and anaerobic oxidation - Sedimentation, coagulation, filtration, disinfection, desalination and ion exchange. Trickling filters, activated sludge process and sludge digestion. USAB process and deep well injection. Sewage and sewage analysis. Use and conservation of water resources – Rainwater harvesting.	4.4	4	4	Lecture/presentation

Module 5: The Role of Chemistry in Sports (6 Hrs)				
Cold packs, hydration fluids and sports drinks. Design of suitable materials for clothing and shoes for athletes.	5.1	5	2	Lecture/presentation
Design of materials to be used in sports equipment e.g. football/tennis ball, poles for vaulting, tennis racquets and golf clubs, spikes.	5.2	5	2	Lecture/presentation
Performance testing methods. Blood lactate level testing. Anti-inflammatory drugs. Anabolic steroids. Drug testing at sporting events.	5.3	5	2	Lecture/presentation
Module 6: Chemistry in the Kitchen and in the Atmosphere (6 Hrs)				
Butter and cooking oil - saturated and unsaturated fatty acids, hydrogenation of oil. Chemistry of cooking - physical and chemical changes	6.1	5	2	Lecture/presentation
Stability of nutrients during cooking. Microwave cooking (basic idea of what is happening)	6.2	5	2	Lecture/presentation
Pollution. Acid rain. Ozone layer. Global warming. Green chemistry. Relevant international conventions.	6.3	5	2	Lecture/presentation
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. S. R. Mudambi, S. M. Rao, Food Science, Revised Edn., New Age International, New Delhi, 2015.
2. V. K Ahluwalia, M. Chopra, Medicinal Chemistry, Ane Books Pvt Ltd, 2009
3. R. Stuetz, Principles of Water and Wastewater Treatment Processes, IWA Publishing, 2010
4. B. K. Sharma, Industrial Chemistry, 17th Edition, Krishan Prakashan, 2014.
5. S. C. Rastogi, Biochemistry, 3rd Edition, McGraw Hill Education, 2010

Reference

1. G. L. Patrick, An introduction to medicinal chemistry, 4th Edn, Oxford 2009
2. D. Sriram, P. Yogeeswari; Medicinal Chemistry, 2nd Edn, Pearson, 2011
3. G. L. Karia, R.A. Christian, Wastewater Treatment. Concepts and Design Approach, 2nd Edn, PHI Learning Pvt. Ltd, 2002
4. A.K. De, Environmental Chemistry, New Age International Ltd., New Delhi, 2006
5. J.W. Hill, T.W. McCreary, D. K. Kolb, Chemistry for Changing Times, 12th Edition, Prentice Hall, 2010.
6. Ben Selinger, Chemistry in the Marketplace (5th ed.) Harcourt Brace (1998)
7. Karukstis, Kerry K, Van Hecke, Gerald R, Chemistry Connections, The Chemical Basis of Everyday Phenomena, Harcourt/Academic Press (2003)
8. Luning Prak, Dianne J, Copper, Christine L, A Chemistry Minute: Recognizing Chemistry in Our Daily Lives, J. Chem. Educ, 2008, 85 (10), p 1368

Course designed by: Dr Gejo George

SBU24CH3VAC200: EXPLORING NATURAL RUBBER LATEX: FROM SAP TO FINAL PRODUCTS

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)	Nil		

Course Outcomes

No.	Description	Cognitive Level
CO1	Generate basic idea on natural rubber latex and its characteristics	U
CO2	Understanding latex compounding process and evaluation of compound	U
CO3	Understand latex dipping process	U
CO4	Generate knowledge on how recipe for different latex compounds is derived.	U
CO5	Get an idea of other synthetic latices and their products	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	1	1	1	-	1	1
CO2	1	1	1	1	1	2	1	-	1	1
CO3	1	-	1	-	-	1	1	-	1	1
CO4	2	-	1	-	1	2	1	-	2	1
CO5	1	-	-	-	-	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva	Written test	MCQ	
CO1	x	-	x	x	x	x
CO2	x	x	x	x	x	x
CO3	-	x	x	x	-	x
CO4	x	-	x	x	-	x
CO5	-	x	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Latex Characteristics and Concentration Methods (9 Hrs)				
Brief introduction on polymers (different types of polymers and classification). Definition of Latex, classification, Latex particle size and distribution	1.1	1	2	Lecture/presentation
Factors that control the stability of latex (especially natural rubber latex). Comparison between latices and polymer solutions	1.2	1	2	Lecture/presentation

Natural rubber latex –origin, tapping, bulking and preservation. Composition of field latex, properties, preservation methods.	1.3	1	2	Lecture/presentation
Methods of concentrating latex - creaming, centrifuging, & evaporation. Properties of NR latex (KOH number, Volatile fatty acid number, Dry rubber content, Total solid content)	1.4	1	3	Lecture/presentation
Module 2: Latex Compounding (9 Hrs)				
Latex compounding-Ingredients (crosslinking agent, accelerator, activator, antioxidant). Preparation of Dispersions, Emulsion, Slurries	2.1	2	3	Lecture/presentation
Machineries- Ball mill, Pearl mill. Preparation of latex compound and maturation	2.2	2	3	Lecture/presentation
Prevulcanized latex - Preparation, properties and application. Evaluation of the latex compound- Chloroform number, swelling index test formulation.	2.3	2	3	Lecture/presentation
Module 3: Latex Dipping Process (9 Hrs)				
Principle and types of dipping processes (straight dipping, coagulant dipping and heat-sensitive dipping)	3.1	3	3	Lecture/presentation
Dipping plant design, formers, sequence of operation, post processing	3.2	3	3	Lecture/presentation
Manufacture of Gloves, Catheters, Balloons formulations, process, specification, testing and troubleshooting.	3.3	3	3	Lecture/presentation
Module 4: Latex Foam, Sheeting and Spraying (9 Hrs)				
Principle and Manufacture of Foam-Dunlop and Talalay process	4.1	4	3	Lecture/presentation
Compound design-Process details. Foam properties, testing and defects	4.2	4	3	Lecture/presentation
Foam applications, Latex sheeting; latex binders and carpet backing- Basics and process.	4.3	4	3	Lecture/presentation
Module 5: Extrusion and Products Based on Synthetic Latex (9 Hrs)				
Principle and Manufacture of latex elastic threads; latex tubing; latex casting process specification and testing, defects.	5.1	5	3	Lecture/presentation
Synthetic latex- Types, properties, and application- surface coatings, adhesives, paper industries.	5.2	5	3	Lecture/presentation
Visit to an Industry or R&D lab to understand the processing and how final products are made of any of these materials.	5.3	5	3	Industrial/R&D Visit
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. D. C. Blackley, High Polymer Latice, Vol 1 and 2, Chapman & Hall, 1997
2. R. F. Mausser, The Vanderbilt Latex Handbook, 3rd edition, R.T. Vanderbilt Company, 1987.
3. Calvert, Polymer Latex and Applications, Applied Science Publishing Ltd, 1985.

Course designed by: Dr Gejo George

SEMESTER IV

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH4DSC200	Major	Organic Chemistry - II	5	75	4
SBU24CH4DSC201	Major	Physical Chemistry - I	5	75	4
SBU24CH4DSC202	Minor	Advanced Physical Chemistry - II	5	75	4
SBU24CH4DSC203	Minor	Chemistry in Industry and Agriculture	5	75	4
SBU24CH4DSE200	Elective	Materials Chemistry	4	60	4
SBU24CH4DSE201	Elective	Industrial Chemistry and Entrepreneurship	4	60	4
SBU24CH4SEC200	SEC	Dairy Chemistry	3	45	3
SBU24CH4VAC200	VAC	Environmental Chemistry	3	45	3

SBU24CH4DSC200: ORGANIC CHEMISTRY - II

Type of Course	DSC		
Course Level	200 – 299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic organic chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the basic classifications of alcohols and phenols, describe the general methods for their preparation, outline their fundamental physical and chemical properties, and summarize their basic industrial applications.	U
CO2	Explain the basic structure and significance of ethers, epoxides, thiols, thioethers and esters, describe the fundamental methods for their preparation and the general mechanisms of their reactions, and summarize their applications in organic chemistry.	U
CO3	Understand the fundamental properties, preparation methods, and reaction mechanisms of carbonyl compounds, recognizing their role and applications in organic chemistry.	U
CO4	Understand the structure and reactivity, and synthetic utility of active methylene compounds, particularly in the preparation of diethyl malonate, cyanoacetic ester, and ethyl acetoacetate, and their subsequent use in organic synthesis.	U
CO5	Perform microscale qualitative analysis and prepare derivatives for identification of various organic compounds such as alcohols, phenols, aldehydes, ketones, carboxylic acids, and their derivatives, thereby gaining hands-on experience in organic analytical techniques.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	-	1	2	2	-	1	1
CO2	2	2	2	-	1	2	2	-	1	1
CO3	2	2	2	-	1	2	2	-	1	1
CO4	2	2	2	-	1	2	2	-	1	1
CO5	3	3	1	-	3	3	3	-	2	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment/ Seminar	Viva	Written test	MCQ	
CO1	x	-	x	x	x	x
CO2	x	x	x	x	-	x
CO3	x	-	x	x	x	x
CO4	x	x	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Lab involvement	Viva	Lab Test	Record	
CO1	-	-	-	-		-
CO2	-	-	-	-		-
CO3	-	-	-	-		-
CO4	-	-	-	-		-
CO5	x	x	x	x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Alcohols and Phenols (15 Hrs)				
Introduction to Alcohols and Phenols- Definition and classification of alcohols and phenols. Classification of alcohols: primary, secondary, and tertiary; monohydric, dihydric, and polyhydric. Importance in organic chemistry and biological systems.	1.1	1	1	Lecture/Presentation
Preparation of Alcohols- Preparation of monohydric alcohols: hydroboration, oxidation, reduction of carbonyl compounds, Grignard synthesis. Preparation of dihydric and trihydric alcohols.	1.2	1	2	Lecture/Presentation
Properties and Reactions of Alcohols- Physical properties: hydrogen bonding and acidic nature. Chemical properties: reactions with sodium, esterification and oxidation reactions.	1.3	1	2	Lecture/Presentation
Tests and Transformations of Alcohols -Lucas test, Victor Meyer's test, and Dichromate test for alcohol differentiation. Conversion methods among primary, secondary, and tertiary alcohols. Ascending and descending in alcohol homologous series.	1.4	1	4	Lecture/Presentation
Industrial Aspects of Alcohols: Manufacture of ethanol and methanol, formulation of methylated spirits, and their use as solvents, fuel additives, disinfectants, and chemical intermediates.	1.5	1	1	Lecture/Presentation
Nomenclature, Properties, and Preparation of Phenols: Phenol nomenclature and physical properties, comparison of the acidity of phenols with that of alcohols, and preparation from diazonium salts, sulfonic acids, and industrial sources.	1.6	1	2	Lecture/Presentation
Reactivity and Applications of Phenols: Acidity and the Effect of Substituents. Electrophilic Substitution Reactions including Nitration, Halogenation, and the Reimer-Tiemann Reaction. Uses of Phenols and their Derivatives, such as Catechol, Resorcinol, Quinol, and Picric Acid.	1.7	1	3	Lecture/Presentation

Module 2: Ethers, Epoxides, Thiols, and Thioethers (5 Hrs)				
Introduction to Ethers and Epoxides- An overview of ethers and their importance in organic chemistry, including the structure and stability of ethers. Introduction to epoxides and their significance.	2.1	2	1	Lecture/Presentation
Preparation of Ethers and Epoxides-Williamson's ether synthesis and the alkoxymercuration-demercuration methods for synthesizing ethers. Preparation of epoxides by the epoxidation of alkenes using peroxyacids like mCPBA.	2.2	2	1	Lecture/Presentation
Reactions of Ethers and Epoxides-Cleavage reactions of ethers with acids. Reactions of epoxides with alcohols, ammonia derivatives, and LAH. Claisen Rearrangement and Zeisel's method for estimating alkoxy groups.	2.3	2	2	Lecture/Presentation
Thiols, Thioethers, and Crown Ethers-Preparation and reactions of thiols and thioethers. Introduction to crown ethers.	2.4	2	1	Lecture/Presentation
Module 3: Carbonyl Compounds (15 Hrs)				
Introduction to Carbonyl Compounds- Nomenclature and classification of carbonyl compounds. Comparison of reactivity of aldehydes and ketones.	3.1	3	1	Lecture/Presentation
Preparation of Aldehydes and Ketones- From alcohols using oxidizing agents: chromic acid, Collins reagent, Oppenauer oxidation, Swern Oxidation. Catalytic dehydrogenation and Rosenmund reduction.	3.2	3	3	Lecture/Presentation
Reactivity and Properties of Carbonyl Compounds- Acidity of alpha hydrogen and enolization reactions. Nucleophilic Addition Reactions: Mechanisms involving nucleophiles such as water, alcohols, ammonia, derivatives, Grignard reagents, and cyanide. Addition of bisulfate.	3.3	3	4	Lecture/Presentation
Condensation Reactions and Rearrangements- Aldol, Perkin, Benzoin and Knoevenagel condensation reactions. Mannich, Wittig and Cannizzaro reaction. Beckmann rearrangement reaction.	3.4	3	4	Lecture/Presentation
Oxidation and Reduction of Carbonyl Compounds- Baeyer-Villiger oxidation. Reduction with sodium borohydride ($NaBH_4$) and lithium aluminum hydride ($LiAlH_4$). Clemmensen, Wolff-Kishner and MPV reduction.	3.5	3	3	Lecture/Presentation
Module 4: Esters (5 Hrs)				
Introduction and Preparation of Esters - Brief overview of esters and their role in organic chemistry. Preparation of Esters from carboxylic acids and alcohols. Conversion of acid chlorides to esters with alcohols. Trans-esterification reaction- its role in biodiesel production.	4.1	2	2	Lecture/Presentation
Reactivity and Reaction Mechanisms- Hydrolysis of Esters: Acid hydrolysis mechanism. Base hydrolysis (saponification) mechanism and its significance in the industrial production of soaps. Introduction to advanced	4.2	2	2	Lecture/Presentation

reactions- Claisen Condensation, Dieckmann Condensation and Reformatsky reaction.				
Applications and Transformations - Conversion of Esters to acids via hydrolysis, to amides through aminolysis, to primary and secondary alcohols via reduction.	4.3	2	1	Lecture/Presentation
Module 5: Active Methylene Compounds (5 Hrs)				
Introduction to Active Methylene Compounds -Definition of active methylene compounds. General properties and reactivity of active methylene groups. Keto-enol tautomerism and its relevance to the stability of active methylene compounds.	5.1	4	2	Lecture/Presentation
Preparation and Synthetic Applications of Diethyl Malonate -Structure and preparation of diethyl malonate. Alkylation and acylation reactions of diethyl malonate. Malonic ester synthesis of carboxylic acids.	5.2	4	1	Lecture/Presentation
Structure and Synthetic Applications of Cyanoacetic Ester-Structure and preparation of cyanoacetic ester. Role in the synthesis of amino acids, heterocycles, and other organic compounds.	5.3	4	1	Lecture/Presentation
Synthetic Applications of Ethyl Acetoacetate-Structure and preparation of ethyl acetoacetate. Use of ethyl acetoacetate in the synthesis of ketones and carboxylic acids.	5.4	4	1	Lecture/Presentation
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., Golden Jubilee Year Edition, 2020.
2. A. Bahl, B. S. Bahl, Advanced Organic Chemistry, S. Chand, 2012.
3. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd ed., Oxford University Press, 2014.

Reference

1. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th ed., Pearson Education India, 2010.
2. T. W. Graham Solomon, C. B. Fryhle, S. A. Snyder, Organic Chemistry, Wiley, 2014.
3. J. McMurry, Organic Chemistry, 7th ed., Cengage Learning, 2013.
4. L. Finar, Organic Chemistry, Vol. 1 & 2, Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry: Part A: Structure and Mechanisms, Springer Science & Business Media, 2007.
6. R. O. C. Norman, J. M. Coxon, Principles of Organic Synthesis, Routledge, 2017.
7. S. H. Pine, Organic Chemistry, Tata McGraw-Hill, 2014.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Organic Analysis (30 Hrs)				
Qualitative Microscale analysis of organic compounds- Identification and preparation of derivatives of alcohols, phenols, aldehydes, ketones, carboxylic acid, and carboxylic acid derivatives.	7.1	5	30	Demonstration, Hands-on experiments, Analysis, and Discussions

Textbook

1. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry- Qualitative Analysis, University Press, 2000.

Reference

1. B. S. Furniss, A. J. Hannaford, V. Rogers, P. W. G. Smith, A. R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5th ed., Pearson Education, 2005.
2. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4th ed., Pearson Education, 2009.

Course designed by Dr Shijo K Cherian

SBU24CH4DSC201: PHYSICAL CHEMISTRY - I

Type of Course	Major		
Course Level	200		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Knowledge of basic thermodynamics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Define phases and phase rule, describe phase diagram of different types of systems	U
CO2	Describe different types of solutions and principle behind distillation process	A
CO3	Explain critical solution temperature and determine the critical solution temperature from experiments	U
CO4	Acquire knowledge on colligative properties and solve problems based on colligative properties	U
CO5	Able to apply the principles of phase equilibrium in constructing phase diagrams of various systems, conduct experiments based on colligative properties	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	-	2	-	-	-	-
CO2	1	-	-	-	-	2	-	-	1	-
CO3	2	-	-	-	-	2	-	-	-	-
CO4	2	-	-	-	-	2	-	-	1	-
CO5	1	1	-	-	2	2	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva	Written test	MCQ	
CO1	x	x	x	x	x	x
CO2	x	-	x	x	x	x
CO3	x	-	x	x	x	x
CO4	x	-	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Viva	MCQ	Lab Test	Record	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Phase Equilibrium (15 Hrs)				
Concept of phases, components and degrees of freedom, condition for equilibrium between phases, Gibbs phase rule, derivation	1.1	1	2	Lecture/ICT enabled class
One component system: water and sulphur systems	1.2	2	1	”
Two component systems: solid - liquid equilibrium - simple eutectic system, general phase diagram	1.3	2	2	”
Lead - silver system, potassium iodide - water system	1.4	2	2	”
Thermal analysis, cooling curve, freezing mixtures	1.5	2	1	Lecture/ICT enabled class
Formation of compounds with congruent melting point and incongruent melting point - general phase diagrams	1.6	2	2	”
Three component system, phase diagram of acetic acid-chloroform-water system	1.7	2	2	”
Nernst distribution law - derivation and applications	1.8	2	3	”
Module 2: Solutions (30 Hrs)				
Raoult’s law, ideal and non - ideal solutions, positive and negative deviations from ideality	2.1	3	4	Lecture/ICT enabled class
Fractional distillation, distillation of immiscible liquids	2.2	3	4	”
Solubility of partially miscible systems – critical solution temperature; UCST and LCST	2.3	4	3	”
Henry’s laws and its applications	2.4	5	4	Lecture/ICT enabled class
Colligative Properties: Thermodynamic derivation using chemical potential to derive relations between the four colligative properties (i) relative lowering of vapour pressure (ii) elevation of boiling point, (iii) depression of freezing point and (iv) osmotic pressure and amount of solute.	2.5	5	5	”
Applications in calculating molar masses of normal dissociated and associated solutes in solution, van’t Hoff factor, applications	2.6	5	5	”
Problems based on theory	2.7	5	5	Collaborative learning
Module 3: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. B. R. Puri, M. S. Pathania, L. R. Sharma, Principles of Physical Chemistry, 48th Edn., Vishal Publishing Co., 2020
2. K. L. Kapoor, A Textbook of Physical Chemistry: Thermodynamics and Chemical Equilibrium, Vol. 2, 5th Edn., McGraw Hill Education, 2015

Reference

1. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics: Classical, Statistical and Irreversible, Pearson Education, 2013
2. P. Atkins, J. de Paula, Atkin's Physical Chemistry, 11th Edn., Oxford University Press, 2018
3. T. Engel, P. Reid, Physical Chemistry, 3rd Edn., Pearson, 2013

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 4: Physical Chemistry Practical (30 Hrs)				
Determination of the transition temperature of sodium thiosulphate.	4.1	5	2	Practical experiments
Determination of the transition temperature of sodium acetate.	4.2	5	2	”
Construction of phase diagrams of simple eutectics.	4.3	5	6	”
Construction of phase diagram of compounds with congruent melting point: diphenyl amine-benzophenone system.	4.4	5	6	”
Critical solution temperature (CST) of phenol-water system	4.5	5	2	”
Estimation of unknown concentration of KCl using CST	4.6	5	4	”
Estimation of unknown concentration of NaCl using CST	4.7	5	2	”
Determination of molecular weight by Rast's Method (using naphthalene, camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene as solute)	4.8	5	4	”
Determination of heat of neutralization of strong acid and strong base, weak acid and strong base, heat of solution of KNO_3	4.9	5	2	”

Textbook

1. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999
2. V. D. Athawale, Parul Mathur, Experimental Physical Chemistry, New Age International Publications, 2008
3. B. Viswanathan, P. S. Raghavan, Practical Physical Chemistry, Viva Books Pvt. Ltd., 2005

Course designed by Dr Bejoy Francis

SBU24CH4DSE200: MATERIALS CHEMISTRY

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	Basic inorganic chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the fundamentals of structure of materials	U
CO2	Provide the structure and properties of different class of materials	A
CO3	Analyse the properties of inorganic polymers and extraction of metals	An
CO4	Discuss the properties and applications of various class of materials for energy production	U
CO5	Describe the properties and applications of biomaterials	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	1	-	-	1	-	-	-	-
CO2	-	-	1	-	-	1	-	-	-	-
CO3	-	-	1	-	-	1	-	-	-	-
CO4	-	2	1	-	2	1	-	-	1	2
CO5	-	2	2	-	2	1	-	-	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	-	x
CO3	-	-	x	x	x	x
CO4	x	-	x	x	-	x
CO5	x	-	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Structure of Materials (10 Hrs)				
Types of bonds, construction and characteristics of electrovalent, covalent, coordinate, hydrogen and metallic bonds, Intermolecular force of attraction.	1.1	1	2	Lecture/PPT
Classification and characteristics of crystals- Molecular crystal (water molecule), Covalent crystal (graphite and diamond), Ionic crystal (NaCl and CsCl) and Metallic crystal	1.2	1	2	Lecture/PPT

Molecular arrangement in solid. Difference between crystalline and amorphous solids, Concept of crystalline structure	1.3	1	1	Lecture/PPT
Structure of metal-unit cell, close packing of spheres-BCC, FCC and HCP. Examples and properties of metallic structures, packing efficiency, voids, radius ratio, Packing fraction, number of particles in unit cell, density of unit cell. Space lattice and unit cell, Bravais Lattices	1.4	1	4	Lecture/PPT
Physical, chemical, electrical, electromagnetic and thermal properties of materials	1.5	1	1	Lecture/PPT
Module 2: Chemistry of Materials (15 Hrs)				
Nanomaterials – classification (0D, ID, 2D and 3D) and size-dependent properties	2.1	2	2	Lecture/PPT
Synthesis of nanomaterials – chemical precipitation, mechanic-chemical method, micro emulsion method, reduction technique, chemical vapour deposition and sol-gel method (brief study).	2.2	2	3	Lecture/PPT
Refractory materials: carbides, nitrides, borides - properties and applications	2.3	2	3	Lecture/PPT
Graphite and graphite oxide, intercalation compounds of alkali metals, carbon monofluoride, intercalation compounds of graphite with metal halides	2.4	2	3	Lecture/PPT
Glass, silicates, zeolites, ultramarines and ceramics	2.5	2	2	Lecture/PPT
Alloys-major elements, reasons to add and important effect on material properties, Ferrous metals, Classification, Steels- Plain carbon steel, alloy steel including stainless steel and cast iron.	2.6	2	2	Lecture/PPT
Module 3: Inorganic Polymers and Metallurgy (10 Hrs)				
Types of inorganic polymers, comparison with organic polymers	3.1	3	1	Lecture/PPT
Synthesis, structural aspects and applications of silicones and siloxanes, phosphazenes.	3.2	3	3	Lecture/PPT
Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent.	3.3	3	2	Lecture/PPT
Electrolytic Reduction, Hydrometallurgy	3.4	3	2	Lecture/PPT
Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining	3.5	3	2	Lecture/PPT
Module 4: Materials for Energy (10 Hrs)				
Photovoltaics: Solar energy and energy conversion, fundamentals of semiconductors and photovoltaic cells. I-V plot and efficiency parameters.	4.1	4	2	Lecture/PPT
Advancement in photovoltaic research and design of new generation solar cells - hybrid, quantum dot, dye-sensitized and perovskite solar cells. (Brief idea only)	4.2	4	2	Lecture/PPT
Basic concepts of Batteries, Primary and rechargeable batteries, Li-ion Battery.	4.3	4	2	Lecture/PPT

Fuel cells: Hydrogen- oxygen cell and hydrocarbon - oxygen cell. Storage cells. Lead storage cell and Nickel cadmium cell	4.4	4	2	Lecture/PPT
Photoactive polymers: Photo conducting polymers, polymers used in optical applications, Light emission in polymers, Semi conducting materials as light emitting materials.	4.5	4	2	Lecture/PPT
Module 5: Biomaterials (15 Hrs)				
Biomaterials: Introduction to classes of materials used in medical applications: Metals, polymers, ceramics, bioresorbable and biodegradable materials, coatings and medical fibres.	5.1	5	2	Lecture/PPT
Dental materials: Introduction to dental materials; polymers, ceramics and metals, applications of dental materials, physico-chemical, mechanical, toxicological and in vitro clinical performance of dental materials and implants.	5.2	5	3	Lecture/PPT
Smart biomaterials: Stimuli responsive polymers (pH, temperature, light, magnetic and biomolecules) and their applications as biomaterials. Stimuli responsive hydrogels	5.3	5	3	Lecture/PPT
Polymers in drug delivery: Introduction to polymeric drug delivery systems, Targeted drug delivery. Passive or active targeting, polymer-protein conjugates, polymer drug-conjugates. Application of hydrogels in controlled drug delivery systems.	5.4	5	4	Lecture/PPT
Nano biomaterials: Interaction of bio-molecules and nano particle surfaces. Biocompatible nanomaterials, Nanogels and microgels: preparation methods, characterization and applications.	5.5	5	3	Lecture/PPT
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, M.S. Pathania, L. R. Sharma, Principles of Physical Chemistry, 48 th Edition, Vishal Publishing Co., 2020
2. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co., Jalandhar, 2020
3. T. Pradeep, Nano; The Essentials, Mc Graw-Hill Education, New Delhi, 2006
4. A. Cottrel, An Introduction to Metallurgy, 2nd Edn., Universities Press, 1975
5. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., Wiley Interscience, 1999

Reference

1. L.V. Azaroff, Introduction to Solids, McGraw Hill, 1984
2. A.R. West, Solid-State Chemistry and its Applications, Wiley-India, 2007
3. D. K. Chakrabarty, Solid State Chemistry, New Academic Science, 2010
4. D. M. Adams, Inorganic Solids: An Introduction to Concepts in Solid-State Structural Chemistry, Wiley, 1974
5. Principles of the Solid State, H.V.Keer, Wiley Eastern, New Delhi 1993

6. J. E. Mark, H. R. Allcock and R. West, Inorganic Polymers, Prentice Hall, Englewood Cliffs, NJ, 1992.
7. C.N.R. Rao, Chemical approaches to synthesis of inorganic materials, Ist Edn, Wiley, 1995
8. V. Chandrasekhar, Inorganic and Organometallic Polymers, Springer, Berlin, 2005
9. A Padinjakkara, A Thankappan, F. G. Souza, Jr. and S Thomas, Biopolymers and Biomaterials, CRC Press, Taylor and Francis group 2021.

Syllabus designed by: Dr Renchu Scaria

SBU24CH4DSE201: INDUSTRIAL CHEMISTRY AND ENTREPRENEURSHIP

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	Basic principles of chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	To identify the chemical constituents of various industrial products	U
CO2	To explain the preparation/production/formulation of industrial products	U
CO3	To describe the concept and characteristics of entrepreneurship	U
CO4	To identify opportunities, incentives, and grants for entrepreneurship	An
CO5	To apply for funds and set up a chemical industry/start- ups	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	-	-	-	1	-	-	-	-
CO3	1		-	-	-	1	-	-	-	-
CO4	-	-	1	-	-	-	1	-	-	-
CO5	-	-	-	-	1	-	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva	Written test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	-	x	x	x	x
CO3	-	x	x	x	x	x
CO4	-	x	x	x	x	x
CO5	x	-	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Industrial Chemistry – Part A (15 Hrs)				
Preparation of domestically useful chemical products Soap, washing powder, dish washing liquid, toilet lotion, toilet air freshener, shampoo, soap oil, face powder, pain balm, hand wash, sanitisers.	1.1	1,2	2	Lecture/ PowerPoint
Pulp & Paper Raw materials, methods of pulping, general principles of some mechanical and chemical pulping, production of	1.2	1, 2	2	Lecture/ PowerPoint

sulphate and sulphite pulp. production of paper, wet process, paper properties testing, fibre revery.				
Soap & Detergents Introduction, manufacture of soaps and detergents, emulsions and their characteristics, industrial applications: smoke precipitation, purification of water, tanning of leather and sewage disposal.	1.3	1, 2	2	Lecture/ PowerPoint
Cosmetics and Perfumes Introduction, ingredients of shampoos, lotions, creams, hair sprays & hair dyes, tooth powders & tooth pastes. synthesis of some important synthetics chemicals used in perfume industry: citral, geraniol, linalool, eugenol, civetone, vanillin, citronellol, benzyl acetate; perfume formulation, some representative formulation of rose, jasmine, sandal wood and lavender	1.4	1, 2	3	Lecture/ PowerPoint
Ayurvedic and naturopathic medicines from Indian medicinal plants Palak, Vallarai, Kizhanelli, Thumbai, Hibiscus, Adadodai, Thoothuvalai, Nochi, Thulasi, Aloe vera - Chemical nstituents and medicinal uses	1.5	1, 2	2	Lecture/ PowerPoint
Spice extraction Extraction of Oleoresins – concept and importance of oleoresins in food processing, processing of spices like chili, turmeric, pepper, ginger etc. for solvent extraction of Oleoresins technology, desolventization methods. Extraction of Natural Food Colours - Extraction of Natural Food colours from paprika, turmeric, blue grapes, beet root etc. Their importance in food processing	1.6	1, 2	4	Lecture/ PowerPoint
Module 2: Industrial Chemistry – Part B (15 Hrs)				
Glass & Ceramics Different types of glasses, raw materials, manufacture of glasses, glass fibers, ceramics and refractory, annealing, finishing. Raw materials of ceramics and manufacturing of porcelain and china clay.	2.1	1, 2	2	Lecture/ PowerPoint
Cement Types and properties, chemical composition, manufacture of Portland cement, setting and hardening of cement, reaction in the kiln, mixing of additives, manufacturing of lime, gypsum and plaster of Paris.	2.2	1, 2	2	Lecture/ PowerPoint
Heavy & Fine Chemicals Explanation of the terms heavy (bulk) and fine (speciality) chemicals; industrial production and uses of gases / solids: H_2, NH_3, Cl_2, NaCl; industrial production and uses of acids / bases: HCl, H_2SO_4, NaOH, and Na_2CO_3; industrial importance of boron compounds: Borax and boric acid; industrial oxidizing and reducing agents: $KMnO_4$, $K_2Cr_2O_7$, H_2O_2 and $Na_2S_2O_3$.	2.3	1, 2	3	Lecture/ PowerPoint
Fertilizers Industrial manufacturing of urea, ammonium sulphate, ammonium nitrate; manufacturing process of phosphatic	2.4	1, 2	4	Lecture/ PowerPoint

fertilizers: single and triple super phosphates; manufacturing of phosphoric acid by electric furnace process; commercial potassic fertilizers: manufacturing process of potassium sulphate, diammonium phosphate. mixed fertilizers, bio-fertilizers.				
Alloys Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon, decarbonization, demanganization, desulphurization, dephosphorisation) and surface treatment (argon treatment, heat treatment nitriding, carburizing). Composition and properties of different types of steels.	2.5	1, 2	4	Lecture/ PowerPoint
Module 3: Paint and Latex Technology (15 Hrs)				
Dyes & Paints Synthesis and applications of azo, phthalene, xanthene, rhodamine, anthraquinone, indigoid, phthalocyanine dyes. properties of coating, paints, plasticizers, dyes and bioactive additives, Pigmentation: pigments and paint making, Solvents: chemistry and physics of solvents and diluents, paint formulations, Paint additives: modifying application, curing and appearance,	3.1	1, 2	3	Lecture/ PowerPoint
Lacquers, emulsion paints and non-aqueous dispersions: paints drying by evaporation, Oil and alkyd paints: paints drying through oxidation, Thermosetting alkyd, polyester and acrylic paints: paints based on nitrogen resins, Epoxy coatings: paints based on epoxy resins, polyurethanes: isocyanate-based coatings	3.2	1, 2	4	Lecture/ PowerPoint
Latex Chemistry NR & Synthetic lattices & their constitution. Types of NR lattices, Latex versus dry rubber. Pre-processing of latex, Pre- coagulation, anticoagulants for short term preservation. Different type of preservative used for latex stabilization, Dosage of preservatives, Latex concentration processes – Evaporation, Electrodecantation, Creaming, Centrifugation, Standard specifications.	3.3	1, 2	4	Lecture/ PowerPoint
Physical modification of latex, Chemical modification of latex – Prevulcanized latex, Hydroxyl amine modified latex (HRH latex), Deprotenized latex, Compounding of Latex – vulcanizing agent, accelerators, anti-oxidants, fillers and pigments, viscosity modifies. Latex products – Dipped latex products, Foamed latex products, Latex casting, Latex spreading.	3.4	1, 2	4	Lecture/ PowerPoint
Module 4: Entrepreneurship (15 Hrs)				
Concepts of Entrepreneurship Development, Evolution of the concept of Entrepreneur	4.1	3	1	Lecture/ PowerPoint
Attributes and Characteristics of a successful Entrepreneur	4.2	3	1	Lecture/ PowerPoint

Role of Entrepreneur in Indian economy and developing economies with reference to Self -Employment Development	4.3	3	2	Lecture/ PowerPoint
Entrepreneurial Culture	4.4	3	1	Lecture/ PowerPoint
Business Planning Process, Environmental Analysis - Search and Scanning, Identifying Problems and opportunities	4.5	4	2	Lecture/ PowerPoint
Defining Business Idea, Basic Government Procedures to be complied with, Technical, Financial, Marketing, Personnel and Management Feasibility	4.6	4	2	Lecture/ PowerPoint
Estimating and Financing funds requirement -Schemes offered by various commercial banks and financial institutions like IDBI, ICICI, SIDBI, SFCs, Venture Capital Funding.	4.7	4	2	Lecture/ PowerPoint
Role of Central Government and State Government in promoting Entrepreneurship	4.8	4	1	Lecture/ PowerPoint
Introduction to various incentives, subsidies and grants, Fiscal and Tax concessions available	4.9	4	1	Lecture/ PowerPoint
Role of following agencies in the Entrepreneurship Development -District Industries Centres (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB), National Innovation Foundation, Atal Innovation Mission, Startup India, Kerala Startup Mission, Innovation Grant Scheme	4.10	4	2	Lecture/ PowerPoint
Drafting of proposal based on a small scale industry/innovative idea - start up	4.11	4,5	1	Lecture/ PowerPoint
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. K. Sharma, Industrial Chemistry, 17th Edn. Krishan Prakashan, 2014
2. David H. Holt, Entrepreneurship: New Venture Creation, Prentice Hall PTR, 1992.

Reference

1. V. Nagawade, Industrial Chemistry, Nirali Prakashan, Educational, 2016
2. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Entrepreneurship, McGraw-Hill Education, 2013.

Course designed by: Prof. Dr. Tomlal Jose E

SBU24CH4DSC202: ADVANCED PHYSICAL CHEMISTRY - II

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Illustrate laws of photochemistry related to photochemical and photophysical processes.	U
CO2	Correlate molecular symmetry with group theory and identify the molecular point groups.	A
CO4	Summarize various molecular transitions (rotational, vibrational, electronic and nuclear) associated with light-matter interaction	An
CO4	Differentiate between various crystal systems, packing arrangements and defects in the solid state.	A
CO5	Acquire knowledge in performing various physical chemistry experiments in the laboratory.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	-	-	1	1	-	-	-
CO2	-	-	-	-	-	1	1	-	-	-
CO3	-	-	-	-	-	1	1	-	-	-
CO4	-	-	-	-	-	1	-	-	-	-
CO5	-	1	-	-	1	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Assignment	Written test	MCQ	
CO1	-	x	-	x	x	x
CO2	-	x	-	-	x	x
CO3	x	-	x	x		x
CO4	x	-	x	-	x	x
CO5	-	x	x	x	-	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva voce	Lab test	Laboratory report	
CO1	x	-	x	x	-	x
CO2	x	-	x	x	x	x
CO3	-	x	x	-	x	x
CO4	x	-	x	x	x	x
CO5	x	x	-	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Photochemistry (8 Hrs)				
Definition, difference between thermal and photochemical reactions	1.1	**1**	2	Lecture/PPT
Jablonski diagram, fluorescence and phosphorescence	1.2	1,2	1	Lecture/PPT
Laws of Photochemistry - Beer - Lambert's law, Grothus - Draper law and Stark - Einstein law, Quantum yield	1.3	3	2	Lecture/PPT
Experimental determination. Various types of actinometers, examples of reactions with high and low quantum yield and explanation	1.4	4	2	Lecture/PPT
Photosensitisation, chemiluminescence.	1.5	1,5	1	Lecture/PPT
Module 2: Molecular Symmetry and Group Theory (7 Hrs)				
Elements of symmetry of molecules: identity, proper axis of rotation, reflection plane	2.1	1	2	Lecture/PPT
inversion centre, improper axis of rotation, Schonflies notation.	2.2	1,2	1	Lecture/PPT
Combinations of symmetry operations, mathematical group, point groups of simple molecules - CO_2, BF_3, NH_3, H_2O, trans-dichloroethylene	2.3	3,4	2	Lecture/PPT
Group multiplication table for C_2v, C_3v and C_2h.	2.4	5	2	Lecture/PPT
Module 3: Molecular Spectroscopy (15 Hrs)				
Interaction of electromagnetic radiation with matter, energy levels in molecules.	3.1	1	2	Lecture/PPT
Rotational spectrum, rigid rotator, expression for energy, selection rule, calculation of bond length, moment of inertia.	3.2	1,2	2	Lecture/PPT
Vibrational spectra of diatomic molecules: simple harmonic oscillator, selection rule, vibrational modes of CO_2 and H_2O, calculation of force constant.	3.3	3	2	Lecture/PPT
Raman spectroscopy: brief description, Stokes and anti-Stokes lines and their intensity difference, rotational Raman spectrum and its selection rules, mutual exclusion principle.	3.4	3,4	3	Lecture/PPT
Electronic spectroscopy: UV spectrum, absorption maximum, chromophore, auxochrome, red shift, blue shift, types of transition. Frank - Condon principle, dissociation energy of diatomic molecule.	3.5	3,5	2	Lecture/PPT
NMR spectroscopy: principle, number of signals, position of signals, chemical shift, intensity of signals, spin-spin coupling, NMR spectra of simple organic molecules.	3.6	4	2	Lecture/PPT
ESR spectroscopy: theory, hyperfine splitting of methyl radical.	3.7	4,5	2	Lecture/PPT
Module 4: Solid State (15 Hrs)				
Law of constancy of interfacial angles, crystal systems, space lattice, unit cell, Bravais lattices.	4.1	1	2	Lecture/PPT

Law of rational indices, Miller indices, interplanar spacing in a crystal system	4.2	2	2	Lecture/PPT
Bragg equation – derivation, brief description of rotating crystal method and powder method, x-ray diffraction patterns of cubic system	4.3	3	2	Lecture/PPT
structure of NaCl and CsCl, types of crystals	4.4	4,5	2	Lecture/PPT
Close packing of spheres, hcp, ccp, tetrahedral and octahedral voids. Defects of crystals: Nonstoichiometric and stoichiometric defects	4.5	5	2	Lecture/PPT
Point defects, Schotky and Frenkel defects, (derivation required) metal excess defects, metal deficiency defects.	4.6	4	3	Lecture/PPT
Liquid crystals: classification and its applications (theory not required).		4,5	2	Lecture/PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R Puri, L. R Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 60th edition, Vishal Publishing Company, 2020.
2. Gurdeep Raj, Advanced Physical Chemistry, 39th Edition, Krishan Prakashan, 2014.

Reference

1. C. N Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, McGraw Hill Education, 2017.
2. Y. R. Sharma, Elementary Organic Spectroscopy, 5th Edition, S. Chand & Company Ltd., New Delhi, 2013.
3. P. W. Atkins, Physical Chemistry, 9th Edition, Oxford University Press, 2009.
4. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, 2nd Edition, New Age International Pvt. Ltd., 2020.
5. L. V. Azaroff, Introduction to Solids, 34th Reprint, Mc Graw Hill, 2010.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: CST (4 Hrs)				
CST of phenol water system, estimation of unknown concentration of KCl and NaCl using CST	6.1	1,5	2	Lab work
Determination of CST of phenol water system using a spreadsheet	6.2	2,3	2	Lab work
Module 7: Transition temperature of salt hydrates (8 Hrs)				
Determination of the transition temperature of sodium thiosulphate	7.1	1	2	Lab work
Determination of the transition temperature of sodium acetate	7.2	2	2	Lab work
Determination of the transition temperature using a spreadsheet.	7.3	2,3	2	Lab work

Determination of the transition temperature of sodium sulphate decahydrate	7.4	4,2	2	Lab work
Module 8: Determination of molecular weight (6 Hrs)				
Determination of molecular weight by Rast's Method (using naphthalene as solvent, Biphenyl as solute)	8.1	3	2	Lab work
Determination of molecular weight by Rast's Method (using naphthalene as solvent, Biphenyl amine as solute)	8.2	4	2	Lab work
Determination of molecular weight by Rast's Method (using naphthalene as solvent, acetanilide, p-dichlorobenzene as solute)	8.2	5	2	Lab work
Module 9: Determination of heat of solution (4 Hrs)				
Determination of heat of solution of potassium nitrate in water	9.1	3	2	Lab work
Determination of heat of solution of ammonium chloride	9.2	4	2	Lab work
Module 10: Polarimetry (4 Hrs)				
Determine the specific rotation of sugar using a polarimeter	10.1	5	2	Lab work
Module 11: Phase Diagram (6 Hrs)				
Construct the phase diagram of naphthalene diphenyl amine system	11.1	3	3	Lab work
Construct the phase diagram of naphthalene alpha-naphthyl amine system	11.2	2	3	Lab work

Reference

1. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999
2. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press, 2009
3. J. B. Yadav, Advanced Practical Physical Chemistry, 29thEdn., Krishna Prakashan Media Pvt. Ltd., 2010.
4. R. C. Das, B. Behera, Experiments in Physical Chemistry, Tata McGraw-Hill, 1983
5. K. K. Sharma, An Introduction of Practical Chemistry, Vikas Publishing House, New Delhi, 2003

Course designed by: Dr Sam John

SBU24CH4DSC203: CHEMISTRY IN INDUSTRY AND AGRICULTURE

Type of Course	Minor for Biological Science		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the chemistry behind drugs	U
CO2	Learn the chemistry of pesticides and fertilizers	R
CO3	Comprehend the formulations of personal care products	R
CO4	Understand food additives, food adulterants and chemistry involved in ayurveda and industry.	U
CO5	Analyse the ions in fertilizer samples and common adulterants in milk sample	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-		-	-	-	1	-	-	-
CO2	1	-	2	-	-	-	1	-	-	-
CO3	1	-	1	-	-	-	1	-	-	-
CO4	1	-	1	-	-	-	1	-	-	-
CO5	-	1	-	-	1	-	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Assignment	Written test	MCQ	
CO1	x	x	-	x	-	x
CO2	x	-	-	x	-	x
CO3	x	x	-	x	x	x
CO4	x	-	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab Involvement	Assignment	Viva	Lab test	Laboratory Report	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Chemistry of Drugs, Cosmetics and Cleansing Agents (15 Hrs)				
Classification of drugs. Structure, therapeutic uses and mode of action (synthesis not required) of Antibiotics: Ampicillin and Chloramphenicol. Sulpha drugs: Sulphanilamide.	1.1	1	5	Lecture
Antipyretics: Paracetamol, Analgesics- Aspirin and Ibuprofen, Antacids-Ranitidine, Antimalarials: Chloroquine. Anti-cancer drugs: Chlorambucil and Anti-HIV agents: Azidothymidine (Zidovudine). Psychotropic drugs: Tranquilizers, antidepressants and stimulants with examples. Radioisotopes in medicine: diagnosis of thyroid tumor, magnetic resonance imaging of diseased organs (thyroid, brain, kidney), diagnosis of heart disorders, treatment of thyroid cancer and blood cancer, radiation therapy in cancer. Drug addiction and abuse.	1.2	1	5	Lecture
Cosmetics: definition, shampoos, hair dyes, face wash, moisturizing cream and shaving cream. Talcum powder, antiperspirants and deodorants, toothpaste, mouth wash (composition and action).	1.3	1	2	Lecture
Cleansing agents: Soaps definition, classification of soaps and composition- toilet soaps, washing soaps and liquid soap. TFM and grades of soaps. Cleansing action of soaps. Detergents - definition, types of detergents - anionic, cationic, non-ionic and amphoteric detergents. Common detergent additives. Environmental aspects.	1.4	1	3	Lecture
Module 2: Chemistry of Fertilizers, Pesticides and Plant Hormones (15 Hrs)				
Fertilizers - classification- straight, mixed and complex, NPK fertilizers. Nano urea- preparation and advantages Biofertilizers- Nitrogen-Fixing Biofertilizers, Phosphate-Solubilizing Biofertilizers, Potassium Solubilizing Biofertilizers, Plant Growth-Promoting Rhizobacteria (PGPR), Mycorrhizal Fungi and Cyanobacteria (Blue-Green Algae) Biofertilizers	2.1	2	5	Lecture
Pesticides: classification, examples. Insecticides: Preparation and use of Insecticides: DDT and BHC. Herbicides – structure and function of 2,4 -D and 2,4,5 T Biopesticides. Excessive use of pesticides, environmental hazards	2.2	2	5	Lecture
Plant growth hormones- Definition, functions of auxin, gibberllines, cytokinins, abscisic acid and ethylene. Artificial hormones used in agriculture and horticulture-functions.	2.3	2	5	Lecture

Module 3: Chemistry of Food Additives, Textile, Ayurvedic Plants and Paper Manufacturing (15 Hrs)				
Food Additives: Food preservatives, artificial sweeteners, flavours, emulsifying agents, antioxidants, leavening agents and flavour enhancers (definition and examples, structures not required). Commonly used permitted and non-permitted food colours (structures not required). Food adulterants.	3.1	3	4	Lecture
Textile Industry- Fiber production (natural and synthetic fibers), dyeing and printing. (basics only)	3.2	4	3	Lecture
Ayurvedic plants and bioactive components-Ashwagandha (Withania somnifera), Tulsi (Ocimum sanctum), Neem (Azadirachta indica), Brahmi (Bacopa monnieri), Amla (Phyllanthus emblica), Turmeric (Curcuma longa), Extraction techniques of bioactive components- (basics only)	3.3	4	5	Lecture
Paper manufacturing Industry- pulping, bleaching, refining, sizing, colouring, and coating. (basics only)	3.4	4	3	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Vikas Publishing Co., Jalandhar, 2020.
2. G. R. Chatwal, Synthetic Drugs, Himalaya Publishing House, 2016.
3. B. K. Sharma, Industrial Chemistry, 17th Edition, Krishan Prakashan, 2014.

Reference

1. A. O. Bentley, J.E. Driver, L. M. Atherden – Bentley and Drivers' Text Book of Pharmaceutical Chemistry, 1969.
2. M. Vimaladevi, Textbook of Herbal Cosmetics, CBS Publisher, 2019.
3. O. P. Agarwal, Chemistry of Organic Natural Products Vol. I, 40th Edition, Krishna Prakashan Media Pvt. Ltd., Meerut, 2010.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Text Book of Organic Chemistry, 2nd Edition, Vikas Publishing Pvt. Ltd., 2003.
5. G. Patrick, Medicinal Chemistry, Garland Science, 5th Edition., 2013.
6. J.W. Hill, T.W. McCreary, D.K. Kolb, Chemistry for Changing Times, Prentice Hall, 12th Edition, 2010.
7. R. Magazine, Drugs and Cosmetics Formulations, CBS Publisher, 2019.
8. B. Sreelakshmi, Food Science, 7th Edition, New Age International Publishers, 2018.
9. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, 2nd Edition, Ane Books India, 2013.
10. A. Bahl, S. Bahl, Advanced Organic Chemistry, S. Chand Publishers, 2010.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Detection of Ions in Fertilizers and Common Adulterants in Milk Sample (30 Hrs)				
Detection of anions-carbonate, nitrate and phosphate	5.1	5	10	Lab work
Detection of cations- ammonium, calcium and magnesium.	5.2	5	10	Lab work
Detection of Sodium chloride/hydrogen peroxide/ sulphate/ starch in milk sample	5.3	5	10	Lab work

Reference

1. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999
2. Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell Vogel's Textbook of Practical Organic Chemistry, 5thEdn., Longman Scientific & Technical, 1989
3. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4thEdn., Pearson Education, 2009
4. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry: Qualitative Analysis, Universities Press, 2000

Course designed by: Capt James Baben George

SBU24CH4SEC200: DAIRY CHEMISTRY

Type of Course	SEC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)	Nil		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the composition and constituents of milk	U
CO2	Illustrate different milk processing techniques	U
CO3	Assessment of quality of milk and detection of adulteration	U
CO4	Differentiate between different types of milk	U
CO5	Identify different value-added products of milk	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	-	-	1	1	-	1	-
CO2	1	1	1	-	-	1	1	-	1	-
CO3	1	1	-	-	-	1	1	-	1	-
CO4	1	1	-	-	-	1	1	-	1	-
CO5	1	1	-	-	-	1	1	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	-	x	x	x	x
CO4	-	-	x	x	-	x
CO5	x	x	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Milk: Composition, Properties and Nutritional Role (9 Hrs)				
Composition of Milk, Constituents of Milk (lipids, proteins, carbohydrates, vitamins, and minerals), Natural Inhibitory Substances in Milk, Physico-Chemical Properties of Milk (colour, odour, acidity, specific gravity, viscosity, and conductivity), Nutritional Value of Milk.	1.1	1	9	Lecture
Module 2: Quality of Milk (8 Hrs)				
Grading of Milk, Dye Detection Test, Platform Test, Sensory Evaluation, Milk and Public Health, Common	2.1	2,3	8	Lecture

Milk Borne Disease, Spoilage-Causes and Prevention, adulterants, preservatives, and neutralizer, examples and their detection.				
Module 3: Milk Processing and Microbiology (7 Hrs)				
Microbiology of milk, destruction of microorganisms in milk, and physical-chemical changes in milk due to processing, boiling, and pasteurization.	3.1	2	7	Lecture
Module 4: Major Milk Products (7 Hrs)				
Cream: definition, composition, the chemistry of the creaming process, estimation of fat in the cream. Butter: definition, composition. Ghee: major constituents, common adulterants added to ghee and their detection, rancidity: definition - prevention - antioxidants and synergists - natural and synthetic.	4.1	5	7	Lecture
Module 5: Fluid Milk Varieties and Special Milks (7 Hrs)				
Standardized milk: definition, merits. reconstituted milk: definition, the flow diagram of manufacture, Homogenised milk, flavored milk, vitaminised milk, toned milk.	5.3	4,5	7	Lecture
Module 6: Fermented and Other Milk Products (7 Hrs)				
Fermented milk products: fermentation of milk, definition, conditions. Ice cream: definition, percentage composition types, ingredients, ice-cream manufacture. milk powder: definition, need for making milk powder, drying process, types of drying	6.1	5	7	Lecture
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. P. F. Fox, and P. L. H. McSweeney, Advanced Dairy Chemistry: Volume 1A: Proteins: Basic Aspects, 4th ed. New York: Springer, 2015
2. M. P. Mathur, D. R. Datta, and P. Dinakar, Text book of Dairy Chemistry, Directorate of Information and Publs., ICAR, New Delhi, 1999

Reference

1. J. Robert, P. Stuart, Principles of Dairy Chemistry, R. E. Krieger Publishing Company, 2018
2. Fox, P.F. and Sweeny, Mc. (1998). Dairy Chemistry and Bio-Chemistry. Academic /Platinum Publ., New York.
3. P. F. Fox, Developments in Dairy Chemistry. Applied Sci. Publ., New York, 2006
4. R. Jenness, and S. Patton, Principles of Dairy Chemistry. Wiley Eastern Pvt. Ltd, New Delhi, 1984

Course designed by: Dr Benson Joseph

SBU24CH4VAC200: ENVIRONMENTAL CHEMISTRY

Type of Course	VAC		
Course Level	200 -299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Develop an overview about ecosystem, energy resources and lithosphere	A
CO2	Summarize various types of environmental pollutions and their preventive measures.	U
CO3	Describe different environmental sampling methods and their analysis.	U
CO4	Illustrate the biochemical effects of toxic substances to environment.	A
CO5	Generate awareness to protect and conserve nature and natural resources.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2	-	-	1	1	1	-	1
CO2	1	1	2	1	1	1	1	1	2	1
CO3	-	1	-	-	1	1	-	1	1	1
CO4	-	1	2	1	1	1	1	-	1	1
CO5	2	1	2	1	1	1	1	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Viva	Assignment	Written test	MCQ	
CO1	x	x	-	x	x	x
CO2	x	x	-	x	x	x
CO3	x	x	x	x	-	x
CO4	x	x	-	x	x	x
CO5	x	x	-	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Ecosystem and Lithosphere (8 Hrs)				
Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Food chains, food webs and ecological pyramids.	1.1	1,5	1	Lecture/PowerPoint presentation

Classification of energy resources: primary and secondary, conventional and non-conventional, renewable and non-renewable. Geothermal energy, hydroelectric power, hydrogen energy, nuclear energy, solar energy, wind energy, tidal power.	1.2	1,5	2	Lecture/PowerPoint presentation
Use of alternate energy sources-Energy from Wastes, Biogas Plants, Biomass and Biofuels, Conservation of Energy. Water conservation, rain water harvesting, water shed management.	1.3	1,5	2	Lecture/PowerPoint presentation
Weathering of rocks- physical, chemical and biological processes. Factors controlling the formation of soil; soil profile and classification of soil. Composition of soil: organic and inorganic components in soil. Micro- and macro- nutrients, NPK in soil. Nitrogen Cycle. Acid base and ion exchange reactions in the soil.	1.4	1,5	3	Lecture/PowerPoint presentation
Module 2: Environmental Pollution and their Preventive Measures (18 Hrs)				
Air pollution, water pollution, soil pollution, noise pollution – sources, effects and control measures.	2.1	2,5	3	Lecture/PowerPoint presentation
Global and local environmental issues: global warming and climate change; ozone layer depletion; greenhouse effect; acid rain.	2.2	2,5	3	Lecture/PowerPoint presentation
Solid waste management: types, causes, effects and control measures of urban and industrial solid wastes, biodegradable and non-degradable solid wastes.	2.2	2,5	2	Lecture/PowerPoint presentation
Carbon trading; carbon credit, carbon sequestration.	2.3	2,5	1	Lecture/PowerPoint presentation
Introduction to hazards, Distinction between hazard and disaster, classification of hazards: natural and anthropogenic. Disaster management.	2.4	2,5	3	Lecture/PowerPoint presentation
Biological effects of nuclear radiations, nuclear waste disposal. Nuclear Accidents and its consequences, Chernobyl Disaster, nuclear holocaust.	2.5	2,5	3	Lecture/PowerPoint presentation
Sand mining, wetland deterioration, landscape changes, deforestation, soil erosion, overexploitation of resources. flood and drought, desertification, earthquakes, cyclones, tsunami, floods, landslides, droughts.	2.6	2,5	3	Lecture/PowerPoint presentation
Module 3: Environmental Sampling and Analysis (10 Hrs)				
Environmental Sampling: Spatial and temporal variability, Types of samples: water sampling: surface and groundwater sampling, Analysis and sampling of soil: pH, cation exchange capacity, total nitrogen, phosphorous and potassium.	3.1	3,5	3	Lecture/PowerPoint presentation
Extraction of organic analytes from liquid samples, Preservation techniques of the samples. Air quality index parameters.	3.2	3,5	2	Lecture/PowerPoint presentation
Discussion on physicochemical parameters of water quality such as pH, salinity, conductivity, total solids,	3.3	3,5	3	Lecture/PowerPoint presentation

total dissolved solids, total suspended solids, dissolved oxygen				
Biochemical oxygen demand, chemical oxygen demand and hardness. Eutrophication, biomagnification.	3.4	3,5	2	Lecture/PowerPoint presentation
Module 4: Biochemical Effects of Toxic Substances to Environment (9 Hrs)				
Environmental ethics: Issues and possible solutions. Environment protection act. Air and water act. Isues involved in enforcement of environmental legislation.	4.1	4,5	2	Lecture/PowerPoint presentation
Definition, toxic chemicals in the environment, impact of toxic chemicals on enzymes.	4.2	4,5	2	Lecture/PowerPoint presentation
Biochemical effects of As, Cd, Pb, Hg, pesticides and carcinogenic substances.	4.3	4,5	2	Lecture/PowerPoint presentation
Case Studies: Bhopal Gas Trajedy, Minamata Disease, Itai-Itai Disease, Hiroshima-Nagasaki Nuclear tragedy.	4.4	4,5	3	Lecture/PowerPoint presentation
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. A. K. De, Environmental Chemistry, 7th Edn., New Age International, 2007.
2. Gopinath Chandradasan, Environmental Chemistry, Vishal Publishing Co. Jalandhar, 2017.
3. V. K. Ahluwalia, Environmental Chemistry, 2nd Edn., Ane Books Pvt. Ltd., New Delhi, 2013.
4. B. B. Kebbekus, S. Mitra, Environmental Chemical Analysis, Chapman and Hall, 1998.
5. Gurumani N, Research methodology for biological sciences, M.J.P. Publications, Chennai,2006.

Reference

1. G. W. van Loon, S. J. Duffy, Environmental Chemistry A Global Perspective, Oxford University Press, New York, 2008.
2. N. Singh, A. K. Thakur, Climatic Change and Environmental Issues, The Energy and Resource Institute, New Delhi, 2016.
3. R. P. Cote, P. G. Wells, Controlling Chemical Hazards: Fundamentals of the Management of Toxic Chemicals, Springer, 2012.
4. G. M. Tyler, Living in the Environment: Principles, Connections, and Solutions, Thomson Brooks/Cole, 2005.
5. R. B. Baird, Standard Methods for the Examination of Water and Wastewater, 23rd Edn., American Water Works Association, 2017.
6. D. D. Mishra, S. S. Dara, A Textbook of Environmental Chemistry and Pollution Control, S. Chand Publishing, 1993.
7. P. Singh, Environmental Pollution and Management, Chugh Publications, 1985.
8. R. Gopalan, A. Anand, R. W. Sugumar, A Laboratory Manual for Environmental Chemistry, International Publishing House Pvt. Ltd., 2009.
9. R. A. Malviya, Environmental Pollution and its Control Under International Law, Chugh Publications, 1987.
10. Kothari C.R., Research Methodology: Methods and Techniques 2nd Edn. New Age International Publishers, New Delhi, 2008.

Course designed by: Dr. Ajith R. Mallia

SEMESTER V

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH5DSC300	Major	Inorganic Chemistry - II	5	75	4
SBU24CH5DSC301	Major	Physical Chemistry - II	5	75	4
SBU24CH5DSE300	Elective	Biochemistry	4	60	4
SBU24CH5DSE301	Elective	Advanced Coordination Chemistry and Organometallics	4	60	4
SBU24CH5DSE302	Elective	Green Chemistry: From Fundamentals to Frontiers	4	60	4
SBU24CH5DSE303	Elective	Medicinal Chemistry and Drug Design	4	60	4
SBU24CH5DSE304	Elective	Theoretical Spectroscopy and Kinetics	4	60	4
SBU24CH5SEC300	SEC	Analytical Instrumentation for Chemists	3	45	3

SBU24CH5DSC300: INORGANIC CHEMISTRY - II

Type of Course	Major		
Course Level	300 - 399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Inorganic Chemistry - I		

Course Outcomes

No.	Description	Cognitive Level
CO1	Interpret structure, properties and bonding of compounds of p – block elements	U
CO2	Discuss the chemistry and general group trends of transition metals, lanthanides and actinides.	U
CO3	Recall the chemistry of Noble gases.	R
CO4	Differentiate various reactions in non-aqueous solvents.	U
CO5	Learn the characteristic tests of common cations and anions	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	-	-	1	1	-	-	-
CO2	1	1	1	-	-	1	1	-	-	-
CO3	1	1	1	-	-	1	1	-	-	-
CO4	1	1	1	-	-	1	1	-	-	-
CO5	-	-	-	-	2	-	-	-	-	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written Test	MCQ	
CO1	-	x	x	x	-	x
CO2	x	-	x	x	-	x
CO3	-	x	x	x	x	x
CO4	-	x	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva voce	Lab test	Laboratory report	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Characteristic and Distinctive Properties of p - Block Elements (15 Hrs)				
p-Block elements: comparative study of the p-block elements - groups 13 - 18 with special reference to electronic configuration, structure of elements and trends in atomic and ionic radii, ionization potential, electron affinity, electronegativity and oxidation states, inert pair effect.	1.1	1	3	Lecture
Study of structure, bonding, preparation, properties and uses of borohydrides (diborane) and carboranes	1.2	1	2	Lecture
Study of structure, bonding, preparation, properties and uses of boron nitride, borazene, boric acid and borates.	1.3	1	2	Lecture
Study of structure, bonding, preparation, properties and uses of silanes, oxides and oxoacids of nitrogen, phosphorus and chlorine.	1.4	1	4	Lecture
Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.	1.5	1	4	Lecture
Module 2: d and f Block Elements (15 Hrs)				
Transition Metals: Electronic configurations, elements of first transition series, elements of second transition series, elements of third transition series. General characteristics of d-Block elements with special reference to variable oxidation states, colour, magnetic and catalytic properties, tendency to form complexes.	2.1	2	3	Lecture
Stability of various oxidation states and e.m.f.-Latimer and Pourbaix diagrams. Difference between first, second and third transition series.	2.2	2	2	Lecture
Chemistry of Ti, V, Cr, Mn, Fe and Co in various oxidation states (extractive metallurgy not expected).	2.3	2	2	Lecture
Lanthanides and Actinides: Comparative study of lanthanide elements with respect to electronic configuration, oxidation states, atomic and ionic radii, colour, magnetic properties and complex formation.	2.4	2	2	Lecture
Lanthanide contraction-cause and consequences, Occurrence and principles of separation of lanthanides.	2.5	2	2	Lecture
General features and chemistry of actinides. Comparative study of actinide elements with respect to electronic configuration, oxidation states, atomic and ionic radii, colour, complex formation.	2.6	2	2	Lecture
Actinide contraction, Trans-uranium elements, Genesis of elements and extension of periodic table, extraction of U-233 and Pu-239, processing of spent nuclear fuel-solvent extraction and ion exchange methods.	2.7	2	2	Lecture

Module 3: Chemistry of Noble Gases (9 Hrs)				
Compounds of Noble gases -clathrates, preparation and properties of XeF_2, XeF_4, and XeF_6; nature of bonding in noble gas compounds (valence bond treatment and MO treatment for XeF_2).	3.1	3	3	Lecture
Molecular shapes of noble gas compounds – fluorides and oxy fluorides (VSEPR theory). Separation of noble gases and uses.	3.2	3	3	Lecture
Module 4: Non-aqueous Solvents (6 Hrs)				
Acid base concept in non-aqueous media-HSAB concept, solvent effects, linear free energy relationship-mechanism and methods of determination.	4.1	4	2	Lecture
Reactions in non-aqueous solvents. Ammonia - solutions of metals in liquid ammonia.	4.2	4	2	Lecture
Protonic solvents: anhydrous sulfuric acid, hydrogen halides.	4.3	4	2	Lecture
Aprotic solvents: non-polar solvents, non-ionizable polar solvents, polar solvents undergoing autoionization, liquid halogens, inter-halogen compounds, oxy halides, dinitrogen tetroxide, sulphur dioxide.	4.4	4	3	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Vikas Publishing Co., Jalandhar, 2013
2. R. Gopal, Inorganic Chemistry for Undergraduates, Universities press, India Pvt. Ltd., 2009.
3. P. L. Soni, Text Book of Inorganic Chemistry, S. Chand and Sons, 2007

Reference

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edn. Pearson Education, 2006.
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edn, Chapman & Hall, 2002
3. D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 3rd Edn., Oxford University Press, New Delhi, 2004
4. F.A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., Wiley Interscience, 1999

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Qualitative Inorganic Analysis (30 Hrs)				
Basic principles of qualitative analysis Ionic product of water, common ion effect, solubility product, relation between solubility product and molar solubility of sparingly soluble salts, applications of solubility product principle.	6.1	5	10	Lab work

Study of reactions of anions Study of reactions of the following anions CO_3^{2-}, S^{2-}, SO_4^{2-}, NO_3^-, F^-, Cl^-, Br^-, BO_2^- $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, CH_3COO^-, PO_4^{3-}, AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-} Elimination of interfering anions Spot tests for cations	6.2	5	20	Lab work (A minimum of five anion mixtures with interfering anions must be done and recorded.)

Reference

1. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999.
2. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edn., Pearson Education, New Delhi, 2006.
3. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.

Course designed by: Dr Subin Joseph

SBU24CH5DSC301: PHYSICAL CHEMISTRY - II

Type of Course	Major		
Course Level	300 – 399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic Physical Chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the structure of ionic solution and interpret the laws governing ionic conductivity.	An
CO2	Explain the features of concentration cells and fuel cells, and the working principle Electro-Chemical cells. Explain the causes of corrosion and prevention methods. Understand electrode polarisation and related aspects.	An
CO3	Learn the basic principles of voltammetry and describes voltammogram by analysing the peak current and peak potential. Categorise different electrodes based on their function and apply Nernst equation to calculate electrode potential.	An
CO4	Explain the electrical properties of molecules	An
CO5	Students performing the experiments will be capable of handling the conductivity meter, pH meter and potentiometer and verification of Debye-Huckel-Onsager equation.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	1	-	-	-	-
CO2	1	-	1	-	-	1	-	-	-	-
CO3	1	-	1	-	-	1	-	-	-	-
CO4	-	2	1	-	2	1	-	-	1	2
CO5	-	2	2	-	2	1	-	-	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Assignment	Written test	MCQ	
CO1	-	x	-	x	x	x
CO2	-	x	-	x	x	x
CO3	x	-	x	x	-	x
CO4	-	x	-	x	x	x
CO5	x	-	x	x	-	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva voce	Lab test	Laboratory report	
CO1	x	x	-	x	x	x
CO2	x	-	x	x	x	x
CO3	x	x	-	x	x	x
CO4	x	-	x	x	x	x
CO5	x	x	-	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Conductance (15 Hrs)				
Arrhenius theory of electrolytic dissociation. Conductivity, difference between electrolytic conductance and metallic conductance, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution.	1.1	1	3	Lecture/PPT
Kohlrausch law of independent migration of ions. Debye Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.	1.2	2	3	Lecture/PPT
Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities.	1.3	3	2	Lecture/PPT
Determination of transference numbers using Hittorf and Moving Boundary methods.	1.4	4	2	Lecture/PPT
Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.	1.5	1,5	5	Lecture/PPT
Module 2: Electrochemistry (20 Hrs)				
Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials. Chemical cells, reversible and irreversible cells with examples.	2.1	1	3	Lecture/PPT
Thermodynamics of reversible electrodes. Relation between electrical energy and enthalpy of a cell reaction. Determination of ΔH, ΔG and ΔS of a cell reaction.	2.2	2	1	Lecture/PPT
Thermodynamic derivation of Nernst equation. Standard cells, half cells/electrodes, different types of electrodes (with examples).	2.3	1	2	Lecture/PPT
Standard electrode potential (IUPAC convention) and principles of its determination.	2.4	2	1	Lecture/PPT
Potentiometric titrations: acid-base and redox. Concentration cells: electrode concentration cell and electrolyte concentration cells. Types of electrolyte	2.5	3	4	Lecture/PPT

concentration cells – with transference and without transference, liquid junction potential.				
Application of emf measurements, determination of activity coefficients of electrolytes, transport number, solubility product constants, determination of P^H using hydrogen electrode, quinhydrone and glass electrode.	2.6	4	3	Lecture/PPT
Polarography-decomposition potential, residual current, migration current, supporting electrolyte, diffusion current, polarogram, half wave potential, limiting current density, polarograph, explanation of polarographic waves.	2.7	1,5	3	Lecture/PPT
Fuel cells, classification based on working temperature, chemistry of fuel cells, H_2-O_2 fuel cells.	2.8	1	2	Lecture/PPT
Corrosion, types, theories and methods to prevent corrosion	2.9	2	2	Lecture/PPT
Module 3: Electrical & Magnetic Properties of Atoms and Molecules (10 Hrs)				
Basic ideas of electrostatics, Electrostatics of dielectric media,	3.1	1	3	Lecture/PPT
Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements.	3.2	2,4	3	Lecture/PPT
Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation	3.3	3,5	4	Lecture/PPT
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

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

Reference

1. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
2. Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011).
3. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
4. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
6. Rogers, D. W. Concise Physical Chemistry Wiley (2010).
7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).
8. Kapoor, K. L. A Textbook of Physical Chemistry (Volume 1) McGraw Hill Education; Sixth edition (2019).

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Conductometry (14 Hrs)				
Determination of cell constant	5.1	5	2	Lab work

Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.	5.2	5	2	Lab work
Perform the following conductometric titrations: (vi) strong acid against strong base (vii) weak acid against strong base (viii) weak acid against weak base (ix) strong acid against weak base (x) Mixture of acids against strong base	5.3	5	10	Lab work
Module 6: Potentiometry (7 Hrs)				
Potentiometric titration – Fe^{2+} vs. $Cr_2O_7^{2-}$	6.1	5	2	Lab work
Potentiometric titration – Fe^{2+} vs. MnO_4^-	6.2	5	2	Lab work
Determination of pH by potentiometric method	6.3	5	3	Lab work
Module 7: (3 Hrs)				
Verification of Debye- Huckel Onsager equation	7.1	5	3	Lab work
Module 8: (3 Hrs)				
Determination of solubility of silver chloride, lead sulphate	8.1	5	3	Lab work
Module 9 (3 Hrs)				
Verification of Kohlrausch Law.	9.1	5	3	Lab work

Reference

1. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press, 2009
2. J. B. Yadav, Advanced Practical Physical Chemistry, 29th Edn., Krishna Prakashan Media Pvt. Ltd., 2010
3. R. C. Das and B. Behera, Experiments in Physical Chemistry, Tata McGraw-Hill, 1983
4. K. K. Sharma, An Introduction of Practical Chemistry, Vikas Publishing House, New Delhi, 200

Course designed by: Dr Sam John

SBU24CH5DSE300: BIOCHEMISTRY

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Basic biological and biochemistry concepts		

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate a comprehensive understanding of the fundamental principles and concepts underlying biochemistry, including the structure, function, and interrelationships of biomolecules.	U
CO2	Predict the structure and metabolism of lipids, amino acids, peptides, proteins, carbohydrates, nucleic acids, and vitamins.	A
CO3	Interpret complex biochemical processes associated with carbohydrates.	A
CO4	Achieve a deep understanding of enzyme kinetics, including the factors influencing enzyme activity, substrate binding, and the regulation of enzymatic reactions.	U
CO5	Acquire practical skills in various biochemical techniques, such as chromatography, electrophoresis, and spectroscopy.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	1	1	1	-	1	1
CO2	1	-	1	-	1	1	1	-	1	1
CO3	1	-	1	-	1	1	1	-	1	1
CO4	1	-	1	-	1	1	1	-	1	1
CO5	1	2	2	-	2	1	1	-	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written test	MCQ	
CO1	-	x	x	x	-	x
CO2	-	x	x	x	x	x
CO3	-	-	x	x	x	x
CO4	-	-	x	x	x	x
CO5	x	-	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Foundation to Biochemistry (15 Hrs)				
Overview of biochemistry: Definition and scope of biochemistry, historical perspective, importance of biochemistry in medicine, agriculture and industry.	1.1	1	3	Lecture/ PowerPoint or Video Presentation

Introduction to biomolecules: Primary (carbohydrates, proteins, lipids) and secondary metabolites (flavonoids, alkaloids, phenolics, terpenoids) (basics only). Overview of metabolism and metabolic pathways: Anabolism vs. catabolism.	1.2	1	3	Lecture/ PowerPoint or Video Presentation
Lipids: Definition and properties. Classification- simple, compound and derived lipids.	1.3	2	1	Lecture/ PowerPoint or Video Presentation
Simple lipids: Oils, fats and waxes- definition, structure, biological functions and examples. Properties of oils and fats: Hydrolysis, hydrogenation, drying and rancidity. Analysis of oils and fats: Acid value, saponification value, iodine value and RM value.	1.4	2	3	Lecture/ PowerPoint or Video Presentation
Trans fats and their effect. Common fatty acids present in oils and fats. Compound lipids: Phospholipids and glycolipids and their biological functions.	1.5	2	2	Lecture/ PowerPoint or Video Presentation
Lipid Metabolism (basics only): Lipid digestion and absorption, fatty acid synthesis (lipogenesis), β-oxidation of fatty acids, triglyceride and phospholipid metabolism, cholesterol metabolism, lipoprotein transport, regulation of lipid metabolism.	1.6	2	3	Lecture/ PowerPoint or Video Presentation
Module 2: Amino acids, Peptides and Proteins (15 Hrs)				
Amino acids: Classification, methods to distinguish between α, β, and γ-amino acids, structure of α-amino acids. Properties: Zwitter ion formation, isoelectric point, betaines formation.	2.1	2	2	Lecture/ PowerPoint or Video Presentation
Synthesis of α-amino acids- phthalimide synthesis, reductive amination of α- ketoacids, amination of α-halo acids, and Strecker synthesis.	2.2	2	2	Lecture/ PowerPoint or Video Presentation
Peptides: Formation and geometry of peptide bond. Structure of peptides. Solution phase peptide synthesis (upto dipeptides). Solid phase peptide synthesis – basic principles of Merrifield's SPPS, advantages of SPPS.	2.3	2	2	Lecture/ PowerPoint or Video Presentation
Amino acid metabolism: Nitrogen metabolism and balance, ammonia detoxification and urea cycle, disorders related to amino acid metabolism.	2.4	2	2	Lecture/ PowerPoint or Video Presentation
Protein: Classification of proteins based on solubility, structure and functions with examples.	2.5	2	1	Lecture/ PowerPoint or Video Presentation
Primary structure of proteins, methods of determining N- and C- terminal amino acids, amino acid composition, sequencing by Edmanís method. Colour reactions of proteins- Biuret, Millons, Xanthoproteic tests.	2.6	2	2	Lecture/ PowerPoint or Video Presentation
Secondary structure- α-helix, β-pleated sheet. Tertiary and quaternary structure. Denaturation and renaturation of proteins. Functions of proteins.	2.7	2	2	Lecture/ PowerPoint or Video Presentation
Protein synthesis and degradation: Transcription and translation, ribosomes, tRNA, and mRNA in protein synthesis, and the translation process. Protein degradation (proteolysis).	2.8	2	2	Lecture/ PowerPoint or Video Presentation

Module 3: Carbohydrates and Enzyme (15 Hrs)				
Carbohydrates: Classification and nomenclature of monosaccharides. D and L designations - Fischer projections of glucose and fructose.	3.1	3	2	Lecture/ PowerPoint or Video Presentation
Glucose: Preparation, properties, epimers, anomers and mutarotation in glucose. Reactions - oxidation, reduction, acetylation, reaction with hydroxylamine and phenylhydrazine. Cyclic structure - pyranose and furanose forms - Haworth projection formula.	3.2	3	2	Lecture/ PowerPoint or Video Presentation
Determination of ring size of glucose. Interconversions of aldoses and ketoses - chain lengthening (Kiliani-Fischer synthesis) and shortening of aldoses (Ruff degradation).	3.3	3	2	Lecture/ PowerPoint or Video Presentation
Disaccharides: Structure of sucrose, inversion of sucrose, structure of lactose, and maltose.	3.4	3	1	Lecture/ PowerPoint or Video Presentation
Polysaccharides: structure of starch (amylose and amylopectin) and cellulose. Industrial applications of starch and cellulose (structural elucidation not required).	3.5	3	1	Lecture/ PowerPoint or Video Presentation
Overview of carbohydrate metabolism: Glycolysis and gluconeogenesis, citric acid cycle, pentose phosphate pathway.	3.6	3	2	Lecture/ PowerPoint or Video Presentation
Enzymes: Nomenclature. Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUB classification of enzymes.	3.7	4	2	Lecture/ PowerPoint or Video Presentation
Mechanism of enzyme action: Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. Enzyme inhibition - reversible inhibition (competitive, uncompetitive, and non-competitive) and irreversible inhibition.	3.8	4	2	Lecture/ PowerPoint or Video Presentation
Kinetics of enzyme action: Factors affecting rate of enzyme catalyzed reaction - effect of substrate, enzyme, product concentration, pH, temperature. Michaelis-Menten equation (derivation).	3.9	4	1	Lecture/ PowerPoint or Video Presentation
Module 4: Nucleic Acids and Vitamins (9 Hrs)				
Nucleic acids: Components of nucleic acids, nucleosides and nucleotides. Structure of pentose sugar, adenine, guanine, cytosine, uracil and thymine.	4.1	2	2	Lecture/ PowerPoint or Video Presentation
Watson and Crick model of DNA – differences between DNA and RNA. Functions of nucleic acids: Protein bio-synthesis and replication of DNA.	4.2	2	3	Lecture/ PowerPoint or Video Presentation
Vitamins: Fat soluble vitamins: A, D, E and K- structure, sources, deficiency symptoms and biological role.	4.3	2	2	Lecture/ PowerPoint or Video Presentation
Water soluble vitamins: Sources, deficiency symptoms and biological role of thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folic acid, and cyanocobalamin. Structure, sources, deficiency symptoms and biological role of vitamin C.	4.4	2	2	Lecture/ PowerPoint or Video Presentation

Module 5: Biochemical Techniques and Applications (6 Hrs)				
Electrophoresis: Polyacrylamide gel electrophoresis (PAGE) - separation of proteins and nucleic acids, agarose gel electrophoresis- separation of nucleic acids.	5.1	5	1	Lecture/ PowerPoint or Video Presentation
Paper, thin and ion-exchange chromatography - applications in biomolecule separation.	5.2	5	1	Lecture/ PowerPoint or Video Presentation
Immunoassay: Radioimmunoassay (RIA) - applications in quantifying biomolecules, Enzyme-linked immunosorbent assay (ELISA) - applications in biomolecule detection.	5.3	5	2	Lecture/ PowerPoint or Video Presentation
Polymerase chain reaction (PCR) - applications in DNA amplification, DNA fingerprinting.	5.4	5	1	Lecture/ PowerPoint or Video Presentation
Spectrophotometry- applications in biomolecules	5.5	5	1	Lecture/ PowerPoint or Video Presentation
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. A. Bahl, B. S. Bahl, Advanced Organic Chemistry, S. Chand & Company Pvt Ltd, 2016.
2. S. S. Gupta, Organic Chemistry, Oxford University Press, 2017.
3. I. L. Finar, Organic Chemistry, Volume- I, 6th Edition, Pearson, 2002.
4. N. Tewari, Organic Chemistry, A Modern Approach, Volume-III, McGraw Hill Education, 2019.
5. A. K. Berry, A Textbook of Biochemistry, Emkay Publications, Delhi, 2000.
6. J.L Jain, Sunjay Jain, Nitin Jain, Fundamentals of Biochemistry, S. Chand & Company Pvt Ltd, 2016.

Reference

1. D. L. Nelson, M. M. Cox, Lehninger's Principles of Biochemistry, 7th Edition, W. H. Freeman, 2021.
2. J.M. Berg, J.L. Tymoczko, L. Stryer, Biochemistry, 9th Edition. W.H. Freeman and Co., 2019.
3. U. Satyanarayana, U. Chakrapani, Biochemistry, 6th Edition. Elsevier India Pvt. Ltd, 2021.
4. D. M. Vasudevan, S. Sreekumari, Textbook of Biochemistry for Medical Students, Jaypee Brothers Medical Publishers, 2023.
5. F. A. Carey, R. M. Giuliano, Organic Chemistry, 10th Edition, 2016.
6. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th Edition, Pearson Education India, 2010.

Course designed by: Dr Sajini T

SBU24CH5DSE301: ADVANCED COORDINATION CHEMISTRY AND ORGANOMETALLICS

Type of Course	DSE		
Course Level	300 -399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Basic inorganic chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Construct molecular orbital diagrams of metal complexes	U
CO2	Interpret spectral properties of metal complexes	U
CO3	Distinguish coordination complexes and identify the possible number of isomers of the compound.	An
CO4	Summarize the nature of bonding and applications of organometallic compounds with specific examples.	U
CO5	Describe the basic principles of bioinorganic chemistry and the importance of metals in biological systems	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	-	-	1	1	-	-	-
CO2	1	1	1	-	-	1	1	-	-	-
CO3	1	1	1	-	-	1	1	-	-	-
CO4	1	1	1	-	-	1	1	-	-	-
CO5	1	1	1	-	-	1	1	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written Test	MCQ	
CO1	-	-	x	x	-	x
CO2	x	x	x	x	x	x
CO3	-	x	x	x	x	x
CO4	-	x	x	x	x	x
CO5	-	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Spectral Properties of Transition Metal Complexes (15 Hrs)				
Molecular orbital theory-MO energy level diagrams for octahedral and tetrahedral complexes without and with π-bonding. Sigma and pi bonding ligands such as CO, NO, CN^-, R_3P, and Ar_3P.	1.1	1	3	Lecture

Electronic Spectra of complexes-Term symbols of d^n system, Racah parameters, splitting of terms in weak and strong octahedral and tetrahedral fields.	1.2	2	2	Lecture
Correlation diagrams for d^n and d^{10-n} ions in octahedral and tetrahedral fields (qualitative approach).	1.3	2	1	Lecture
Interpretation of electronic spectra of complexes-Orgel diagrams, demerits of Orgel diagrams, Tanabe-Sugano diagrams, calculation of Dq, B and β (Nephelauxetic ratio) values, spectra of complexes with lower symmetries.	1.4	2	5	Lecture
d-d transition, selection rules for electronic transition-effect of spin-orbit coupling and vibronic coupling.	1.5	2	2	Lecture
Charge transfer spectra, and luminescence spectra.	1.5	2	2	Lecture
Module 2: Stereochemistry of Coordination Compounds (15 Hrs)				
Geometrical and optical isomerism in octahedral, square planar and tetrahedral complexes. Bailar's method.	2.1	3	5	Lecture
Resolution of optically active complexes, determination of absolute configuration of complexes by ORD and circular dichroism, stereoselectivity and conformation of chelate rings, asymmetric synthesis catalyzed by coordination compounds.	2.2	3	5	Lecture
Linkage isomerism-electronic and steric factors affecting linkage isomerism. Symbiosis-hard and soft ligands, Prussian blue and related structures	2.3	3	5	Lecture
Module 3: Organometallic compounds (15 Hrs)				
Introduction to organometallic compounds, Hapticity in Organometallic compounds.	3.1	4	1	Lecture
The 18- electron rule, numerical problems, and stability	3.2	4	1	Lecture
Organometallic compounds with linear pi donor ligands-olefins, acetylenes, dienes and allyl complexes-synthesis, structure and bonding.	3.3	4	3	Lecture
Carbene and carbyne complexes - synthesis, structure and bonding.	3.4	4	2	Lecture
Preparation, properties, structure and bonding of simple mono and binuclear metal carbonyls, vibrational spectra of metal carbonyls, Polynuclear metal carbonyls with and without bridging.	3.5	4	5	Lecture
Metal nitrosyls, metal cyanides and dinitrogen complexes - synthesis, structure and bonding.	3.6	4	3	Lecture
Module 4: Bioinorganic chemistry (15 Hrs)				
Metals in Biological Systems: Bulk, trace and ultra trace metals for living systems, their biological roles.	4.1	5	2	Lecture
Dioxygen Management: Myoglobin and Haemoglobin, structure, chemistry of oxygen binding, electronic structural changes, functions of Myoglobin and Haemoglobin, Cooperativity of Haemoglobin. Bohr Effect. Haemerythrin and haemocyanin: structure and mechanism of dioxygen transport.	4,2	5	3	Lecture

Electron Transfer in Biological Systems: Fe-S proteins: Rubredoxins and Ferredoxins; Cytochromes: (Introduction only)	4.3	5	2	Lecture
Nitrogen Fixation: Diazotrophs, Symbiosis, Nitrogenases and their components, Chemistry of biological nitrogen fixation.	4.4	5	2	Lecture
Chemistry of Photosynthesis: Light reactions: Reaction centre, photosystem, Z Scheme, Photosystem I and II, structure and function of Mn cluster.	4.5	5	2	Lecture
Introduction to Metalloenzymes: Structure and functions of Carbonic anhydrase II, Carboxypeptidase A, Coenzyme forms of vitamin B12.	4.6	5	2	Lecture
Metals in Medicine: Cis-platin: its mode of action in cancer treatment. Basic principles of chelation therapy, Application of therapeutic chelating agents: with examples; Chrysotherapy: Antiarthritic agents containing gold	4.7	5	2	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Vikas Publishing Co., Jalandhar, 2020
2. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press, India Pvt. Ltd., 2009
3. P. L. Soni, Text Book of Inorganic Chemistry, S. Chand and Sons, 2013

Reference

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edn., Pearson Education, 2006
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edn., Chapman & Hall, 2008
3. D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 7th Edn., Oxford University Press, New Delhi, 2018
4. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., Wiley Interscience, 2009

Course designed by: Dr Subin Joseph

SBU24CH5DSE302: GREEN CHEMISTRY: FROM FUNDAMENTALS TO FRONTIERS

Type of Course	DSE		
Course Level	Course Level: 300 - 399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

After the successful completion of the course, the students will be able to:

No.	Description	Cognitive Level
CO1	Explain the 12 principles of green chemistry and articulate the significance of each principle in relation to sustainable chemical practices.	U
CO2	Analyse the application and impact of the twelve principles of green chemistry in achieving environmental sustainability and safety in chemical processes through the study of various industrial case studies and practices.	An
CO3	Analyse the integration and effectiveness of green chemistry tools, such as life cycle analysis in promoting sustainable practices across various industries.	An
CO4	Understand and interpret the evolution and impact of current research trends in Green Chemistry, recognizing how it translates into practical applications both in the laboratory and in educational settings.	U
CO5	Comprehend the challenges, ethical considerations, and barriers that Green Chemistry faces for its integration into industry, including the influence of policies and regulations on its adoption and implementation.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	-	2	2	2	-	2	2
CO2	2	2	3	-	2	3	3	-	3	3
CO3	2	1	3	-	2	2	2	-	2	2
CO4	1	1	2	-	2	2	2	-	2	2
CO5	1	1	2	-	1	2	2	-	1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment/ Seminar	Viva	Written test	MCQ	
CO1	x	-	x	x	x	x
CO2	x	x	x	x	-	x
CO3	x	x	x	x	x	-
CO4	x	-	-	x	x	x
CO5	x	-	-	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Green Chemistry and its Principles (7 Hrs)				
Introduction to the concept of Green Chemistry- necessity and the goals it aims to achieve. Historical background and the evolution of Green Chemistry.	1.1	1	2	Lecture/Presentation
Sustainability challenges in the modern world and the role of Green Chemistry. Case studies demonstrating the need for Green Chemistry-Understanding the role chemists have in the sustainability of our planet and the development of environmentally friendly chemical processes.	1.2	1	2	Lecture/Presentation
Introduction to the 12 principles of Green Chemistry introduced by Paul Anastas and John Warner.	1.3	1	1	Lecture/Presentation
An introduction to green metrics for measuring the 'greenness' of a reaction. -tools and methods to quantify the environmental impact of chemical reactions.	1.4	1	2	Lecture/Presentation
Module 2: Principles of Green Chemistry: Detailed Examination and Case Studies Part 1 (15 Hrs)				
Detailed Discussion on Principle 1: Prevention: Strategies for minimizing waste production and preventing waste at the source. Introduction to metrics for evaluating waste generation and prevention- E-factor and its calculations. Case studies illustrating the application of the Prevention principle.	2.1	2	3	Lecture/ Discussion
Detailed Discussion on Principle 2: Atom Economy- Concept of atom economy and its significance in Green Chemistry and sustainability. Calculation of atom economy. Atom economic and atom uneconomic reactions. Calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Real-world examples demonstrating improved Atom Economy in chemical syntheses.	2.2	2	3	Lecture/ Discussion
Principle 3: Less Hazardous Chemical Syntheses- Understanding the importance of designing syntheses that are less hazardous to human health and the environment. Techniques for reducing toxicity in chemical synthesis. Approaches to minimize the use of hazardous substances. Discussion on how these changes impact the environment and workplace safety. Discussion of the challenges faced in implementing less hazardous syntheses in the chemical industry.	2.3	2	3	Lecture/ Discussion
Principle 4: Designing Safer Chemicals- Understanding the goal of designing chemicals that achieve their desired function while being safe for humans and the environment. An introduction to the basic concepts of toxicology. Practical approaches to designing safer chemicals and	2.4	2	3	Lecture/ Discussion

alternative assessment strategies. Exploring how safer chemicals are being developed and applied in various industries.				
Principle 5: Safer Solvents and Auxiliaries- Definition and roles of solvents and auxiliaries in chemical reactions. Overview of common hazards associated with traditional solvents. Criteria for selecting safer solvents, including toxicity, environmental impact, and functionality. Analysis of case studies where traditional solvents have been successfully replaced with safer alternatives.	2.5	2	3	Lecture/ Discussion
Module 3: Principles of Green Chemistry: Detailed Examination and Case Studies Part 2 (15 Hrs)				
Principle 6: Design for Energy Efficiency- Importance of energy conservation for sustainability and cost reduction. Strategies to minimize energy consumption in chemical reactions, including process intensification and alternative energy sources. Industrial examples of energy-efficient design in chemical manufacturing.	3.1	2	3	Lecture/ Discussion
Principle 7: Use of Renewable Feedstocks- Definition and significance of renewable feedstocks in green chemistry. Examination of various renewable sources such as plant biomass, algae, and waste materials. Analysis of the economic viability and environmental impacts of using renewable feedstocks in comparison with petrochemical alternatives.	3.2	2	2	Lecture/ Discussion
Principle 8: Reduce Derivatives- Definition and role of derivatives and protecting groups in chemical synthesis. Drawbacks of using derivatives in chemical reactions. Techniques and methodologies to avoid or minimize the use of derivatives in syntheses. Case studies showcasing successful reduction or elimination of protecting groups.	3.3	2	3	Lecture/ Discussion
Principle 9: Catalysis- Definition and importance of catalysts in promoting more sustainable chemical processes. Introduction to biocatalysis and the role of enzymes in green chemistry. Exploration of new catalytic systems, including organocatalysts and nano-catalysts. Case studies of catalytic processes that have been implemented in industry.	3.4	2	3	Lecture/ Discussion
Principle 10: Design for Degradation- Understanding the significance of designing chemicals that can degrade into non-harmful substances after use. Identifying the characteristics of persistent organic pollutants and their environmental impact. Methods for testing and verifying biodegradability. Analysis of case studies involving the design of chemicals and materials for improved degradation.	3.5	2	2	Lecture/ Discussion
Principle 11: Real-time Analysis for Pollution Prevention- Understanding the concept of real-time analysis in chemical processes. Importance of continuous monitoring for pollution prevention. Overview of modern analytical	3.6	2	1	Lecture/ Discussion

techniques used for real-time monitoring. Examination of successful applications of real-time analysis in industry.				
Principle 12: Inherently Safer Chemistry for Accident Prevention- Discussion of the rationale behind designing safer chemical processes. Strategies to minimize the potential for accidents in the chemical industry. Case studies on how inherent safety can prevent accidents and reduce risks.	3.7	2	1	Lecture/ Discussion
Module 4: Green Chemistry Tools and Implementation of Green Chemistry (15 Hrs)				
Overview of Green analytical chemistry techniques	4.1	1,3	1	Lecture/Presentation
Life Cycle Analysis (LCA) and its application in product development.	4.2	3	2	Lecture/Presentation
Overview of computational tools and software for Green Chemistry.	4.3	1,3	1	Lecture/Presentation
Green Chemistry in the context of circular economy	4.4	1	1	Lecture/Presentation
Case study discussions and analysis using green chemistry tools. Energy sector and Green Chemistry – biofuels and solar energy. Green Chemistry in the pharmaceutical industry. Green Chemistry in nanotechnology and materials science. Green Chemistry in the agriculture and food industry. Green Chemistry in water treatment and purification.	4.5	2,3	10	Seminar/ Discussion
Module 5: Green Chemistry in Research and Future Perspectives (8 Hrs)				
Current research trends in Green Chemistry. Green Chemistry in classroom. Innovative teaching methods for Green Chemistry education. Green Chemistry in Laboratory. Green Chemistry Career prospects. Green Chemistry and entrepreneurship. Collaboration between academia and industry in Green Chemistry. Green Chemistry and scaling up – from lab to industry.	5.1	4	4	Lecture/Presentation
International perspectives on Green Chemistry. Challenges and Ethical considerations in Green Chemistry. Barriers to industrial adoption of Green Chemistry. Policy and Regulation Impact on Green Chemistry	5.2	5	4	Lecture/Presentation
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. V. K. Tiwari, A. Kumar, S. Rajkhowa, G. Tripathi, A. K. Singh, Green Chemistry Introduction: Application and Scope, Springer Nature Singapore Pte Ltd., 2022.
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Ane Books India, New Delhi, 2006.
3. M. Lancaster, Green Chemistry: An Introductory Text, The Royal Society of Chemistry, UK, 2002.
4. R. K. Sharma, A. Srivastava, Green Chemistry for Beginners, Jenny Stanford Publishing Pvt. Ltd., 2021.

Reference

1. W. Zhang, B. W. Cue, Green Techniques for Organic Synthesis and Medicinal Chemistry, John Wiley & Sons Ltd., 2018.
2. S. E. Manahan, Green Chemistry and The Ten Commandments of Sustainability, 2nd Edition, Chemchar Research, Inc., 2006.
3. P. Dicks, Green Organic Chemistry in Lecture and Laboratory, CRC Press, Taylor & Francis Group, 2012.
4. S. C. Ameta, R. Ameta, Green Chemistry Fundamentals and Applications, Apple Academic Press, Inc., 2013.
5. J. Clark, D. Macquarrie, Handbook of Green Chemistry and Technology, Blackwell Science Ltd. 2002.
6. P. Anastas, J. C. Warner, Green Chemistry: Theory and Practice, Oxford University press, USA, 2000.

Course designed by Dr Shijo K Cherian

SBU24CH5DSE303: MEDICINAL CHEMISTRY AND DRUG DESIGN

Type of Course	DSE		
Course Level	300 -399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Basic organic chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Remember and understand the core principles of medicinal chemistry, including drug nomenclature, pharmacokinetics, and pharmacodynamics.	R
CO2	Apply knowledge of drug synthesis to analyze the chemical structure and therapeutic function of various pharmacological agents.	A
CO3	Analyze and evaluate drug-receptor interactions and signal transduction pathways to understand the molecular basis of drug action.	A
CO4	Create solutions using advanced medicinal chemistry knowledge, including cheminformatics, pharmacogenomics, and computational drug design.	U
CO5	Evaluate and synthesize current research and trends in medicinal chemistry to foster innovation in pharmaceutical development and pharmacy practice.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	1	2	-	-	-	1	2	-	-	-
CO3	1	1	-	-	-	-	1	-	-	-
CO4	-	-	-	-	-	-	-	-	1	-
CO5	-	1	-	-	2	-	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Pharmacy/Lab Visit	Written test	MCQ	
CO1	x	-	-	x	-	x
CO2	x	-	-	x	-	x
CO3	x	-	-	x	-	x
CO4	-	x	-	x	x	x
CO5	-	-	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Foundations of Medicinal Chemistry (15 Hrs)				
Introduction to Medicinal Chemistry: Scope and significance in the pharmaceutical industry. Drug Nomenclature and Classification: Chemical, generic, and trade names; classification based on structure and therapeutic use.	1.1	1	2	Lecture
General concepts of toxicity, teratogenicity & carcinogenicity, LD50, ED50, MIC- anti infectives.	1.2	1	2	Lecture
Drug discovery process- Target identification, target validation, lead identification, lead optimisation, IND, different phases of clinical trials, NDA, post approval studies.	1.3	1	3	Lecture
ADME (Absorption, Distribution, Metabolism and Excretion), drug metabolism and prodrugs,	1.4	2	2	Lecture
SAR and QSAR with examples	1.5	2	2	Lecture
Ethical considerations during drug development	1.5	1	1	Lecture
Basic pharmacy practise	1.6	5	3	Field Visit
Module 2: Drug Action and Pharmacokinetics (15 Hrs)				
Introduction to Drug Targets: Definition and importance of drug targets, Types of drug targets- Proteins, nucleic acids, Cellular structure, Relationship between drug target and therapeutic effects (DNA binders- application of C2B10 for Drug Design)	2.1	3	3	Lecture
Theories of drug action: Receptor theory, occupancy theory, induced fit theory, activation aggravation theory. Types of Receptors in Drug Action: Introduction to receptors and signalling, Types of receptors- Drug-receptor interactions, agonists, antagonists, selective receptor targeting G Protein coupled receptors, Ionotropic receptors, Metabotropic receptors and Kinase linked receptors.	2.2	3	3	Lecture
Enzymes as Drug Targets: Enzymes: active sites, mechanism of catalysis, Enzyme inhibitors, Enzyme selectivity	2.3	3	2	Lecture
Membrane Transporters and Channels: Active transporters and passive transporters.	2.4	3	2	Lecture
Pharmacological studies: Study of anti-inflammatory activity, anticancer activity, cytotoxicity, antimicrobial activity and hepatoprotective activity	2.6	3	5	Video Lectures
Module 3: Pharmacological Agents and Their Synthesis (15 Hrs)				
Antibiotics- Classification, mechanism of action and therapeutic uses- Penicillin, Cephalosporins, Quinolones, Aminoglycosides. Structure Activity Relationship of penicillin	3.1	2	3	Lecture

Cardiovascular Drugs: Cardiotonic drugs: cardiac glycosides-their chemistry digoxin and digitoxin, Calcium channel blockers-verapamil, β-blockers-propranolol	3.2	2	3	Lecture
Drugs that act on CNS: Classification, mode of action, specific examples. SAR of morphine, habituation & addiction of narcotic analgesics and barbiturates	3.3	2	3	Lecture
Anticancer Drugs: Role of alkylating agents, antimetabolites and folate antagonists in the treatment of cancer. Carcinolytic antibiotics and mitotic inhibitors. Plant derived drugs- vincristine, taxol, Hormones and their antagonists.	3.4	2	3	Lecture
Antiviral drugs- mode of action and therapeutic uses of amatidine and ribavirin. Anti HIV drugs.	3.5	2	3	Lecture
Module 4: Advanced Topics in Medicinal Chemistry and Emerging Technologies (15 Hrs)				
Advanced Therapeutics: Antibody-drug conjugates, gene therapy, targeted cancer treatment	4.1	4	3	Lecture
Cheminformatics and Computer-Aided Drug Design (CADD): Informatics in drug design, database mining, structure-activity relationship analysis, computational tools, molecular modelling, and simulation techniques for drug design.	4,2	4	4	Lecture and Demonstration
Pharmacogenomics and Personalized Medicine: Genetic basis of drug action, role in personalized medicine	4.3	5	4	Lecture
AI and ML in Drug Discovery: AI and ML applications in drug behaviour prediction, design optimization, and personalization	4.4	5	4	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. V. Alagarsamy, A Textbook of Medicinal Chemistry, 2nd Edition, CBS Publishers & Distributors, 2010.
2. D. Sriram, P. Yogeswari, Medicinal Chemistry, Pearson Education India, 2nd Edition, 2016.
3. Ashutosh Kar, Medicinal Chemistry, 5th Edition, New Age International Publishers, 2007.

Reference

1. K. G. Bothara, Medicinal Chemistry, 1st Edition, Nirali Prakashan, 2008.
2. A. Korolkovas, J. Burckhalter, Essentials of Medicinal Chemistry, 2nd Edition, John Wiley & Sons, 1988.
3. G. Patrick, Medicinal Chemistry, BIOS, 2001.
4. T. Nogrady, D.F. Weaver, Medicinal Chemistry, Oxford University Press, 2005.
5. W.O. Foye, T.L. Lemke, D.A. Williams, Principles of Medicinal Chemistry, 4th Edition, Williams & Wilkins, 1995.
6. J.P. Remington, Remington's Pharmaceutical Sciences, Vol.13, 19th Edition, Mack, 1990.
7. K. D. Tripathi, Essentials of Medical Pharmacology, 6th Edition, Jaypee, 2008.
8. L.S. Goodman, A. Gillman, The Pharmacological Basis of Therapeutics, 10th Edition, McGraw Hill, 2001.
9. S.S. Kadam, Principles of Medicinal Chemistry, Vol.I & II, Pragati Books, 2008.

10. C.O. Wilson, J.M. Beale, J.H. Block, Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams & Wilkins, 12th Edition, 2010

Course designed by: Dr Renjith Thomas

SBU24CH5DSE304: THEORETICAL SPECTROSCOPY AND KINETICS

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	To categorize the various regions of electromagnetic radiation and energy modes of matter	U
CO2	To interpret the interaction of radiation with matter	U
CO3	To apply spectroscopy for chemical analysis through spectral analysis	An
CO4	To categorise the chemical reactions based on the rate of reactions	U
CO5	To describe the factors affecting rate of chemical reactions	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	-	2	-	-	-	-
CO2	1	-	-	-	-	1	-	-	-	-
CO3		-	-	-	1	-	-	-	1	-
CO4	1	-	-	-	-	1	-	-	-	-
CO5	1	-	-	-	-	1	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	-	x	x	x	x
CO3	x	-	x	x	x	x
CO4	-	x	x	x	-	x
CO5	-	-	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basic Spectroscopy (15 Hrs)				
Introduction: Electromagnetic radiation, regions, quantization of energy	1.1	1	1	Lecture/ PowerPoint
Types of molecular energies, absorption and emission, representation of spectra	1.2	1	1	Lecture/ PowerPoint
Factors affecting width and intensity, Born- Oppenheimer approximation	1.3	1	1	Lecture/ PowerPoint
Microwave (rotational) spectroscopy: Classification of molecules, interaction of radiation with rotating molecule	1.4	2	1	Lecture/ PowerPoint

Rigid diatomic molecules, selection rules	1.5	2	1	Lecture/ PowerPoint
Representation of rotational energy levels and spectrum, determination of bond lengths of diatomic molecules	1.6	2	1	Lecture/ PowerPoint
Effect of isotopic substitution, Stark effect, basic instrumentation, applications.	1.7	3	2	Lecture/ PowerPoint
Infra - red spectroscopy: Potential energy curve, simple harmonic oscillator, zero-point energy, force nstant	1.8	1	1	Lecture/ PowerPoint
Anharmonic oscillator, Morse curve, energy levels, selection rules	1.9	1	1	Lecture/ PowerPoint
Dissociation energies, fundamental frequencies, overtones, hot bands	1.10	2	2	Lecture/ PowerPoint
Combination frequencies, Fermi resonance, skeletal vibrations, finger print region, group frequencies	1.11	2	1	Lecture/ PowerPoint
Fundamental vibrations of water and carbon dioxide, basic instrumentation, sample handling	1.12	2	1	Lecture/ PowerPoint
Basic theory of FTIR, applications	1.13	3	1	Lecture/ PowerPoint
Module 2: Electronic spectroscopy and NMR spectroscopy (15 Hrs)				
Electronic spectroscopy: Types of electronic transitions, representation of electronic spectrum	2.1	1	1	Lecture/ PowerPoint
Born – Oppenheimer approximation and basic idea about vibrational coarse structure and rotational fine structure, Franck-Condon principle	2.2	2	2	Lecture/ PowerPoint
Dissociation and pre - dissociation	2.3	2	1	Lecture/ PowerPoint
Photoelectron spectroscopy,	2.4	2	1	Lecture/ PowerPoint
Chemical analysis by electronic spectroscopy	2.5	3	1	Lecture/ PowerPoint
Nuclear Magnetic Resonance (NMR) spectroscopy: Magnetic properties of nuclei, spin, magnetic moment	2.6	2	1	Lecture/ PowerPoint
Interaction of spin and magnetic field, Larmor precession, resonance condition	2.7	2	1	Lecture/ PowerPoint
Representation of low resolution and high-resolution spectra	2.8	2	1	Lecture/ PowerPoint
Chemical shift	2.9	2	1	Lecture/ PowerPoint
Spin-spin coupling	2.10	2	1	Lecture/ PowerPoint
Application of increased field, chemical exchange	2.11	2	1	Lecture/ PowerPoint
First order spectrum- AX, AMX systems	2.12	3	1	Lecture/ PowerPoint
Interpretation of PMR spectra of simple organic molecules like acetaldehyde, ethyl alcohol, benzene and aniline	2.13	3	2	Lecture/ PowerPoint
Module 3: Advanced Spectroscopy (15 Hrs)				
Raman spectroscopy: Quantum theory of Raman effect, Rayleigh, Stokes and anti-Stokes lines	3.1	1	1	Lecture/ PowerPoint

Classical theory, molecular polarizability and polarizability ellipsoid	3.2	2	1	Lecture/ PowerPoint
Pure rotational Raman spectra of linear molecules, position of spectral lines	3.3	2	1	Lecture/ PowerPoint
Vibrational Raman spectra	3.4	2	1	Lecture/ PowerPoint
Rule of mutual exclusion, basic instrumentation, applications	3.5	2	1	Lecture/ PowerPoint
Electron Spin Resonance (ESR) spectroscopy: Basic principle	3.6	1	1	Lecture/ PowerPoint
Hyperfine structure, ESR spectrum of methyl radical	3.7	2	1	Lecture/ PowerPoint
Factors affecting g values	3.8	2	1	Lecture/ PowerPoint
Zero field splitting and Kramers' degeneracy, McConnell equation, applications	3.9	2	1	Lecture/ PowerPoint
NQR spectroscopy: Basic principle, energy levels, energy levels of boron nucleus	3.10	2	1	Lecture/ PowerPoint
Effect on NMR spectrum, basic applications.	3.11	2	1	Lecture/ PowerPoint
Mossbauer spectroscopy: Basic principle, recoilless emission and absorption	3.12	1	1	Lecture/ PowerPoint
Isomer shift	3.13	2	1	Lecture/ PowerPoint
Fundamentals on quadrupole interaction and magnetic hyperfine interaction	3.14	2	1	Lecture/ PowerPoint
Basic applications	3.15	2	1	Lecture/ PowerPoint
Module 4: Kinetics (15 Hrs)				
Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction	4.1	4	1	Lecture/ PowerPoint
Differential and integrated form of rate expressions for zero, first and second order reactions,	4.2	4	2	Lecture/ PowerPoint
Experimental methods of the determination of rate laws	4.3	4	2	Lecture/ PowerPoint
half-life time for first order and second order reactions	4.4	4	1	Lecture/ PowerPoint
Determination of order of reactions	4.5	4	1	Lecture/ PowerPoint
Kinetics of complex reactions (integrated rate expressions up to first order only): (i) opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.	4.6	5	4	Lecture/ PowerPoint
Effect of temperature on reaction rates, effect of catalyst, Arrhenius equation; activation energy	4.7	5	1	Lecture/ PowerPoint
Collision theory of reaction rates	4.8	5	1	Lecture/ PowerPoint
Activated complex theory- Eyring equation,	4.9	5	1	Lecture/

				PowerPoint
Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.	4.10	5	1	Lecture/ PowerPoint
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. N. Banwell, E.M. McCash, Fundamentals of Molecular Spectroscopy, 5thEdn., Tata McGraw Hill, 2017.
2. G. Aruldhas, Molecular Structure and Spectroscopy, Prentice Hall of India, 2023
3. K. J. Laidler, Chemical Kinetics, 3rd Edn., Pearson Education India, 2003
4. J. Rajaram, J. C. Kuriakose, Kinetics and Mechanisms of Chemical Transformations, Macmillan India, 2006

Reference

1. P. Atkins, J. de Paula, Atkin's Physical Chemistry, 12th Edn., Oxford University Press, 2023
2. F. A. Alberty, R. J. Silby, Physical Chemistry, 4th Edn., John Wiley & Sons, 2015

Course designed by: Prof. Dr. Tomlal Jose E

SBU24CH5SEC300: ANALYTICAL INSTRUMENTATION FOR CHEMISTS

Type of Course	SEC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Prerequisite (if any)	Basic idea about spectroscopic techniques		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain basic principles of various spectroscopic techniques.	U
CO2	Draw and explain the instrumentation of various spectroscopic techniques.	U
CO3	Explain the functions and workings of different components of spectroscopic instruments.	U
CO4	Identify the practical applications of different spectroscopic techniques.	A
CO5	Explain the various sampling techniques used in spectroscopic techniques	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	2	1	-	1	2	1	-	-	1
CO2	1	2	-	-	1	-	1	-	-	-
CO3	1	1	-	-	1	-	1	-	-	-
CO4	1	1	1	-	1	-	1	-	-	1
CO5	1	1	-	-	1	-	1	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	x	x	x	x	x
CO4	x	-	-	x	-	x
CO5	-	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Molecular Spectral Measurements (18 Hrs)				
UV-Vis spectroscopic instrumentation: components sources, monochromators, detectors. Sample preparations, types of instruments, applications in qualitative and quantitative analysis.	1.1	1,2, 3,4, 5	4	Lecture and PowerPoint presentations

Molecular fluorescence and fluorometers: Photoluminiscence and concentration, electron transition in photoluminescence, factors affecting fluorescence. Instrumentation details. Fluorometric standards and reagents. Applications of photoluminescence methods. Introduction to photoacoustic spectroscopy.	1.2	1,2, 3,4	4	Lecture and PowerPoint presentations
IR spectroscopy: instrumentation designs-various types of sources, monochromators, sample cell considerations, different methods of sample preparations, detectors of IR. FTIR instruments. Application in qualitative and quantitative analysis (Elementary idea only).	1.3	1,2, 3,4, 5	4	Lecture and PowerPoint presentations
Raman spectroscopy Instrumentation: Sources, sample illumination systems. Application of Raman spectroscopy in inorganic, organic, biological and quantitative analysis. (Elementary idea only)	1.4	1,2, 3,4, 5	3	Lecture and PowerPoint presentations
NMR Spectroscopy Instrumentation: Magnets, detectors, sample probes (^{1}H, ^{13}C, ^{31}P).	1.5	1,2, 3	3	Lecture and PowerPoint presentations
Module 2: Mass Spectrometry (9 Hrs)				
Ion sources - EI, CI, FI, MALDI, Electrospray and FAB	2.1	1,2, 3	3	Lecture and PowerPoint presentations
Instrumental components - mass analyzers, magnetic sector, double focussing, quadrupole, TOF, Ion trap, FT instruments.	2.2	1,2, 3	3	Lecture and PowerPoint presentations
Applications in identification of pure compounds, molecular formula, compound identification from comparison spectra, analysis of mixtures by hyphenated methods, quantitative applications. Application of MS with GC, HPLC	2.3	4	3	Lecture and PowerPoint presentations
Module 3: Atomic Absorption and Atomic Fluorescence Spectroscopy (18 Hrs)				
Atomic emission and atomic absorption phenomena: comparison of relative merits and drawbacks.	3.1	1	3	Lecture and PowerPoint presentations
Instrumentation details of AAS. Atomisation techinque flame, electrothermal and plasma techniques, glow discharge and laser ablation, sources: HCl, Detectors wavelength choice detectors	3.2	2,3, 5	5	Lecture and PowerPoint presentations
Interferences in AAS, chemical, and instrumental. Background correction techniques (Zeeman and Continuum source method), applications	3.3	1	4	Lecture and PowerPoint presentations
Atomic emission spectroscopy plasma emissions (ICP), details of wavelength selection, detection systems, applications.	3.4	1,2, 3,4	3	Lecture and PowerPoint presentations
Atomic X-ray spectrometry: emission of X-ray, absorption process, fluorescence, basic instrumentation	3.5	1,2	3	Lecture and ppt
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 7th Edn,. Cengage Learning, 2017
2. G. D. Christian, J. E. O'Reilly, Instrumental Analysis, Allyn and Bacon, Inc., 1986
3. J. G. Dick, Analytical Chemistry, R. E. Krieger Pub., 1978

Reference

1. F.A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, 1997
2. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, Instrumental Methods of Analysis, 7th Edition, CBS Publishers and Distributors, 2018
3. J. H. Kennedy, Analytical Chemistry: Principles, Saunders College Pub., 1990
4. C. L. Wilson, D.W. Wilson, Comprehensive Analytical Chemistry, Elsevier, 1982
5. F. W. Fifield, D. Kealey, Principles and Practice of Analytical Chemistry, Blackwell Science, 2000.

Course designed by: Dr Benson Joseph

SEMESTER VI

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH6DSC300	Major	Inorganic Chemistry - III	5	75	4
SBU24CH6DSC301	Major	Organic Chemistry - III	6	90	4
SBU24CH6DSC302	Major	Theoretical Chemistry	4	60	4
SBU24CH6DSE300	Elective	Forensic Chemistry	4	60	4
SBU24CH6DSE301	Elective	Chemistry of Polymeric Materials	4	60	4
SBU24CH6SEC300	SEC	Data Analysis and Digital Chemistry	3	45	3
SBU24CH6VAC300	VAC	Environmental Chemistry and Human Rights	3	45	3

SBU24CH6DSC300: INORGANIC CHEMISTRY - III

Type of Course	DSC		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Illustrate theory of kinetics and mechanism of reactions in metal complexes.	U
CO2	Summarise the structure, bonding and chemistry of inorganic clusters.	U
CO3	Discuss the chemistry of various types of reactions in organometallic compounds.	U
CO4	Describe the basic principles of analytical chemistry and various chromatographic techniques.	A
CO5	Qualitatively analyze inorganic salt mixture with one interfering anion.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	1	1	-	-	-
CO2	1	-	1	-	-	1	1	-	-	-
CO3	1	-	1	-	-	1	1	-	-	-
CO4	1	1	1	-	-	1	1	-	1	-
CO5	1	1	1	-	2	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Assignment	Written test	MCQ	
CO1	x	-	-	x	x	x
CO2	x	-	x	x	x	x
CO3	x	-	x	x	-	x
CO4	-	x	-	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	MCQ	Viva	Lab Test	Record	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Kinetics and Mechanism of Reactions in Metal Complexes (15 Hrs)				
Stability of complexes, kinetic and thermodynamic aspects of complex formation. Irving-William order of stability. Thermodynamic and kinetic template effect.	1.1	1	3	Lecture
Reactivity of metal complexes; Inert and labile complexes, stable and unstable complexes, stepwise and overall formation constants.	1.2	1	3	Lecture
Kinetics and mechanism of nucleophilic substitution reactions in square planar complexes, trans effect-theory and applications, trans influence.	1.3	1	3	Lecture
Kinetics and mechanism of octahedral substitution- water exchange, dissociative and associative mechanisms, racemization reactions, hydrolysis under acidic conditions, base catalysed hydrolysis reactions.	1.4	1	4	Lecture
Redox reactions: Marcus theory and Taube mechanism.	1.5	1	2	Lecture
Module 2: Metal Clusters and Organometallic Reactions (15 Hrs)				
Metal Clusters: Definition; low nuclearity carbonyl clusters (LNCC) and high nuclearity carbonyl clusters (HNCC). Halide type clusters	2.1	2	2	Lecture
Electron counting schemes for HNCCs-Wades rules with examples, MNO rule with examples.	2.2	2	2	Lecture
Dinuclear cluster compounds of Re, structure and bonding in $(Re_2X_8)^{2-}$, trinuclear clusters, tetranuclear clusters, hexanuclear clusters.	2.3	2	2	Lecture
Introduction to Chevrel phases, Polyatomic zintl anions and cations	2.4	2	1	Lecture
Organometallic Reactions: Nucleophilic ligand substitution, oxidative addition and reductive elimination.	2.5	3	3	Lecture
Migratory insertion reactions: mechanism of 1,1-and 1,2-insertion reactions, nucleophilic and electrophilic attack on coordinated ligands.	2.6	3	3	Lecture
Rearrangement reactions and fluxional isomerism, 1,2-additions to α,β-unsaturated carbonyl compounds.	2.7	3	2	Lecture
Module 3: Analytical Chemistry (15 Hrs)				
Evaluation of analytical data, significant figures.	3.1	4	1	Lecture
Errors, accuracy and precision, methods of their expression, normal law of distribution, determinate and indeterminate errors.	3.2	4	2	Lecture
Statistical test of data; F, Q, and t test, rejection of data, and confidence intervals.	3.3	4	1	Lecture
Solvent extraction: classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions.	3.4	4	3	Lecture

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.	3.5	4	2	Lecture
Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition and ion exchange.	3.6	4	2	Lecture
Development of chromatograms: frontal, elution and displacement methods.	3.7	4	1	Lecture
Basic principles and applications of LC, GLC, GPC, TLC and HPLC.	3.8	4	3	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Vikas Publishing Co., Jalandhar, 2013.
2. P. L. Soni, Text Book of Inorganic Chemistry, S. Chand and Sons, 2007.
3. H. Kaur, Chromatography, Pragati Prakashan, 2021.

Reference

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edn. Pearson Education, 2006.
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edn, Chapman & Hall, 2002.
3. D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 3rd Edn., Oxford University Press, New Delhi, 2004.
4. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., Wiley Interscience, 1999.
5. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, USA, 1988.
6. Christian, Gary D; Analytical Chemistry, 6th Edn. John Wiley & Sons, New York, 2004.
7. D. West, D. Skoog, F. Holler, S. Crouch, Fundamentals of Analytical Chemistry, 10th Edn, Brooks/Cole, 2021.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Qualitative Inorganic Analysis				
Qualitative analysis of binary salt mixtures Systematic qualitative analysis of inorganic salt mixtures containing two cations and two anions from the following with one interfering anion. Anions: CO_3^{2-}, S^{2-}, SO_4^{2-}, NO_3^-, F^-, Cl^-, Br^-, BO_2^- $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, CH_3COO^-, PO_4^{3-}, AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-} Cations: Ag+, Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, Li^+, Na^+, K^+, NH_4^+ Elimination of interfering anions Identification and confirmation tests are expected.	5.1	5	30	Lab work

A minimum of four inorganic salt mixtures with one interfering anion must be done and recorded.

Reference

1. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999.
2. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
3. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Edn. The English Language Book Society of Longman 2019.

Course Designed by: Dr. Jinesh M. Kuthanapillil

SBU24CH6DSC301: ORGANIC CHEMISTRY - III

Type of Course	Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	60	90
Pre-requisite (if any)	Basics of organic chemistry and reaction mechanisms		

Course Outcomes

No.	Description	Cognitive Level
CO1	Summarize the preparation, identification, and reactions of aliphatic and aromatic nitro compounds and amines.	U
CO2	Identify the preparation and synthetic applications of aromatic diazonium compounds.	A
CO3	Differentiate aliphatic and aromatic carboxylic acids and master the preparation and reactions of carboxylic acid derivatives and benzene sulphonic acids.	A
CO4	Demonstrate the ability to plan and execute chromatographic separation techniques.	A
CO5	Develop proficient skills in designing and implementing organic synthesis strategies, incorporating environmentally conscious and sustainable practices.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		1	-	1	1	1	-	-	-
CO2	1		1	-	1	1	1	-	-	-
CO3	1		1	-	1	1	1	-	-	-
CO4	1	2	1	-	2	2	1	-	1	2
CO5	1	2	2	-	2	2	1	-	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written test	MCQ	
CO1	-	x	-	x	x	x
CO2	-	x	-	x	-	x
CO3	x	-	x	x	x	x
CO4	-	-	-	-	-	-
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva voce	Lab test	Laboratory report	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	x	-	x	x	x	x
CO5	x	x	-	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Nitrogen Compounds (15 Hrs)				
Preparation of aliphatic and aromatic nitro compounds. Nitro-aci-tautomerism. Mulliken-Barker test for identifying nitroalkanes and nitroarenes. Reactions of aliphatic nitro compounds - reduction in acidic and neutral media, Nef carbonyl synthesis, Henry reaction, hydrolysis, reaction with nitrous acid.	1.1	1	3	Lecture/PowerPoint or Video Presentation
Reactions of aromatic nitro compounds - reduction in acidic, neutral and alkaline medium, hydrogenation.	1.2	1	2	Lecture/PowerPoint or Video Presentation
Preparation of aliphatic amines - general methods for the preparation of primary, secondary and tertiary amines- reductive amination, Hofmann hypobromite reaction, Schmidt reaction, Lossen rearrangement. Separation of primary, secondary and tertiary amines with Hinsberg and Hofmann methods.	1.3	1	4	Lecture/ PowerPoint or Video Presentation
Reactions of amines - with mineral acids, nitrous acid and carbonyl compounds (formation of enamines), carbylamine reaction, Liberman's nitrosamine reaction, Hoffmann's exhaustive methylation.	1.4	1	3	Lecture/ PowerPoint or Video Presentation
Preparation of aromatic diazonium compounds: Structure and stability of benzene diazonium salts. Reactions: substitution, reduction and coupling reactions, Sandmeyer, Gatterman and Gomberg reactions. Applications- conversion to benzene, phenol, halo, cyano and nitro benzenes and preparation of azo dyes.	1.5	2	3	Lecture/ PowerPoint or Video Presentation
Module 2: Carboxylic and Sulphonic Acids (15 Hrs)				
Nomenclature and classification of aliphatic and aromatic carboxylic acids. Acidity- effect of substituents on acidity of carboxylic acids (aliphatic acids, mono, di, tri-chloro acetic acids, benzoic acid, o/m/p-nitro benzoic acids).	2.1	3	3	Lecture/ PowerPoint or Video Presentation
Dicarboxylic acid: methods of formation, properties and uses of dicarboxylic acids, hydroxy acids and unsaturated acids like oxalic, succinic, adipic, phthalic, tartaric, citric, cinnamic, crotonic, maleic and fumaric acid.	2.2	3	3	Lecture/ PowerPoint or Video Presentation
Reactions: HVZ reaction, preparation of coumarin - Fries rearrangement (Mechanism expected). Action of heat on hydroxyl and saturated dicarboxylic acids.	2.3	3	3	Lecture/ PowerPoint or Video Presentation
Carboxylic acid derivatives: Preparation and general reactions of acid chlorides, acid anhydrides, amides and esters.	2.4	3	3	Lecture/ PowerPoint or Video Presentation

Benzene sulphonic acids- preparation, reactions and uses. Benzene sulphonyl chlorides: ortho and para toluene benzene sulphonyl chlorides - preparation and uses.	2.5	3	3	Lecture/ PowerPoint or Video Presentation
Module 3: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. A. Bahl, B. S. Bahl, Advanced Organic Chemistry, S. Chand & Company Pvt Ltd, 2016.
2. S. S. Gupta, Organic Chemistry, Oxford University Press, 2017.
3. N. Tewari, Organic Chemistry- A Modern Approach, Volume-III, McGraw Hill Education, 2019.
4. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, Golden Jubilee Year edition, Vishal Publishing Company, 2020.
5. S. M. Mukherji, S. P. Singh, Reaction Mechanism in Organic Chemistry, Revised Edition, Trinity Press, 2015.

Reference

1. F. A. Carey, R. M. Giuliano, Organic Chemistry, 10th Edition, 2016.
2. I. L. Finar, Organic Chemistry, Volume - I, 6th Edition, Pearson, 2002.
3. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th Edition, Pearson Education India, 2010.
4. V. K. Ahluwalia, Rakesh Kumar Parashar, Organic Reaction Mechanism, 4th Edition, Narosa Publishing House, 2022.
5. M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 7th Edition, Wiley, 2015.
6. Maya Shankar Singh, Advanced Organic Chemistry - Reactions & Mechanisms, Pearson, 2014.

Practical

Synthetic Organic Chemistry & Separation Techniques

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 4: Introduction to Chromatographic Separations (10 Hrs)				
TLC: Separation and identification - Determination of Rf value of i. o-nitrophenol ii. p-nitrophenol iii. mixture of ortho and para nitrophenol iv. mixture of ortho and para nitroaniline ***(Any two- including one mixture)***	4.1	4	5	Demonstration Lab work
Column chromatography: Purification of i. p-nitrophenol ii. p-nitroaniline iii. meta-dinitrobenzene ***(Any one purification)***	4.2	4	5	Demonstration Lab work

Module 5: Synthetic Organic Chemistry (30 Hrs)				
i. Synthesis of benzanilide from aniline ii. Synthesis of phenyl benzoate from phenol iii. Synthesis of p-nitro acetanilide iv. Synthesis of α-nitro naphthalene v. Synthesis of 3,5-dinitro benzoic acid vi. Synthesis of 2,4-dinitrotoluene vii. Synthesis of 1-chloro-2,4-dinitroenzene viii. Synthesis of picric acid ix. Synthesis of sodium p-toluene sulphonate x. Synthesis of sodium β-naphthalene sulphonate xi. Synthesis of sulphanilic acid xii. Synthesis of phenolphthalein xiii. Synthesis of phthalimide xiv. Synthesis of hippuric acid from glycine xv. Synthesis of anthracene-maleic acid adduct xvi. Synthesis of benzene azo-β-naphthol from aniline xvii. Synthesis of benzoic acid from ethyl benzoate xviii. Synthesis of benzoic acid from benzamide xix. Synthesis of benzoic acid from benzyl chloride xx. Synthesis of 5-nitro salicylic acid from salicylic acid xxi. Synthesis of m-dinitrobenzene xxii. Synthesis of glucosazone from glucose *xxiii.* Synthesis of urea nitrate from urea *xxiv.* Synthesis of benzyl thiouronium chloride ***(Any ten preparations)***	5.1	5	30	Demonstration Lab work
Module 6: Green and Microwave-Assisted Synthesis (20 Hrs)				
Green synthesis of i. 1,1-bis -2-naphthol ii. Acetanilde from aniline iii. o-methyl acetanilide from o-toludine iv. Benzilic acid from benzil. v. Nitration of phenol ***(Any four synthesis)***	6.1	5	10	Demonstration Lab work
Microwave-assisted green synthesis of i. 2-hydoxy chalcone from salicylaldehyde and acetophenone. ii. Benzoic acid from ethyl benzoate iii. Benzoic acid from alcohol iv. Benzoic acid from methyl benzoate v. Benzoic acid from benzamide vi. Ethyl-3-nitrobenzoate from 3-nitrobenzoic acid vii. Benzoic acid from toluene viii. Propyl benzoate from benzoic acid and n-propanol ix. Benzyl alcohol from benzyl chloride ***(Any four synthesis)***	6.2	5	10	Lab work

Textbook

1. A. O. Thomas, Practical Chemistry, 7th Edition, Scientific Book Centre, Kannur, 1999.

2. Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Longman Scientific and Technical, 2003.
3. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4th Edition, Pearson Education, 2009
4. N. K. Vishnoi, Advanced Practical Organic Chemistry, 3rd Edition, Vikas Publications, 2013.
5. G. D Gem Mathew, Advanced Practical Organic Chemistry, Vishal Publishing, Delhi, 2014.

Reference

1. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry: Preparations and Quantitative Analysis, Universities Press, 2004.
2. R. Adams, J. R. Johnson, J.F. Wilcox, Laboratory Experiments in Organic Chemistry, Macmillan, 1979.
3. P Anatas and J C Warner, Green Chemistry Theory and Practice. Oxford Science Publications, 1998.
4. Madhvi A. Surati, Smita Jauhari, K. R. Desai, A brief review: Microwave assisted organic reaction, Scholars Research Library, 2012.

Course designed by: Dr Sajini T

SBU24CH6DSC302: THEORETICAL CHEMISTRY

Type of Course	DSC		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Knowledge on atomic structure and mathematics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the fundamentals of molecular quantum mechanics	U
CO2	Explain the postulates of quantum mechanics and related concepts through problems	A
CO3	Explain how to apply quantum mechanics to solve chosen problems related to chemistry and physics	A
CO4	Explain the fundamentals of group theory	U
CO5	Describe different molecular and crystallographic point groups	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	2	-	2	1	2	-	-	-
CO2	1	-	1	-	1	2	1	-	-	-
CO3	2	-	2	-	2	1	2	-	-	-
CO4	2	-	2	-	1	2	2	-	-	-
CO5	1	-	1	-	2	1	1	-	-	-

Mapping of CO to Assessment Tools

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva	Written Test	MCQ	
CO1	x	-	x	x	x	x
CO2	x	-	x	x	-	x
CO3	-	x	x	x	x	x
CO4	-	x	x	x	-	x
CO5	x	-	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Quantum Mechanics (20 Hrs)				
A brief history of quantum mechanics: development of the theory, black-body radiation, heat capacity, photoelectric and Compton effects, atomic spectra, Davisson and Germer experiment	1.1	1	2	Lecture
The duality of matter: de Broglie relation	1.2	1	2	Lecture

Operators in quantum mechanics: linear operators; eigen functions and eigen values; commuting and non-commuting operators with examples and significance; construction of operators	1.3	1	2	Lecture
Distinction between dynamical variables and observables with examples, simultaneous and complementary observables, the uncertainty principle	1.4	1	2	Lecture
Hermitian operators: definition of hermiticity, confirming the hermiticity of operators, consequences of hermiticity	1.5	1	2	Lecture
Postulates of quantum mechanics: postulates on states and wavefunctions, operators, outcome of measurements, interpretation of the wavefunction and dynamic evolution of the wavefunction	1.6	2	2	Lecture
Characteristics of wavefunctions: constraints on the wavefunctions; Born interpretation of the wave function, probability and probability density in quantum mechanics and their significance	1.7	2	2	Lecture
Stationary state wave functions; normalization, orthogonality and ortho-normalization in the context of wavefunctions	1.8	2	2	Lecture
Problems based on 1.1 to 1.8	1.9	1, 2	4	Problem Solving
Module 2: Applications of Quantum Mechanics in Chemistry (20 Hrs)				
Schrödinger wave equation: time-dependent and time-independent Schrödinger wave equations, deduction of the latter from classical wave equation	2.1	3	1	Lecture
Application to exactly solvable model problems: translation motion of free particle in one dimension, Hamiltonian and Schrödinger wave equation, solutions	2.2	3	1	Lecture
Particle on a ring: Hamiltonian and Schrödinger wave equation, solutions, normalized wave functions, circular harmonics, quantization of energy	2.3	3	1	Lecture
Particle in one dimensional box with infinite potential walls: Hamiltonian and Schrödinger wave equation, solution, normalization of the wave functions, calculation of energy, plots of probability density	2.4	3	2	Lecture
Particle in 3D box: Hamiltonian and Schrödinger wave equation, solutions (derivation not required), calculation of energy, concept of degeneracy	2.5	3	2	Lecture
Quantum Harmonic Oscillators: Hamiltonian and Schrödinger wave equation, solution (derivation is not expected), Hermite polynomials, normalization of the wave functions, expression for energy, zero-point energy, plots of probability density, comparison between classical and harmonic oscillators	2.6	3	2	Lecture
Rigid rotors: Hamiltonian and Schrödinger wave equation, solutions (derivation is not expected). Spherical harmonics	2.7	3	2	Lecture
Hydrogenic systems: Schrödinger wave equation, solutions (derivation is not expected). Hydrogenic radial	2.8	3	2	Lecture

wavefunctions, radial distribution functions, curves. Hydrogenic atomic orbitals: s, p, d and f orbitals				
Introduction to quantum numbers: principal, azimuthal, magnetic, and spin quantum numbers	2.9	3	2	Lecture
Spin: concept, examples, discovery by Stern-Gerlach experiment	2.10	3	2	Lecture
Problems based on 2.1 to 2.8	2.11	3	3	Problem Solving
Module 3: Introduction to Group Theory (20 Hrs)				
Group theory: introduction, the symmetries of objects, group theory as mathematical theory of symmetry	3.1	4	1	Lecture
Symmetry operations and elements: identity, n-fold rotation, reflection, inversion, n-fold improper rotation with examples	3.2	4	2	Lecture
Mathematical groups, types of groups: Abelian, non-Abelian and cyclic groups, order of a group. Sub-groups, similarity transformation and conjugate elements (only basics), Classes in group theory	3.3	4	2	Lecture
Introduction to molecular point groups: Schoenflies symbols, conditions to be satisfied by the elements to form a group, examples of C_{nv} and D_{nh} point groups with special reference to C_{2v} (H_2O), C_{3v} (NH_3) and D_{3h} (BF_3), and their symmetry elements	3.4	5	2	Lecture
Introduction to group multiplication tables: construction of group multiplication tables for C_{2v} and C_{3v} point groups, isomorphic groups with examples	3.5	5	2	Lecture
Molecular point groups in detail: Assigning point groups to molecules based on symmetry elements, Examples from C_1, C_s, C_i, C_n, C_{nv}, C_{nh}, D_n, D_{nh}, D_{nd}, S_n, cubic and icosahedral groups (*T, O, I*), and full rotation group (R_3) for atoms	3.6	5	5	Lecture
Internal symmetry in crystals: 32 Point groups corresponding to 7 crystal systems, Hermann-Mauguin notations (only basics)	3.7	5	2	Lecture
Introduction to space groups: 14 Bravais lattices and 230 space groups (only basics)	3.8	5	2	Lecture
Translational elements of symmetry: screw axis and glide plane. Space groups with- and without translational elements of symmetry, comparison between molecular and crystallographic symmetry	3.9	5	2	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2020
2. M. S. Gopinathan, V. Ramakrishnan, Group theory in Chemistry, 2nd Edition, Vishal Publishing Co., 2013

Reference

1. P. Atkins, R. Friedman, Molecular Quantum Mechanics, 5th Edition, Oxford University Press, 2011
2. P. Atkins, J. Paula, J. Keeler, Physical Chemistry International Edition, Oxford University Press, 2018
3. T. Engel, Quantum Chemistry and Spectroscopy, 3rd Edition, Pearson Education, 2015
4. J. J. Sakurai, Advanced Quantum Mechanics, 1st Edition, Pearson Education, 2002
6. R. K. Prasad, Quantum Chemistry, 4th Edition, New Age International Publishers, 2020
7. D. A. McQuarrie, Quantum Chemistry, Viva Books, 2016
8. I. N. Levine, Quantum Chemistry, 7th Edition, Pearson Education, 2016
9. A. K. Chandra, Introductory Quantum Chemistry, 4th Edition, McGraw Hill Education, 2017
10. F. A. Cotton, Chemical Applications of Group Theory, 3rd Edition, Wiley, 2008

Course designed by: Dr. Cyril Augustine V.

SBU24CH6DSE300: FORENSIC CHEMISTRY

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Develop critical and analytical subject expertise in the field of forensic science.	U
CO2	Describe the prominence of fingerprints in forensic science and methods of their examination, identification and development.	A
CO3	Summarize the scientific aspects of crime scene investigations, management and its reconstruction.	An
CO4	Demonstrate various forgery methods, analysis and detection of forgery.	U
CO5	Familiarize with legal aspects of crime, effective means of prevention, some case studies of crime and their examination.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	1	2	1	1	-	2	1
CO2	1	2	1	1	2	1	2	-	2	1
CO3	1	2	1	1	2	1	2	-	2	1
CO4	1	2	1	1	2	1	1	-	2	1
CO5	1	1	2	1	2	1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Presentation/Discussion	Written test	MCQ	
CO1	x	-	-	x	x	x
CO2	x	-	x	x	x	x
CO3	x	-	x	x	-	x
CO4	x	-	-	x	-	x
CO5	x	-	-	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Forensic Chemistry (12 Hrs)				
Introduction to forensic chemistry, branches of and cases involved in forensic chemistry, preliminary and confirmatory methods used in forensic chemistry.	1.1	1	2	Lecture/Powerpoint presentation

Laws and basic principles of forensic science, branches of forensic science, organizational set-up of a forensic science laboratory. Investigative strategies.	1.2	1	1	Lecture/ppt
Sampling of chemical evidences, presumptive, screening (colour/ spot test), inorganic analysis. Examination procedures involving standard methods and instrumental techniques. Significance of alcohol in breath and breath screening devices.	1.3	1	2	Lecture/ ppt
Fundamentals of sample collection and interpretation. Extraction of samples from debris (distillation, filtration, direct and solvent extraction methods) and their analysis.	1.4	1	1	Lecture/ ppt
Preservation and marking of documents, importance of natural variations and disguise in writing.	1.5	1	2	Lecture/ ppt
Various types of forensic documents- genuine and forged documents, holographic documents, principles of handwriting identification, basic tools needed for Forensic Document Examination & their use, analysis of paper and inks.	1.6	1	2	Lecture/ ppt
Various writing features and their estimation, general characteristics of handwriting, individual characteristics of handwriting, ethnic and gender variability of handwriting.	1.7	1	2	Lecture/ ppt
Module 2: Fingerprints in Forensic Science (12 Hrs)				
Dactyloscopy, dermatoglyphics, basis of the science of fingerprints, morphogenesis of friction ridge skin, definition of fingerprint, fingerprint as forensic evidence, visible fingermarks, latent fingermarks.	2.1	2	3	Lecture/ ppt
Classification of fingerprints- Henry's system of classification, single-digit Classification. Automatic fingerprint identification system (AFIS). Poroscopy and edgeoscopy.	2.2	2	2	Lecture/ ppt
Biometric evidences: finger impressions, retina, iris pattern, voice, gait pattern, face recognition, 3D face recognition, multibiometric systems and their recent developments, biometric databases.	2.3	2	2	Lecture/ ppt
Collection, tracing, lifting and casting of impressions. Casting of footprints in different medium, electrostatic lifting of latent footprints.	2.4	2	2	Lecture/ ppt
Methods of development of latent fingerprints-Powdering (black and grey, fluorescent and magnetic), fuming method, chemical method, reagent chemistry and formulations, sequential treatment and enhancement (brief idea only).	2.5	2	3	Lecture/ ppt
Module 3: Fundamentals of Criminalistics (12 Hrs)				
Securing the crime scene (via photography and sketching) and its documentation. Hypothesis formulation and crime scene reconstruction.	3.1	3	1	Lecture/ ppt
Crime scene photography and basic use of forensic photography- photographs as evidence, close-up work. Digital photography of crime scene. Introduction to	3.2	3	3	Lecture/ ppt

forensic use of digital images, resolution, colour space, file formats, photo sensors, memory and media, computing images				
Crime scene investigations, protecting and isolating the crime scene; Documentation, sketching, field notes and photography. preservation and transportation of physical evidences. Chain of custody and Reconstruction of scene of crime. Report writing.	3.3	3	3	Lecture/ ppt
Forensic Video Analysis: Introduction to video, Video Cameras, Video images, Video Captures, CCTVs, Retrieval of images and their evidence analysis	3.4	3	1	Lecture/ ppt
Accidental explosion during manufacture of matches and fireworks. Metal detector devices and other security measures for VVIP.	3.5	3	2	Lecture/ ppt
Chemistry and forensic examination of Bribe trap cases using Phenolphthalein.	3.6	3	1	Lecture/ ppt
Introduction to cosmetics of forensic interest and their role in crime investigation.	3.7	3	1	Lecture/ ppt
Module 4: Forgery and Counterfeiting (12 Hrs)				
Forgery and its types and characteristics, identification and examination of forgeries.	4.1	4	1	Lecture/ ppt
Different types of forged signatures-simulated and traced forgeries- inherent signs of forgery methods- writing deliberately. Examination of forged documents. Uses of ultraviolet rays- comparison of type written letters.	4.2	4	2	Lecture/ ppt
Various types of forgeries and their detection, examination of signatures – characteristics of genuine and forged signatures, identification of forger, identification of writer of anonymous letters.	4.3	4	2	Lecture/ ppt
Examination of passport/visas, stamp papers, postal stamps etc., examination of fake credit cards, e documents, digital signatures. Introduction to computer forensics,	4.4	4	2	Lecture/ ppt
Determination of age of documents by examination of signatures, paper, ink etc., Examination of alterations, erasures, over writings, additions and obliterations, decipherment of secret writings, indentations & charred documents, physical matching of documents, examination of seal, rubber and other mechanical impressions	4.5	4	2	Lecture/ ppt
Checking silver line water mark in currency notes, alloy analysis using atomic absorption spectroscopy detect counterfeit coins.	4.6	4	1	Lecture/ ppt
Detection of gold purity in 22 carat ornaments - detecting gold plated jewels - authenticity of diamond. Hall marking.	4.7	4	2	Lecture/ ppt
Module 5: Legal Aspects of Forensic Science (12 Hrs)				
Definition, concept and scope of crime. Types of crime. Causes, effects, control and prevention of crime. Aim and scope of criminology.	5.1	5	2	Lecture/ ppt

Criminal behaviour and theories of criminal behaviour: classic, positivist, sociological. Organized crimes, white collar crime. Juvenile delinquency.	5.2	5	2	Lecture/ ppt
Charges: bailable/non-bailable offences, cognizable/ non-cognizable, summon case and warrant cases. Expert testimony. Arms Act, Explosives Act.	5.3	5	2	Lecture/ ppt
Difference between a civil case & a criminal case, case acceptance, case opening, and case examination, production of evidence, expert witness.	5.4	5	2	Lecture/ ppt
Introduction of forensic criminology, control and prevention of crime in context with organization. Food and adulteration act, drugs and cosmetic act, arms act, explosives act.	5.5	5	2	Lecture/ ppt
Introduction to criminal profiling, definition, need and types, forensic scientific evidence, crime and psychopathology, genetics and crime, serial murders. Modus Operandi.	5.6	5	2	Lecture/ ppt
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Houck, M.M & Siegel, J.A; Fundamentals of Forensic Science, 2nd Edition, Academic Press, London, 2006.
2. Sharma, B.R; Forensic Science in Criminal Investigation & Trials, 6th Edition, Universal Publishing Co., New Delhi, 2003.
3. James, S.H and Nordby, J.J; Forensic Science- An Introduction to Scientific and Investigative Techniques, 4th Edition, CRC Press, USA, 2003.
4. Saferstein; Criminalistics- An Introduction of Forensic Science, 12th Edition, Prentice Hall Inc, USA, 2007.
5. Barry, A.J. Fisher; Techniques of Crime Scene Investigation, 7th Edition, CRC Press, New York, 2003.
6. Mordby, J. & Reckoning, D; The Art of Forensic Detection, 1st Edition, CRC Press New York, 2003.
7. G.R. Chatwal; Analytical Spectroscopy, 2nd Edition, Himalaya Publishing House New Delhi, 2002.
8. Robertson and Vignaux; Interpreting Evidence, 1st Edition, John Wiley, New York, 1995.
9. Lyman, M.D; Criminal Investigation-The Art &the Science, 2nd Edition, Prentice Hall, New Jersey, 2002.
10. O'Hara CE &Osterburg, JW; An Introduction to Criminalistics, 1st Edition, Indiana University. Press, London, 1972.

Course designed by: Dr. Ajith R. Mallia

SBU24CH6DSE301: CHEMISTRY OF POLYMERIC MATERIALS

Type of Course	DSC		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	**Basic organic chemistry**		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the history, basic properties, and characteristics of different types of polymers (commercial as well as speciality polymers) and their recycling	U
CO2	Familiarize with mechanism of polymerisation	U
CO3	Learn the structure property relationship of polymers and basic degradation mechanisms associated with polymer systems	U
CO4	Study the different types of polymerisation techniques and processing methods	U
CO5	Study the vulcanisation process associated with natural rubber and learn how to develop a recipe for a rubber compound	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	1	1	-	-	1
CO2	2	2	1	-	1	2	2	-	1	2
CO3	2	1	1	-	1	1	1	-	1	2
CO4	1	1	1	-	2	1	1	-	1	2
CO5	1	2	1	-	2	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Seminar or Assignment	Viva	Written test	MCQ	
CO1	-	-	x	x	x	x
CO2	-	x	x	x	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	x	-	x
CO5	x	-	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction and Polymerization Reactions (15 Hrs)				
History of polymer and general characteristics of polymers in comparison with common organic compounds.	1.1	1	1	Lecture/presentation

Polymers and macromolecules – Monomers – Homo and hetero polymers – Copolymers - Classification based on origin (natural, semi synthetic and synthetic), synthesis (addition and condensation), structure (linear, branched, chain and cross linked) and intermolecular forces (elastomers, fibres, thermoplastics and thermosetting polymers).	1.2	1	3	Lecture/presentation
Tacticity of polymers. Definitions and importance of isotactic, syndiotactic, and atactic polymers. Relationship between tacticity and polymer chain conformation Influence of tacticity on the glass transition temperature (Tg) and melting temperature (Tm)	1.3	1	3	Lecture/presentation
Chain and step growth polymerisations – Free radical, ionic (both cationic and anionic) and coordination polymerisations with mechanism – Zeigler-Natta polymerization and its advantages (mechanism expected for all). Living polymerization. Brief discussions on the kinetics (derivation not required).	1.4	2	4	Lecture/presentation
Copolymerization and its mechanism. Ring-opening & group transfer polymerizations (Mechanism expected). Self healing and shape memory polymers (basic idea only).	1.5	2	4	Lecture/presentation
Module 2: Structure-Property Relationships of Polymers and Polymer Degradation (15 Hrs)				
Crystallization and Crystallinity: Determination of crystalline melting point and degree of crystallinity. Factors affecting crystalline melting point.	2.1	3	1	Lecture/presentation
Molecular weight of polymers***:*** Determination of Molecular Weight of Polymers (*Mn*, *Mw*, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods (Derivation for light scattering and osmotic pressure method). Molecular weight distribution and its significance.	2.2	3	4	Lecture/presentation
Polydispersity index and its significance - Molecular weights and degree of polymerisation.	2.3	3	3	Lecture/presentation
Glass Transition Temperature (Tg): Definition. Factors influencing glass transition temperature (Tg). Tg and molecular weight. Tg and melting point. Importance of Tg.	2.4	3	3	Lecture/presentation
Degradation: Basic idea of thermal, photo and oxidative degradations of polymers. Basic determinants of polymer properties: Polymer chain flexibility, Factors affecting chain flexibility etc (basic idea).	2.5	3	4	Lecture/presentation
Module 3: Polymerisation Techniques and Processing (8 Hrs)				
Polymerisation Techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerisations (advantages and disadvantages of each method is also required).	3.1	4	4	Lecture/presentation
Polymer Processing: Compression moulding, Injection moulding, Blow moulding, Extrusion moulding, Thermoforming, Die casting, Film casting, Rotational casting, Calendering and Spinning (advantages and	3.2	4	4	Lecture/presentation

disadvantages of each method is also required). Polymer industry in India.				
Module 4: Commercial Polymers and Recycling of Polymers (7 Hrs)				
Preparation, properties, and uses of polyethylene (LDPE and HDPE), polypropylene, polystyrene, PVC, PVP, teflon, PAN, PMMA, synthetic rubbers (BR, SBR, nitrile rubber, neoprene, butyl rubber and silicone rubber), and polyurethanes, poly carbonates, silicones, phenol-formaldehyde resin and urea-formaldehyde resin.	4.1	1	3	Lecture/presentation
Plastic identification codes, Pollution due to plastics - Recycling of plastics.	4.2	1	1	Lecture/presentation
Industrial visit: Visit to an Industry or R&D lab to understand the processing and how final products are made of any of these polymers.	4.3	1	3	Industrial Visit
Module 5: Specialty Polymers (7 Hrs)				
High temperature resistant and flame retardant polymers.	5.1	1	1	Lecture/presentation
Biomedical applications of polymers.	5.2	1	1	”
Controlled drug delivery systems.	5.3	1	2	”
Conducting polymers - polyacetylene, polyaniline, polypyrrole, Conduction mechanism of any one of the above and applications.	5.4	1	3	”
Module 6: Vulcanisation of rubber and Mechanical Properties (8 Hrs)				
Introduction to vulcanisation of natural rubber - types of vulcanisations {(Efficient Vulcanization (EV), semi-efficient vulcanization and conventional vulcanization (CV)}, activator system, accelerator system, anti-oxidants, plasticizers.	6.1	5	3	Lecture/presentation
Rheograph, cure time, scorch time.	6.2	5	1	Lecture/presentation
Compound development-formulation of mixes, basic recipe, typical simple rubber formulations – rubber mats, rubber band etc.	6.3	5	2	Lecture/presentation
Mechanical properties-stress, strain, elongation, modulus of elasticity, ultimate strength, stress- strain behaviour of different types of polymers, tensile strength, tear strength, hardness, impact properties (basic ideas).	6.4	5	2	Lecture/presentation
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Claude M. Blow, Claude Hepburn, Rubber Technology and Manufacture, Elsevier Science & Technology Books, 1982.
2. Howard L. Stephens, Krishna C. Baranwal, Basic Elastomer Technology, Rubber Division, American Chemical Society, 2001.
3. V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age International (P) Ltd., 2011

4. B.K. Sharma, Polymer Chemistry, Goel Publishing House, Meerut, 1989
5. F. Mohammad, Specialty Polymers: Materials and Applications, I. K. International Pvt Ltd, 2007
6. R. Bahadur, N. V. Sastry, Principles of Polymer Science, Narosa, New Delhi, 2003

Reference

1. Anil K. Bhowmick, Malcom M Hall, Henry A Benarey, Rubber Products Manufacturing Technology, Marcel Dekker, 1994.
2. G. Odian, Principles of Polymerization, 4th Edn., Wiley, 2004
3. F.W. Billmeyer Jr, Textbook of Polymer Science, John Wiley and Sons, New Delhi, 2007
4. M. G. Arora, M. Singh, M. S. Yadav, Polymer Chemistry, 2nd Revised Edition., Anmol Publications Private Ltd., New Delhi, 1989
5. M. P. Stevens, Polymer Chemistry: An Introduction, 3rd Edition, Oxford University Press, USA, 1998
6. R. W. Lenz, Organic Chemistry of Synthetic High Polymers, Interscience Publishers, New York, 1967
7. R. W. Dyson, Specialty Polymers, Chapman and Hall, New York, 1998

Course designed by: Dr Gejo George

SBU24CH6SEC300: DATA ANALYSIS AND DIGITAL CHEMISTRY

Type of Course	SEC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)	Basic mathematics and computer knowledge		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe scientific methods for designing experiments systematically	U
CO2	Apply statistical tools for data analysis	A
CO3	Drawing, and interpretation of spectroscopic data	A
CO4	Drawing and visualization of chemical structures and schemes	A
CO5	Apply scientific communication skills to prepare presentations and mini-reviews.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	1	1	1	-	1	1	1
CO2	1	2	-		1	1	-	1	1	1
CO3	1	1	-	1	1	1	-	1	1	1
CO4	1	1	-	1	1	1	-	1	1	1
CO5	1	1	-	1	1	1	-	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written test	MCQ	
CO1	-	x	x	x	-	x
CO2	-	x	x	x	x	x
CO3	-	-	x	x	x	x
CO4	-	-	x	x	x	x
CO5	x	-	-	-	-	-

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Data Analysis and Presentation (16 Hrs)				
The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.	1.1	1	3	Lectures, Computer classes, and online resources
Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests.	1.2	2	4	Lectures, Computer classes, online resources

Chemometrics. Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, Basic aspects of multiple linear regression analysis.	1.3	2	6	Lectures, Computer classes, online resources
Scientific data presentation, and formatting (MS Word, and MS PowerPoint), Managing references and citations (Zotero)	1.4	5	3	Lectures, Computer aided classes, online resources
Module 2: Data Plotting and Analysis (15 Hrs)				
Importing Spectral Data (Establishing a Baseline, Finding Peaks, Integration, and Peak Fitting and Deconvolution) Spectroscopy Plot Types (Stack Graph, Stacked Lines by Y Offsets Graph, 2D Graph with Insert Graph, and 2D, 3D Waterfall Graph), Analyzing Spectra, Batch Peak Analysis	2.1	1	3	Lectures, Computer classes, online resources
UV-Vis spectra plotting, identification of absorption maxima, Absorption v/s concentration plot, and molar absorptivity measurement.	2.2	3	3	Lectures, Computer classes, online resources
IR spectra plotting, identification of absorption peaks.	2.3	3	3	Lectures, Computer classes, online resources
Powder XRD spectra plotting, identification of peaks, spacing calculations, and crystallinity determination.	2.4	3	3	Lectures, Computer classes, online resources
TGA data plotting and analysis	2.5	3	3	Lectures, Computer classes, online resources
Module 3: Chemical Analysis and Imaging (14 Hrs)				
NMR spectral analysis using free software: spectra plotting, peak identification, integration, and coupling constant calculation.	3.1	3	3	Lectures, Computer classes, online resources
Mercury, ORTEP, CSD(CCDC): Three-dimensional visualization of the X-ray crystal structure of organic and inorganic compounds, exploration of crystal packing in a unit cell, H-bonding interaction.	3.2	4	4	Lectures, Computer classes, online resources
Drawing of Chemical structures (1D, 2D, and 3D) and reaction schemes using drawing programs like Chemsketch and wwMacMolPlt, etc.	3.3	4	4	Lectures, Computer classes, online resources
ImageJ software for size determination from SEM, TEM, etc images	3.4	4	3	Lectures, Computer classes, online resources
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 7th Ed., Cengage Learning, 2017

Reference

1. D. B. Hibbert, and J. J. Gooding, Data analysis for chemistry. Oxford University Press, 2006
2. J. Topping, Errors of observation and their treatment. Fourth Ed., Chapman Hall, London, 1984
3. Origin Tutorials, https://www.originlab.com/doc/Tutorials/Tutorial-GettingStarted

Course designed by: Dr Benson Joseph

SBU24CH6VAC300: ENVIRONMENTAL CHEMISTRY AND HUMAN RIGHTS

Type of Course	VAC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)	Basic General Knowledge		

Course Outcomes

No.	Description	Cognitive Level
CO1	Study Environmental issues and learn chemicals involved in toxicology	U
CO2	Basic Understanding of Human Rights	U
CO3	Understanding Lithosphere and basic sampling techniques with focus on soil sampling	U
CO4	Learn and explore basic concepts of Air sampling	A
CO5	Learn and explore basic concepts of Water sampling	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	1	-	-	-	-	1	-	-	-	-
CO3	1	-	-	-	-	1	-	1	-	-
CO4	1	-	-	-	-	1	-	1	-	-
CO5	1	-	-	-	-	1	-	1	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Poster Presentation	In class discussions	Assignment	Written Test	Case Study	
CO1	x	x	-	x	x	x
CO2	-	x	x	x	x	x
CO3	x	-	x	x	x	x
CO4	x	-	x	x	x	x
CO5	x	-	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Chemical Toxicology, Environmental issues and highlighting Human Rights (10 Hrs)				
Chemical Toxicology: definition, toxic chemicals in the environment	1.1	1	1	Lecture
Physiological classification of materials;	1.2	1	1	Lecture
impact of toxic chemicals on enzymes	1.3	1	1	Lecture

Biochemical effects of As, Cd, Pb, Hg, CO, NOx, SO_2 O3, CN- pesticides, persistent organic pollutants and carcinogenic substances.	1.4	1	3	Lecture
Environmental issues: Chemicals causing Ozone depletion with mechanism; Gases responsible for Global warming and Green-house effect;	1.5	1	2	Lecture
Acid rain- causes and its implications; Nuclear accidents- Chernobyl incident	1.6	1	1	Lecture
Local issue case study: Kuttanad wetland system	1.7	1	1	Video Lecture
Module 2: Introduction to Human Rights (5 Hrs)				
National and International Perspectives: Definitions of Human Right, Human Rights International Norms.	2.1	2	2	Lecture/ Video Lecture
Relevance of Human Rights in India-Social Aspects-Economic Aspects-Political Aspects	2.2	2	1	Lecture/ Video Lecture
Human Rights violation in India with any three case studies	2.3	2	2	Lecture/ Video Lecture/Class Room discussions
Module 3: Lithosphere, Environmental sampling and Soil Analysis (15 Hrs)				
Lithosphere: Weathering of rocks- physical, chemical and biological processes.	3.1	3	2	Lecture
Factors controlling the formation of soil; soil profile and classification of soil.	3.2	3	2	Lecture
Composition of soil: organic and inorganic components in soil. Micro- and macro nutrients, NPK in soil. Nitrogen Cycle. Acid base and ion exchange reactions in the soil.	3.3	3	3	Lecture
Environmental Sampling: Spatial and temporal variability, Types of samples: water sampling surface and groundwater sampling, soil sampling.	3.4	3	2	Lecture
Sample preparation techniques – extraction of organic analytes from liquid samples, Preservation techniques of the samples	3.4	3	3	Lecture
Sampling and Analysis of Soil: pH, cation exchange capacity, total nitrogen, phosphorous and potassium	3.4	3	3	Lecture
Module 4: Air and Water Sampling (15 Hrs)				
Sampling and Analysis of Air Samples: CO, H2S, SO2, Solid Particulate Matter (SPM) and hydrocarbons in air sample	4.1	4	2	Lecture
Air Pollution Control Devices, Control of CO, SOx, NOx, Particulate matter and Hydrocarbons.	4.2	4	5	Lecture
Sampling and Analysis of Water: Estimation of some physico-chemical parameters of water quality such as pH, salinity, conductivity, total solids, total dissolved solids, total suspended solids, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand and hardness.	4.3	5	4	Lecture
Basic principles involved in the analysis of faecal indicator bacteria–test for coliforms–fecal coliforms–E. coli.	4.4	5	4	Lecture

Module 5: Teacher Specific Content
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)
This content will be evaluated internally

Textbooks

1. A. K. De, Environmental Chemistry, 7th Edn, New Age International, 2007
2. Gopinath Chandradasan, Environmental Chemistry, 2nd Edn, Vishal Publishing Co. Jalandhar, 2017.
3. V. K. Ahluwalia, Environmental Chemistry, 2nd Edn., Ane Books Pvt. Ltd, 2013
4. B. B. Kebbekus, S. Mitra, Environmental Chemical Analysis, 2nd Edn, Chapman and Hall, 1998

Reference

1. G. W. van Loon, S. J. Duffy, Environmental Chemistry A Global Perspective, 2d Edn, Oxford University Press, New York, 2008
2. R. P. Cote, P. G. Wells, Controlling Chemical Hazards: Fundamentals of the Management of Toxic Chemicals, 3rd Edn, Springer, 2012
3. R. B. Baird, Standard Methods for the Examination of Water and Wastewater, 23rd Edn., American Water Works Association, 2017
4. P. Singh, Environmental Pollution and Management, 1st Edn Chugh Publications, 1985
5. R. A. Malviya, Environmental Pollution and its Control Under International Law, 1st Edn, Chugh Publications, 1987

Course designed by: Dr Aravind K

SEMESTER VII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH7DSC400	Major	Spectrometric Identification of Organic Compounds	5	75	4
SBU24CH7DSC401	Major	Advanced Quantum Mechanics and Chemical Bonding	4	60	4
SBU24CH7DSC402	Major	Scientific Methods for Chemistry Research and Intellectual Property Rights	4	60	4
SBU24CH7DSC403	Major/Minor	Advanced Topics in Physical Chemistry	4	60	4
SBU24CH7DSC404	Major/Minor	Solid State Chemistry	4	60	4
SBU24CH7DSC405	Major/Minor	Molecular Symmetry and Group Theory	4	60	4

SBU24CH7DSC400: SPECTROMETRIC IDENTIFICATION OF ORGANIC COMPOUNDS

Type of Course	DSC		
Course Level	Course Level: 400 - 499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Molecular spectroscopy		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the principles of electronic transitions in organic molecules, the role of chromophores and auxochromes in UV spectroscopy, and apply the Woodward-Fieser rules to calculate λ_{max} for conjugated systems, recognizing the effects of various structural elements and solvent interactions on electronic spectra.	A
CO2	Understand the fundamental concepts and applications of IR spectroscopy in organic chemistry, including the factors affecting absorption characteristics, and apply systematic methods to interpret IR spectra for identifying and differentiating between various functional groups.	A
CO3	Understand the fundamental principles of ^{1}H and ^{13}C NMR spectroscopy, including chemical shifts, coupling effects, and the interpretation of spectra to deduce the structure and functional groups of organic compounds.	A
CO4	Understand the principles of ionization and fragmentation in mass spectrometry, apply the nitrogen rule for molecular formula determination, and interpret mass spectra to identify functional groups and structural features in organic compounds.	A
CO5	Analyse and integrate data from mass spectrometry, UV-Visible, IR, ^{1}H NMR, and ^{13}C NMR spectra to accurately elucidate and confirm the structures of various organic compounds.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	3	1	-	2	3	1	-	2	2
CO2	2	3	1	-	2	3	1	-	2	2
CO3	2	3	1	-	2	3	1	-	2	2
CO4	2	3	1	-	2	3	1	-	2	2
CO5	3	3	1	-	3	3	1	-	3	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment/ Seminar	Viva	Written test	MCQ	
CO1	x	-	x	x	x	x
CO2	x	-	x	x	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Lab involvement	Viva	Lab Test	Record	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism
Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Electronic Spectroscopy (9 Hrs)				
Overview of electronic spectroscopy and its importance in organic chemistry. Theory of electronic transitions, including σ-σ*, n-σ*, π-π*, and n-π* transitions. Types of Bands in UV spectroscopy.	1.1	1	1	Lecture/ Presentation
Definition and role of chromophores in electronic spectroscopy. Understanding auxochromes and their effect on the absorption characteristics of chromophores. The types of shifts observed in electronic spectroscopy- bathochromic, hypsochromic, hyperchromic, and hypochromic shifts.	1.2	1	2	Lecture/ Presentation
Various structural effects that remarkably influence electronic spectra include the resonance effect, hyperconjugative effect, steric effect, and hydrogen bonding effect. Conjugated systems and transition energies. The role of solvent effects on spectral characteristics and with examples from common solvents such as polar and non-polar solvents affecting the spectra differently	1.3	1	3	Lecture/ Presentation
Calculations of λmax of α, β-unsaturated carbonyl compounds, dienes and trienes based on Woodward-Fieser rules. Exceptions to Woodward-Fieser Rules. General strategies for interpreting UV-Visible spectra compounds.	1.4	1	3	Lecture/ Problem Solving Section
Module 2: Infrared Spectroscopy (9 Hrs)				
Overview of infrared (IR) spectroscopy and its significant role in organic chemistry. Elemental equation of IR spectroscopy. Factors that determine the position and intensity of IR absorptions. Overview of the four regions of the infrared spectrum.	2.1	2	1	Lecture/ Presentation
Discussion on the IR spectrum according to regions. Analysis of the fingerprint region and its significance in structure determination. Key points for the interpretation of IR spectra.	2.2	2	2	Lecture/ Presentation

Detailed explanation of characteristic frequencies of common functional groups- alkanes, alkenes, alkynes, aromatic hydrocarbons, halogen compounds, simple alcohols, phenols, amines, ethers, epoxides, anilines, aldehydes, ketones, carboxylic acids and their derivatives, nitro and sulphur compounds.	2.3	2	4	Lecture/ Presentation
Systematic approach to interpreting IR spectra, including peak assignment and differentiating between similar functional groups.	2.4	2	2	Lecture/ Discussion
Module 3: Nuclear Magnetic Resonance (NMR) Spectroscopy (15 Hrs)				
Overview of NMR phenomena-Basic principles of ^{1}H and ^{13}C NMR. Understanding chemical shift in ^{1}H. Shielding and deshielding mechanisms. Factors influencing chemical shifts. Anisotropic effects in different types of compounds	3.1	3	2	Lecture/ Presentation
Coupling effect and coupling constant *J*. Factors influencing the coupling constant. Discussion of coupling constants according to their kinds.	3.2	3	2	Lecture/ Presentation
Chemical equivalence and Magnetic equivalence. Number of NMR signals. Population densities and signal intensity.	3.3	3	2	Lecture/ Presentation
Characteristics of the ^{1}H spectra of some functional groups- linear, branched and cyclic alkanes, alkenes, alkynes, substituted aromatic compounds, substituted heteroaromatic compounds, alcohols, amines, thiols and carbonyl compounds and carboxylic acids and derivatives.	3.4	3	2	Lecture/ Presentation
Systematic approach to interpretation of ^{1} H NMR spectra- Find impurity peaks, pay attention to the solvent applied. Calculation of the unsaturation number of the unknown compound. Determination of the number of hydrogen atoms corresponding to every peak set in the ^{1}H spectrum. Determination of functional groups of the unknown compound. Analysis of coupling splitting of peak sets. Combination of possible structural units. Assignment of the ^{1}H spectrum according to the deduced structure. Checking of the deduced structure.	3.5	3	2	Lecture/ Presentation
Characteristics and advantages of the ^{13}C NMR spectra. Chemical Shift Equivalence in ^{13}C NMR spectra. Factors affecting chemical shift values.	3.6	3	1	Lecture/ Presentation
Chemical shift values of common functional groups- - Alkanes-linear and branched alkanes, effect of substituents on alkanes, cycloalkanes and saturated heterocyclics, alkenes, alkynes, aromatic compounds, heteroaromatic compounds, alcohols, ethers, acetals, and epoxides, halides, amines, thiols, ketones and aldehydes, carboxylic acids. esters. amides and nitriles.	3.7	3	2	Lecture/ Presentation
Steps for ^{13}C NMR spectrum interpretation- Recognizing impurity peaks and identifying solvent peaks. Consideration of chemical shift values of peaks.	3.8	3	2	Lecture/ Discussion

Determination of carbon atom orders. Postulation of possible functional groups.				
Module 4: Mass Spectrometry (12 Hrs)				
Basic knowledge of organic mass spectrometry and its role in organic chemistry. Understanding the basics of ionization, fragmentation, and the types of peaks observed in mass spectra.	4.1	4	2	Lecture/ Presentation
Identification and interpretation of molecular ion peaks, base peaks, and isotope peaks. Nitrogen rule and its role in deducing molecular formulae from mass spectra. Mechanistic insights into common fragmentation reactions. Factors Governing General Fragmentation Processes. Examination of specialized fragmentation mechanisms such as McLafferty rearrangement, Retro Diels-Alder reaction, and the influence of ortho effects on fragmentation.	4.2	4	4	Lecture/ Presentation
Fragmentation Modes of various classes of organic compounds- Alkanes and alkenes, aromatic hydrocarbons, amines, alcohols, ethers, and phenols, alkyl and aryl halides, ketones and aldehydes, carboxylic acids and derivatives, heterocyclic compounds, nitro compounds and sulphur compounds.	4.3	4	3	Lecture/ Presentation
Systematic approach to interpretation of Mass Spectra- Practical strategies for interpreting mass spectra. Interpretation of fragment ion peaks. Interpretation of rearrangement ion peaks. Mass spectrum patterns of common functional groups.	4.4	4	3	Lecture/ Discussion
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Y. R. Sharma, Elementary Organic Spectroscopy, 5th Edition, S. Chand & Company Ltd., 2013.
2. L. D. S. Yadav, Organic Spectroscopy, Springer Science + Business Media Dordrecht, 2005.

Reference

1. L. D. Field, S. Sternhell, J. R. Kalman, Organic Structures from Spectra, 5th Edition, John Wiley & Sons, Ltd., 2013.
2. W. Kemp, Organic Spectroscopy, 3rd Edition, Macmillan, 1991.
3. J. B. Lambert, S. Gronert, H. F. Shurvell, D. Lightner, R. G. Cooks, Organic Structural Spectroscopy, 2nd Edition, Pearson Education Limited, 2014.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Spectral Analysis and Structure Elucidation (30 Hrs)				
In this practical module, students will engage in the analysis of printed spectroscopic data, utilizing mass spectrometry, UV-Visible, IR, ^{1}H NMR, and ^{13}C NMR spectra to identify and deduce the structures of organic compounds. *Through this exercise, students will interpret provided spectra, recognizing key signals and patterns without performing the actual spectroscopy.*	6.1	5	30	Demonstration, Analysis, and Discussions

Textbook

1. Y-C. Ning, Interpretation of Organic Spectra, John Wiley & Sons (Asia) Ltd., 2011.

Reference.

1. D. F. Taber, Organic Spectroscopic Structure Determination: A Problem Based Learning Approach, Oxford University Press, 2007.
2. R. M. Silverstein, F. X. Webster, D. J. Kiemle, D. L. Bryce, Spectrometric Identification of Organic Compounds, 8th Edition, John Wiley & Sons, Inc., 2015.

Course designed by Dr Shijo K Cherian

SBU24CH7DSC401: ADVANCED QUANTUM MECHANICS AND CHEMICAL BONDING

Type of Course	DSC		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Mathematics, Physics and Chemistry at Class XII and successful completion of foundation courses in Quantum Chemistry and Group Theory		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the concept of angular momentum, shift operators and the related concepts in quantum mechanics	U
CO2	Interpret the problems of particle in 3D box and quantum harmonic oscillators	U
CO3	Describe how to approach the problems of rigid rotor and hydrogenic systems in quantum mechanics	U
CO4	Analyze valence bond and molecular orbital theory of chemical bonding and hybridization	An
CO5	Solve Hückel molecular orbital theory for simple conjugated systems for the estimation of delocalization energy and related parameters	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	2	-	-	-
CO2	2	-	1	-	1	2	1	-	-	-
CO3	1	-	1	-	2	1	2	-	-	-
CO4	1	-	1	-	1	2	2	-	-	-
CO5	2	-	1	-	2	1	2	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva	Written Test	MCQ	
CO1	x	-	x	x	x	x
CO2	x	-	x	x	-	x
CO3	-	x	x	x	x	x
CO4	-	x	x	x	-	x
CO5	x	-	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Topics in Molecular Quantum Mechanics (20 Hrs)				
Angular Momentum in Quantum Mechanics: the angular momentum operators, commutation relations, the shift operators and significance	1.1	1	3	Lecture
Atomic Orbitals: Hydrogen like, Slater and Gaussian type AOs, plots and general features	1.2	1	2	Lecture
Atomic term symbols, microstates, orbital and spin magnetic moments, spin-orbit coupling: L-S coupling, j-j coupling	1.3	1	1	Lecture
Zeeman Effect: normal and anomalous, examples, Paschen-Back effect, Stark effect, spectroscopic term symbols for diatomic molecules	1.4	1	3	Lecture
Quantum Mechanical Tunnelling: Concept, transmission coefficient, examples	1.5	1	1	Lecture
Postulate of spin by Uhlenbeck and Goudsmith, discovery of spin, Stern-Gerlach Experiment and its significance, spin-angular momentum, its orientations	1.6	1	2	Lecture
Spin-Orbitals: spin and orbital functions, construction of spin orbitals with simple examples, symmetric and antisymmetric wave functions	1.7	1	2	Lecture
The Pauli principle, Pauli Exclusion Principle, Slater Determinants: examples and significance	1.8	1	2	Lecture
The spectrum of atomic hydrogen, the energies of the transitions, selection rules	1.9	1	1	Lecture
Problems based on the above topics 1.1 to 1.9	1.10	1	3	Problem Solving
Module 2: Applications of Molecular Quantum Mechanics (20 Hrs)				
Particle in 3D box: Hamiltonian and Schrödinger wave equation, solutions with derivation, calculation of energy, concept of degeneracy	2.1	2	3	Lecture
Quantum Harmonic Oscillators: Hamiltonian and Schrödinger wave equation, solutions with derivation in detail, Hermite polynomials, normalization of the wave functions, expression for energy, zero-point energy, plots of probability density, comparison between classical and harmonic oscillators	2.2	2	3	Lecture
Rigid rotors (particle on a sphere): Hamiltonian and Schrödinger wave equation, solutions with detailed derivation. Spherical harmonics, polar diagrams for S, P and D functions	2.3	3	4	Lecture
Hydrogenic systems: Schrödinger wave equation, solutions with derivation. Hydrogenic radial wavefunctions, radial distribution functions, curves. Expressions for 1s, 2s and 2p Hydrogenic atomic orbitals, shapes of s, p, d and f orbitals	2.4	3	5	Lecture
Problems based on 2.1 to 2.4	2.5	3	5	Problem Solving

Module 3: Chemical Bonding (20 Hrs)				
Valence Bond Theory (VBT): basic principles, VBT of Hydrogen molecule in detail (derivation required), its singlet and triplet state functions	3.1	4	2	Lecture
Molecular Orbital Theory (MOT): Born-Oppenheimer approximation, representation of MOs: separated atom, united atom approaches, linear combination of atomic orbitals (LCAO), secular determinants, overlap, Coulomb and resonance integrals	3.2	4	2	Lecture
MOT of Hydrogen molecule ion in detail (with derivation), comparison of VB and MO theories	3.3	4	1	Lecture
Correlation diagrams for homonuclear and heteronuclear diatomics, significance and non-crossing rules	3.4	4	2	Lecture
Hybridization: Quantum Mechanics of sp, sp^2 and sp^3 hybridizations with examples. Derivations are expected in each case.	3.5	4	2	Lecture
Hückel Molecular Orbital Theory (HMOT): Basics, Hückel approximation. Application to Ethylene, 1, 3-Butadiene, Benzene, Allyl and Cyclopropenyl Systems, estimation of pi-electron energy and delocalization energy in each case	3.6	5	5	Lecture
Hückel 4n+2 rule for aromaticity, Frost-Hückel circle for MO energies of cyclic conjugated systems with examples	3.7	5	1	Lecture
Charge on an atom: calculation of total electron density, charge density, pi-bond order and free valence index	3.8	5	2	Lecture
Problems based on the above topics 3.6 and 3.8	3.9	5	3	Problem Solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. R. K. Prasad, Quantum Chemistry, 4th Edition, New Age International Publishers, 2020
2. A. K. Chandra, Introductory Quantum Chemistry, 4th Edition, McGraw Hill Education, 2017

Reference

1. P. Atkins, R. Friedman, Molecular Quantum Mechanics, 5th Edition, Oxford University Press, 2011
3. P. Atkins, J. Paula, J. Keeler, Physical Chemistry International Edition, Oxford University Press, 2018
4. T. Engel, Quantum Chemistry and Spectroscopy, 3rd Edition, Pearson Education, 2015
5. J. J. Sakurai, Advanced Quantum Mechanics, 1st Edition, Pearson Education, 2002
6. D. A. McQuarrie, Quantum Chemistry, Viva Books, 2016
7. I. N. Levine, Quantum Chemistry, 7th Edition, Pearson Education, 2016
8. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2020

Course designed by: Dr. Cyril Augustine V.

SBU24CH7DSC402: SCIENTIFIC METHODS FOR CHEMISTRY RESEARCH AND INTELLECTUAL PROPERTY RIGHTS

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Develop a comprehensive understanding of advanced research methodologies and critically analyze scientific literature in the field of chemistry.	R
CO2	Skillfully apply sophisticated experimental design and statistical techniques to scientific research.	A
CO3	Utilize advanced statistical tools and AI applications for rigorous data analysis and interpretation.	An
CO4	Assess and uphold ethical standards in scientific practices and critically evaluate scientific literature.	E
CO5	Produce and communicate high-quality research papers and develop a thorough understanding of Intellectual Property Rights, focusing on their application in chemistry.	C

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	-	2	-	-	-	-	1
CO2	-	-	-	-		-	-	-	-	1
CO3	-	-	-	-	1	1	1	-	1	-
CO4	-	-	-	1		-	2	-	-	-
CO5	-	-	-	1	2	-	-	1	-	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Scientific poster	Paper Presentation	Exam	Review paper	
CO1	x	-	-	x	-	x
CO2	x	-	-	x	-	x
CO3	x	-	-	x	-	x
CO4	-	x	-	-	x	x
CO5	-	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Research (9 Hrs)				
Definition, evolution of scientific research and significance of research in advancing scientific knowledge. Importance of nurturing research	1.1	1	1	Lecture
Classification of research with examples.	1.2	1	2	Lecture
Evaluating scientific sources: primary, secondary, tertiary; criteria for selecting journals, understanding peer-review.	1.4	1	2	Lecture
Research process: identifying problems, reviewing literature, identification of research gap, formulating research questions, setting objectives, developing hypotheses.	1.3	1	3	Lecture, Case study
Artificial intelligence and research	1.7	2	1	Lecture, Case study
Module 2: Research Process (15 Hrs)				
Research design – Basic Principles- Need of research design – Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models.	2.1	2	2	Lecture
Developing a research plan - Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.	2.2	2	2	Lecture, Case study
Data Collection: Execution of the research - Observation and Collection of data - Methods of data collection – Sampling Methods- lab precision, calibration, maintenance, standardized data recording protocols. Importance of lab work book and data recording	2.3	2	3	Lecture
Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation. Advanced statistical methods: descriptive vs. inferential statistics, appropriate test selection, data interpretation. Linear regression line, standard deviation, correlation coefficient-Multiple linear regression	2.4	3	4	Lecture, problems
Data presentation: graphical representation using software, statistical software applications.	2.5	3	2	Lecture, practicum
Utilizing databases in chemistry: Protein Data Bank (PDB), CCDC; retrieving and analysing molecular structures.	2.6	3	2	Lecture
Module 3: Scientific Communication (15 Hrs)				
Types of research papers- Original article, review papers, communications, letters. Anatomy of a research paper: structure, components, importance of each section. Thesis and dissertations- general structure	3.1	5	4	Lecture

Writing of a research proposal, research report and synopsis (steps involved), paper writing (steps involved), review writing, report preparation. Types of reports like original research article, communications, review papers, perspective articles, letters to editors, book review	3.2	5	4	Lecture, case study
Citing references during paper/report preparation- Different citation formats relevant to science streams, citation manging software- practical use of open source citation managing software (Zotero or any relevant package)	3.3	5	2	Lecture, hands on training
Scientific publication work flow and Peer review process	3.4	5	1	Lecture, case study
Selecting journals for publication: Quality matrices in research evaluation- Journal Impact Factor, Cite Score, journal ranking matrices like Scopus, WoS, Quartile ranking, Selecting journal for communication of articles- Journal finder, Open Access Publications, Preprint servers Quality matrix of a researcher: H-Index, researcher.com	3.5	5	2	Lecture
Effective scientific communication- Design of conference presentations, poster presentations, blogs etc.	3.6	5	2	Group presentation and poster preparation
Module 4: Ethical Aspects of Research (15 Hrs)				
Academic Integrity- Values Underlying Research Integrity- Framework for Good Academic Research Practices	4.1	4	2	Lecture, case study
Responsible and ethical conduct of research: Research Design - Conducting Research- Data Acquisition and Management- Dissemination.	4.2	4	3	Lecture, case study
Violations of Academic Integrity-Plagiarism- avoiding plagiarism, Avoiding Plagiarism: Cite Your Source, Quoting, Paraphrasing. Summarizing, Taking Careful Notes Falsification, Fabrication, and Misrepresentation with case studies, consequences of ethical violations, promoting responsible authorship.	4.3	4	5	Lecture, case study
Copying and Other Forms of Cheating: Case studies	4.5	4	2	Lecture, case study
Retraction of papers- websites that follows retraction like retraction watch and pubpeer.	4.6	4	3	Lecture
Module 4: Intellectual Property Rights in Chemistry (6 Hrs)				
Basics of Intellectual Property Rights: concepts, types, significance in research.	5.1	5	2	Lecture
Patent search and filing processes: conducting patent searches, understanding the patent filing process.	5.2	5	2	Lecture, case study
Managing Intellectual Property: strategies, licensing, commercial and legal implications.	5.5	5	2	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 4th Edition, SAGE Publications Ltd, 2014.
2. Douglas C. Montgomery, Design and Analysis of Experiments, 9th Edition, Wiley, 2017.
3. D. Brynn Hibbert and J. Justin Gooding, Data Analysis for Chemistry: An Introductory Guide for Students and Laboratory Scientists, 1st Edition, Oxford University Press, 2006.
4. Nadya Reingand, Intellectual Property in Academia: A Practical Guide for Scientists and Engineers, 1st Edition, CRC Press, 2011.

Course designed by Dr Renjith Thomas

SBU24CH7DSC403: ADVANCED TOPICS IN PHYSICAL CHEMISTRY

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	Basic Physical Chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the fundamental aspects and applications of molecular photochemistry.	R
CO2	Illustrate the phenomenon of adsorption and discuss its properties.	U
CO3	Familiarize the concept of catalysis and its applications.	U
CO4	Acquire knowledge on colloids and its uses in various fields.	A
CO5	Discuss the classification of liquid crystals and their applications.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	2	1	1	1	1	1	1	1	1
CO2	-	1	1	1	1	1	1	1	1	1
CO3	-	1	1	-	1	1	1	1	1	1
CO4	-	-	1	-	1	1	-	-	1	1
CO5	1	-	1	-	1	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva	Written test	MCQ	
CO1	x	-	x	x	x	x
CO2	x	-	x	x	x	x
CO3	x	-	x	x	-	x
CO4	x	-	x	x	-	x
CO5	x	x	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Molecular Photochemistry (25 Hrs)				
Nature of light matter interactions, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, examples of low and high quantum yields. Chemical actinometry.	1.1	1	4	Lecture/Powerpoint presentation
Jablonski diagram. Internal conversion, vinbrational relaxation, intersystem crossing, factor affecting deactivation. Fluorescence, Phosphorescence, delayed fluorescence. Quenching of fluorescence (static and	1.2	1	4	Lecture/Powerpoint presentation

dynamic), Stern – Volmer equation (derivation needed). Factors affecting fluorescence.				
Excimers, exciplexes, E-type and P-type fluorescence, Photosensitized reactions (type-I and type-II), dimerization of anthracene, ozone layer depletion. Chemiluminescence, bioluminescence and their applications.	1.3	1	4	Lecture/Powerpoint presentation
Role of photochemical reactions in biochemical processes, photochemistry of vision, reactive oxygen species, photodynamic therapy and its applications, photochromism, photoinduced electron and energy transfer.	1.4	1	4	Lecture/Powerpoint presentation
Photoelectric and photovoltaic effect. Solar cell and the working principle of a p-n junction diode. Characteristics of a solar cell and its efficiency, Shockley-Queisser limit, classification of solar cells (brief idea only).	1.5	1	4	Lecture/Powerpoint presentation
Photochemical Techniques, lasers in photochemistry, pulse radiolysis, transient absorption spectroscopy, femtosecond spectroscopy, two-photon spectroscopy and time resolved fluorescence and their applications.	1.6	1	5	Lecture/Powerpoint presentation
Module 2: Surface Chemistry (18 Hrs)				
Adsorption and surface phenomena, different types of surfaces, thermodynamics of adsorption, physisorption and chemisorption of gases, adsorption isobar, isostere and isotherms,	2.1	2	3	Lecture/Powerpoint presentation
Gibb's adsorption isotherm equation and its verification, Langmuir and Freundlich adsorption isotherms, Langmuir-Hinshelwood mechanism. Multilayer adsorption: BET equation (with derivation) and its use in the surface area determination,	2.2	2	4	Lecture/Powerpoint presentation
Nature of adsorbed state, adsorption and heterogeneous catalysis, surface films and surface pressure. Bimolecular surface reactions (between gas and an adsorbed molecule, between two adsorbed molecules). Inhibition and activation energy of surface reactions.	2.3	2	4	Lecture/Powerpoint presentation
Catalytic activity at the surfaces. Homogeneous and heterogeneous surface reaction rates. Surface heterogeneity.	2.4	2	3	Lecture/Powerpoint presentation
Application of low energy electron diffraction and photoelectron spectroscopy, ESCA and Auger electron spectroscopy, scanning probe microscopy, ion scattering, SEM and TEM in the study of surfaces. Surface Enhanced Raman Scattering techniques in surface chemistry, surfaces for SERS studies.	2.5	2	4	Lecture/Powerpoint presentation
Module 3: Catalysis (5 Hrs)				
Types of catalysis (homogeneous, heterogeneous, acid-base, specific and general catalysis with suitable examples), specificity and selectivity, mechanisms of catalysed reactions at solid surfaces. Autocatalysis, enzyme catalysis.	3.1	3	2	Lecture/Powerpoint presentation

Mechanism of action of a catalyst. Catalytic promoters, inhibitors and deactivators with examples. Industrial processes involving heterogeneous solid catalysts. Design of a catalyst.	3.2	3	2	Lecture/Powerpoint presentation
Developments in solid catalysts, monolith catalysts, fuel cell catalysts, environmental catalysts. Insitu characterization of catalysts.	3.3	3	1	Lecture/Powerpoint presentation
Module 4: Colloids (5 Hrs)				
Structure and stability, the electrical double layer and stability of colloids, zeta potential, electrokinetic phenomena, sedimentation and streaming potential, Donnan membrane equilibrium.	4.1	4	2	Lecture/Powerpoint presentation
Macromolecules, different averages, methods of molecular mass determination- osmotic, viscosity, sedimentation and light scattering methods. Brownian motion and Tyndall effect.	4.2	4	2	Lecture/Powerpoint presentation
Types of colloids, surface tension, soaps and detergents, micelle formation and critical micelle concentration.	4.3	4	1	Lecture/Powerpoint presentation
Module 5: Liquid Crystals (7 Hrs)				
Introduction, mesomorphic state, classification of liquid crystals with examples, application of liquid crystals.	5.1	5	3	Lecture/Powerpoint presentation
Temperature-time graph, thermotropy, vapour pressure-temperature phase diagram. Themotropic and lyotropic liquid crystals. Photoconductivity of liquid crystals.	5.2	5	2	Lecture/Powerpoint presentation
Applications of cholesteric liquid crystals. Order parameters and symmetry in liquid crystals, working principle of liquid crystal display devices.	5.3	5	2	Lecture/Powerpoint presentation
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 47th Edn., Vishal Publishing Company, 2018.
2. I. N. Levine, Physical Chemistry, 6th Edn., McGraw Hill, 2009.
3. K. J. Laidler, Chemical Kinetics, 3rd Edn., Pearson Education India, 2003.
4. P. W. Atkins, J.de Paula, Physical Chemistry: Thermodynamics, Structure, and Change, 10th Edn., Oxford University Press, 2014.
5. Gurdeep Raj, Surface Chemistry, Goel Publishing House, 2006.
6. P. J. Wojtowicz, P. Sheng, E. B. Priestley, Introduction to Liquid Crystals, Springer, 1974.
7. N. J. Turro, V. Ramamurthy, J. C. Scaiano, Principles of Molecular Photochemistry: An Introduction, University Science Books, 2009

Reference

1. J. W. Moore, R. G. Pearson, Kinetics and Mechanisms, 3rd Edition, John Wiley & Sons, 1981.
2. C. Kalidas, Chemical Kinetic Methods: Principles of Fast Reaction Techniques and Applications, New Age International, 2005
3. J. Rajaram, J. C. Kuriakose, Kinetics and Mechanisms of Chemical Transformations, Macmillan India, 2006

4. P. J. Collings, M. Hird, Introduction to Liquid Crystals: Chemistry and Physics, 1st Edn., Taylor & Francis, 1997.
5. A. Goel, Surface Chemistry, Discovery Publishing House, 2006
6. A. W. Adamson, Physical Chemistry of Surfaces, 6th Edn., John Wiley & Sons Inc., 2000.
7. R. J. Silbey, R. A. Alberty, M. G. Bawendi, Physical Chemistry, 4th Edn., John Wiley & Sons, 2005

Course designed by: Dr. Ajith R. Mallia

SBU24CH7DSC404: SOLID STATE CHEMISTRY

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Basic chemistry of solids		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understanding the basics of crystals symmetry	U
CO2	Representation of lattice planes and calculation of interplanar spacing, draw the crystal structures.	An
CO3	Differentiate between amorphous and crystalline solids, Understand an isotropy, symmetry and types of crystals, Xray diffraction methods of study of crystal structure.	An
CO4	Identify the imperfections in crystals	An
CO5	Describe Electronic Properties and Phase transition of solids	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-		1	-		1	-	-	-	-
CO2	-		1	-		1	-	-	-	-
CO3	-		1	-		1	-	-	-	-
CO4	-	2	1	-	2	1	-	-	1	2
CO5	-	2	2	-	2	1	-	-	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Assignment	Written test	MCQ	
CO1	x	x	-	x	x	x
CO2	x	x	-	x	x	x
CO3	x	-	x	x	-	x
CO4	x	x	-	x	x	x
CO5	x	-	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hour	Transaction Mechanism
Module 1: Introduction to crystals symmetry (15 Hrs)				
Crystaline and amorphous solids, size and shape of crystals, interfacial angles, Symmetry of crystals	1.1	1	3	Lecture/PPT
symmetry elements and symmetry operations centre of symmetry, plane of symmetry, proper and improper axes of symmetry	1.2	2	4	Lecture/PPT
crystallographic point groups, Schoenflies symbol, space lattice and unite cell, Bravais lattices, seven crystal	1.3	3	4	Lecture/PPT

systems, Miller indices, types of crystals, calculation of number of atoms in a unit cell				
Close packing of spheres, hcp, ccp, tetrahedral and octahedral voids, limiting radius ratio, radius ratio rule and shape of ionic crystal.	1.4	1	4	Lecture/PPT
Module 2: Structure of solids (10 Hrs)				
Structure of ionic crystals, NaCl crystal, ZnS crystal (zinc blende and wurtzite structure), CsCl crystal, CaF_2 (fluorite and antifluorite structure) crystal, TiO_2 crystal, CaC_2 crystal, CdI_2 crystal	2.1	1	2	Lecture/PPT
Structure of perovskite, ABO_3, K_2NiF_4, spinels and inverse spinels	2.2	1,2	2	Lecture/PPT
lattice energy of ionic solids, calculation of lattice energies of ionic solids, Born equation and its application, experimental determination of lattice energy, Born Haber cycle.	2.3	1,3	3	Lecture/PPT
Bragg equation – derivation, brief description of rotating crystal method and powder method, x-ray diffraction patterns of cubic system.	2.4	4,5	3	Lecture/PPT
Module 3: Imperfection in crystals and Nonstoichiometric (15 Hrs)				
Point defects: Point defects in metals and ionic Crystal – Frenkel defect and Schottky defect.	3.1	1	4	Lecture/PPT
Thermodynamics formation of these defects (mathematical derivation to find defect concentration and numerical problems expected),	3.2	1	3	Lecture/PPT
Defects in non-Stoichiometric compounds, colour centres. Line defects: Edge and Screw Dislocations.	3.3	2	4	Lecture/PPT
Mechanical Properties and Reactivity of Solids. (c) Surface Defects: Grain Boundary and Stacking Fault.		3,4	4	Lecture/PPT
Module 4: Electronic Properties and Phase transition of solids (20 Hrs)				
Free electron theory of solids, results of free electron theory; limitations and success of free electron theory,	4.1	1	3	Lecture/PPT
MO theory of solids. Energy bands-conductors and insulators, intrinsic and extrinsic semiconductors.	4.2	2,4	3	Lecture/PPT
Solid state reactions-diffusion coefficient, mechanisms, Fick's Laws of diffusion,	4.3	3	3	Lecture/PPT
Thermal decomposition of solids-Type I reactions, Type II reactions	4.4	5	2	Lecture/PPT
Phase transition in solids: classification of phase transitions-first and second order phase transitions, kinetics of phase transitions,	4.5	3,5	3	Lecture/PPT
Martensitic transformations, order-disorder transitions and spinodal decomposition, sintering.	4.6	4,5	3	Lecture/PPT
Methods of Single Crystal Growth: Solution growth; Melt Growth-Bridgeman, Czochralski, Kyropoulus, Verneuil; Chemical Vapour Transport; Fused Salt Electrolysis; Hydrothermal method; Flux Growth.	4.7	5	3	Lecture/PPT

Module 5: Teacher Specific Content
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)
This content will be evaluated internally

Textbooks

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co., 2013.

Reference

1. L.V. Azaroff, Introduction to Solids, McGraw Hill, 1984
2. A.R. West, Solid-State Chemistry and its Applications, Wiley-India, 2007
3. D. K. Chakrabarty, Solid State Chemistry, New Academic Science, 2010
4. D. M. Adams, Inorganic Solids: An Introduction to Concepts in Solid-State Structural Chemistry, Wiley, 1974
5. C.N.R. Rao, K.J. Rao, Phase Transitions in Solids, McGraw Hill, 2010
6. Principles of the Solid State, H. V. Keer, Wiley Eastern, 1993, New Delhi

Course designed by: Dr Sam John

SBU24CH7DSC405: MOLECULAR SYMMETRY AND GROUP THEORY

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Structure of molecules, Hybridisation		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the basics of molecular symmetry and the classification of molecules as point groups	U
CO2	Grasp the mathematics behind group theory	A
CO2	Understand the basics of crystal symmetry	U
CO3	Construct the Character table using group theory	A
CO4	Apply character table and group theory in IR, Raman and electronic spectroscopy	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	-	1	1	-	1	-
CO2	2	-	-	-	-	1	1	-	1	-
CO3	2	-	-	-	-	1	1	-		-
CO4	1	-	-	-	-	-	-	-	1	-
CO5	2	-	-	-	-	1	-	-		1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Seminar	Demonstration/Assignment	Written test	MCQ	
CO1	x	-	x	x	x	x
CO2	-	-	-	x	-	x
CO3	x	-	-	x	x	x
CO4		x	-	x	x	x
CO5	-	x	-	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Molecular Symmetry and point groups (15 Hrs)				
Symmetry in molecules. Significance of group theory. (Concept only).	1.1	1	1	Lecture
Symmetry elements, symmetry operations- Identity, Proper rotation-types, Improper rotation, Reflection-types and inversion.	1.2	1	2	Lecture/Demonstration

Point groups- C_1, C_s, C_i, C_n, C_{nv}, C_{nh}, D_n, D_{nd}, D_{nh} – Examples and all symmetry operations.	1.3	1	6	Lecture/Demonstration
Mathematical group rules, Set of symmetry operations as mathematical group, Order of a group.	1.4	2	2	Lecture
Abelian and cyclic groups, subgroups, group multiplication tables C_{2v}, C_{2h} and C_{3v}-classification of group elements using similarity transformation.	1.5	2	4	Lecture
Module 2: Basics of crystal symmetry (15Hrs)				
Symmetry elements and symmetry operations in crystals- Proper rotation axis, mirror plane and rotation inversion axis- types and representation	2.1	3	3	Lecture
Crystal systems, 32 crystallographic point groups (Hermann-Mauguin and Schoenflies symbolism-no derivation needed).	2.2	3	5	Lecture
Space groups: Screw axis and Glide plane. -Types and representation, 230 combinations of space groups (basics only)	2.3	3	7	Lecture
Module 3: Construction of Character table using Group theory (15 Hrs)				
Matrix representation of symmetry operations (examples of C_{2v} and C_{3v})	3.1	4	2	Lecture
Representations of molecular point groups: reducible and irreducible representations. The Great Orthogonality Theorem (GOT). Properties of irreducible representations,	3.2	4	5	Lecture
Introduction to character tables for point groups, major sections; use of GOT to construct character tables for molecular point groups. Examples (C_{2h}, C_{2v}, C_{3v} and C_{4v})	3.3	4	5	Lecture
Decomposing a reducible representation into its irreducible representation using standard reduction formula. (C_{2v} and C_{3v})	3.4	4	3	Lecture
Module 4: Applications of Group theory in Chemistry (15 Hrs)				
Determining the irreducible representations of the vibrational modes in non-linear molecules: Normal modes of vibration in H_2O, NH_3 and trans N_2F_2	4.1	5	3	Lecture
Direct products of irreducible representations, transition dipole moment integral, vanishing of integrals.	4.2	5	4	Lecture
selection rule for IR spectra. Selection rule for vibrational Raman spectra. Mutual exclusion principle with examples (NH_3, H_2O and trans N_2F_2)	4.3	5	4	Lecture
Application in electronic spectra: selection rules for electronic transition, electronic transitions due to the carbonyl chromophore in formaldehyde.	4.4	5	4	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, 2nd Edn., New Age Science Ltd., 2009.
2. S. Swarnalakshmi, T. Saroja, R. M. Ezhilarasi, A Simple Approach to Group Theory in Chemistry, Universities Press, 2008.
3. A. S. Kunju, G. Krishnan, Group Theory and its Applications in Chemistry, 2nd Edn., PHI Learning, 2010.
4. V. Ramakrishnan, M. S. Gopinathan, Group Theory in Chemistry, 2nd Edn., Vishal Publications, 2013.

Reference

1. F. A. Cotton, Chemical Applications of Group Theory, 3rd Edn., Wiley Eastern, 2008.
2. L. H. Hall, Group Theory and Symmetry in Chemistry, McGraw Hill, 1969.
3. M. G. Arora, Group Theory in Chemistry and Physics, Anmol Publications Pvt. Ltd., 2002.
4. R. Ameta, Symmetry and Group Theory in Chemistry, New Age International Pvt. Ltd., 2012.
5. U. C. Agarwala, H. L. Nigam, Sudha Agrawal, S. S. Kalra, Molecular Symmetry in Chemistry via Group Theory, Ane Books Pvt. Ltd., 2016.
6. Robert L. Carter, Molecular Symmetry and Group Theory, John Wiley & Sons, 1997.
7. Gurdeep Raj, Ajay Kumar Bhagi, Vinod Jain, Group Theory & Symmetry in Chemistry, Krishna Prakashan Media (P) Ltd, 2017.
8. Hans H. Jaffe, Milton Orchin, Symmetry in Chemistry, Dover Publications Inc., 2003.
9. David M. Bishop, Group Theory and Chemistry, Dover Publications, 1993.

Course designed by: Capt James Baben George

SEMESTER VIII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH8DSC400	Major	Advanced Topics in Inorganic Chemistry	5	75	4
SBU24CH8DSC401	Major	Advanced Topics in Organic Chemistry	5	75	4
SBU24CH8DSC402	Major	Computational Chemistry	5	75	4
SBU24CH8DSC403	Major	Advanced Organic Reactions	4	60	4
SBU24CH8PRJ400	Major	Project			12

SBU24CH8DSC400: ADVANCED TOPICS IN INORGANIC CHEMISTRY

Type of Course	Major		
Course Level	400 -499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basics in coordination chemistry and spectroscopy		

Course Outcomes

No.	Description	Cognitive Level
CO1	Interpret the magnetic properties of coordination complexes	An
CO2	Construct molecular orbital diagram of ferrocene	A
CO3	Illustrate the applications of organometallic compounds in organic synthesis and catalysis	An
CO4	Deduce the structure of metal complexes using spectral techniques	E
CO5	Design the synthesis and quantitative analysis of metal complexes	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	-	-	1	1	-	-	-
CO2	1	1	1	-	-	1	1	-	-	-
CO3	1	1	1	-	-	1	1	-	-	-
CO4	-	-	-	-	-	1	1	-	2	-
CO5	-	-	-	-	2	-	-	-	-	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written Test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	-	x	x	-	x
CO3	x	x	x	x	x	x
CO4	-	x	x	x	-	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva voce	Lab test	Laboratory report	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Magnetic Properties and Structural Elucidation of Coordination Compounds (15 Hrs)				
Magnetic properties of complexes-paramagnetic and diamagnetic complexes, molar susceptibility, Gouy method for the determination of magnetic moment of complexes, spin only magnetic moment.	1.1	1	5	Lecture
Temperature dependence of magnetism-Curie's law, Curie-Weiss law. Temperature Independent Paramagnetism (TIP), Spin state crossover, Antiferromagnetism-inter and intra molecular interaction. Anomalous magnetic moments.	1.2	1	5	Lecture
Elucidating the structure of metal complexes (Examples; $[V(H_2O)_6]^{3+}$, $[Ni(H_2O)_6]^{2+}$, $[Co(H_2O)_6]^{2+}$, $[CoCl_4]^{2-}$) using electronic spectra, IR spectra and magnetic moments.	1.3	1	5	Lecture
Module 2: Advanced Organometallic Chemistry (15 Hrs)				
Ferrocene: Preparation, structure, aromaticity and reactions (acetylation, alkylation).	2.1	2	2	Lecture
Homogeneous/Heterogeneous catalysis: Tolman catalytic loops, Hydrogenation by Wilkinson Catalyst, Olefin isomerization, Wacker process, Hydroformylation (Co & Rh), Monsanto & Cativa acetic acid process, Ziegler-Natta Polymerization including metallocene based Zr catalyst, Water gas shift reaction, the Fischer-Tropsch reaction (synthesis of gasoline)	2.2	3	5	Lecture
Grubbs (I generation & II Generation) and Schrock catalysts – Preparation and characteristics, Olefin metathesis, ROMP	2.3	3	3	Lecture
Organometallic reagents in organic synthesis –Petasis, Schwartz reagents for organic transformations. Reppe reaction, Dötz reaction	2.4	3	2	Lecture
Hydrogenation reactions- H_2 hydrogenation and isopropanol transfer hydrogenations catalyzed by Ru (II) complexes, ionic hydrogenation, and hydrosilylation.	2.5	3	3	Lecture
Module 3: Inorganic spectroscopic methods (15 Hrs)				
Infrared and Raman Spectroscopy: structural elucidation of coordination compounds containing the following molecules/ions as ligands - NH_3, H_2O, CO, NO, OH^-, SO_4^{2-}, CN^-, SCN^-, NO_2^- and X^- (X=halogen).	3.1	4	5	Lecture
Electron Paramagnetic Resonance Spectroscopy: EPR of d^1 and d^9 transition metal ions in cubic and tetragonal ligand fields, evaluation of g values and metal hyperfine coupling constants.	3.2	4	3	Lecture
Mössbauer Spectroscopy: applications of Mössbauer spectroscopy in the study of Fe(III) complexes.	3.3	4	4	Lecture
Nuclear Magnetic Resonance Spectroscopy: Applications of NMR in Inorganic molecules.	3.4	4	3	Lecture

Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

Practical

Module 6: Preparation and characterization coordination complexes (30 Hrs)				
i. Tris(thiourea)copper(I) complex ii. Potassium tris(oxalato) aluminate (III) iii. Hexammine cobalt (III) chloride iv. Tetrammine copper (II) sulphate v. Potassium tris(oxalato) chromate (III) vi. Potassium tris(oxalato) ferrate (III) ***Students shall characterize the complexes using standard spectra given.***	6.1	5	15	Lab work (A minimum of three preparations must be done and recorded)
Module 7: Colorimetric Analysis				
Colorimetric estimation of Fe, Cu, Ni, Mn, Cr, NH_4^+, nitrate and phosphate ions.	7.1	5	15	Lab work (A minimum of three experiments must be done and recorded)

Textbooks

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Vikas Publishing Co., Jalandhar, 2020
2. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press, India Pvt. Ltd., 2009
3. P. L. Soni, Text Book of Inorganic Chemistry, S. Chand and Sons, 2013
4. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999.
5. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edn., Pearson Education, New Delhi, 2006.
6. K. Nakamoto, IR and Raman Spectra of Inorganic and Coordination Complexes, Part A-Theory and Applications in Inorganic Chemistry, 6th Edn., John Wiley &Sons, 1997

Reference

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edn., Pearson Education, 2006
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edn., Chapman & Hall, 2008
3. D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 7th Edn., Oxford University Press, New Delhi, 2018
4. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., Wiley Interscience, 2009
5. R. S. Drago, Physical Methods in Chemistry, Saunders College, 1992
6. A. I. Vogel, A Text Book of Quantitative Inorganic Analysis, Longman, 1966
7. I. M. Koltoff, E. B. Sandell, Text Book of Quantitative Inorganic analysis, 3 rd Edn., McMillian, 1968
8. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis, 3rd Edn., The National Publishing Company, 1995

Course designed by: Dr Subin Joseph

SBU24CH8DSC401: ADVANCED TOPICS IN ORGANIC CHEMISTRY

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Deeper mechanistic understanding of Organic Chemistry.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Students should be able to identify and analyse different methods in the disconnection approach.	U
CO2	Evaluate synthetic routes to target molecules using retrosynthesis.	A
CO3	Discuss the extraction process and general properties of natural products -oils, fats, terpenes and alkaloids.	U
CO4	Categorise pericyclic reactions, including electrocyclic, sigma tropic, and cycloaddition reactions.	A
CO5	Obtain the skills to develop Food packaging films, Bio adhesive wound dressing materials (films and gels), isolation of organic molecules and monitoring of reaction progress through TLC	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	1	-	-	-	-	1	-	-	-	-
CO3	1	-	-	-	-	1	-	-	-	-
CO4	2	-	-	-	-	1	-	-	-	1
CO5	2	2	-	-	2	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Written Test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	x	x
CO3	x	-	x	x	-	x
CO4	x	x	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Quiz	Viva voce	Lab test	Laboratory report	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Retrosynthetic Analysis (15 Hrs)				
Introduction to Strategies for the Synthesis of Complex Molecules. General principles of retrosynthetic analysis and general strategies for stereochemical control. Concept of synthons and reagents	1.1	1	3	Lecture/ICT
Functional group interconversion. One group and two group carbon-heteroatom disconnection: chemoselectivity and umpolung concept and synthetic equivalents.	1.2	1	2	Lecture/ICT
Disconnection approach for amines, ethers, alcohols, sulfides; introduction of protecting groups and stereoselectivity in retrosynthesis.	1.3	2	5	Lecture/ICT
Disconnection approach for carbonyl compounds and regioselectivity Disconnection approach for heterocyclic systems: (a) furan (b) thiophene (c) pyrrole (d) indole (e) pyrazoles (f) quinoline.	1.4	2	5	Lecture/ICT
Module 2: Phytochemistry and Heterocyclic Compounds (7 Hrs)				
Terpenes: Classification – Isoprene rule – Essential oils – Isolation of essential oils by steam distillation and Enfleurage.	2.1	3	2	Lecture/ICT
Alkaloids: Extraction. Classification based on structure of heterocyclic ring. Physiological actions of nicotine, quinine, coniine.	2.2	3	2	Lecture/ICT
Structure and uses of citral, geraniol, limonene and menthol. Structure elucidation of citral and menthol. Structure of natural rubber – Vulcanization and its advantages.	2.3	3	3	Lecture/ICT
Module 3: Supramolecular Chemistry (8 Hrs)				
Basic concept and principles; History, Molecular recognition, Hydrogen Bonds: Definition, Structure and Stability, strength, Secondary Electrostatic Interactions in Hydrogen Bonding Arrays	2.4	3	4	Lecture/ICT
Non-covalent interactions: Ion pairing, Ion-Dipole Interactions, Dipole-Dipole interactions, Dipole-Induced Dipole and Ion-Induced Dipole interactions, van der Waals or Dispersion Interactions, Hydrogen bonding, Non-covalent interactions: Halogen bonding, Cation-interactions, Anion-pi interactions, pi - pi interactions, Closed shell interactions.	2.5	3	4	Lecture/ICT
Module 4: Pericyclic Reactions (15 Hrs)				
Pericyclic reactions: Classification, electrocyclic, sigmatropic, cycloaddition, chelotropic and ene reactions. Woodward-Hoffmann selection rules.	3.1	4	2	Lecture/ICT
Electrocyclic reactions: FMO approach, Examples of electrocyclic reactions (thermal and photochemical) that	3.2	4	3	Lecture/ICT

involve 4π and 6π electrons and corresponding cycloreversion reactions.				
Cycloaddition reactions: FMO approach, [4+2] cycloaddition- Diels Alder reaction, photochemical [2+2] reactions.	3.3	4	3	Lecture/ICT
Sigmatropic reactions: Sigmatropic shifts and their orders, [i, j] shift- [1, 3] & [1, 5] hydrogen shifts. [1,2] & [2,3] Sigmatropic Rearrangements- Wittig, Mislow-Evans, Stevens and Sommelet-Hauser rearrangements.	3.4	4	4	Lecture/ICT
[3, 3] Sigmatropic rearrangements- Claisen, Cope, Oxy-Cope, aza-Cope, degenerate Cope rearrangements, Carroll rearrangement.	3.5	4	3	Lecture/ICT
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. S. Warren and P. Wyatt, Organic Synthesis: The Disconnection Approach, Wiley, 2008.
2. N. Tewari, Organic Chemistry- A Modern Approach, Volume-III, McGraw Hill Education, 2019.
3. S. M. Mukherji, S. P. Singh, Reaction Mechanism in Organic Chemistry, Revised Edition, Trinity Press, 2015.
4. S. Sankararaman, Pericyclic Reactions-A Textbook, Wiley VCH, 2005
5. Jagdamba Singh, Jaya Singh, Photochemistry and Pericyclic Reactions, New Age Science Ltd, 3rd Edn., 2009

Reference

1. F. A. Carey, R. M. Giuliano, Organic Chemistry, 10th Edition, 2016.
2. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th Edition, Pearson Education India, 2010.
3. M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 7th Edn., Wiley, 2015.
4. W. Caruthers and I. Coldham, Modern Methods of Organic Synthesis, 4th Edition, Cambridge University Press, 2012.
5. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, Springer, 2008.
6. S. S. Gupta, Organic Chemistry, Oxford University Press, 2017

Practical

Synthetic Organic Chemistry & Separation Techniques

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Applications of Films and Gels (16 Hrs)				
a. Food packaging films	5.1	5	8	Lab work
b. Bio adhesive wound dressing materials (films and gels)	5.2	5	8	Lab work
Module 6: Applications of Thin Layer Chromatography at the Advanced Level (16 Hrs)				
1) In monitoring the progress of reactions 2) Identify compounds present in a given mixture	6.1	5	14	Lab work

3) Determine the purity of a substance. 4) Analysing ceramides and fatty acids 5) Detection of pesticides or insecticides in food and water 6) Analysing the dye composition of fibres in forensics 7) Assaying the radiochemical purity of radiopharmaceuticals 8) Identification of anthocyanins 9) Identification of medicinal plants and their constituents *Any four of the above-mentioned area are compulsory				

Textbook

1. A. O. Thomas, Practical Chemistry, 7th Edn., Scientific Book Centre, Kannur, 1999
2. Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, Longman Scientific and Technical, 1989
3. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4thEdn., Pearson Education, 2009

Reference

1. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry: Preparations and Quantitative Analysis, Universities Press, 2004
2. A. I. Vogel, A Text Book of Practical Organic Chemistry, 5th Edition, Prentice Hall, 1989

Course designed by: Dr Benny Thomas

SBU24CH8DSC402: COMPUTATIONAL CHEMISTRY

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic idea of Quantum mechanics, Basic computer knowledge		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand relevance of Computational chemistry and basic concepts	U
CO2	Learn Hartree-fock method, Post Hartree-fock methods, Semi empirical methods and DFT methods with applications	U
CO3	Learn and explore the basic principles of molecular mechanics	U
CO4	Study structure activity relations in Computer aided drug designing	A
CO5	Develop practical skills in molecular property calculation and drug designing	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	1	-	-	-	-	1	-	-	-	-
CO3	1	-	-	-	-	1	-	-	-	-
CO4	1	-	2	-	-	1	-	-	-	-
CO5	2	1	-	-	2	-	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Poster Presentation	In class discussions	Assignment	Written Test	MCQ	
CO1	x	x	-	x	x	x
CO2	x	-	x	x	x	x
CO3	x	x		x	x	x
CO4	x	-	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab Involvement	Assignment	Viva	Lab Test	Lab Report	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basic Introduction to Computational Chemistry (10 Hrs)				
Concept of computational approach and fields of applications	1.1	1	1	Lecture
Potential Energy Surfaces: Stationary points, saddle point, local and global minima, their significance Examples: PES for water.	1.2	1	2	Lecture
Molecular geometry, Cartesian coordinates and z-matrix; detailed construction of z-matrix with examples	1.3	1	3	Lecture
Ab initio Quantum Methods: Slater and Gaussian functions	1.4	1	1	Lecture
Concept of Basis Sets, Types of basis sets- primitive, double zeta, triple zeta, Pople type, split valence, polarisation, diffused and nomenclature	1.5	1	3	Lecture
Module 2*:* Quantum Computational Chemistry I (8 Hrs)				
Hartree-Fock Methods: Basic concepts and approximations in Hartree-Fock (HF)	2.1	2	2	Lecture
Slater determinant and Paulis exclusion principle, Variation Principle, Concept of self-consistent field	2.2	2	2	Lecture
Advantages and Disadvantages; Restricted open-shell Hartree-Fock (ROHF) and Unrestricted Hartree-Fock (UHF) methods	2.3	2	2	Lecture
Post Hartree-Fock Methods: Relevance of post HF methods, Moller-Plesset Perturbation method, Configuration interaction, Couple Cluster method	2.4	2	2	Lecture
Module 3*:* Quantum Computational Chemistry II (7 Hrs)				
Semi-empirical Methods: Basic Concepts brief overview of methods, concept of MNDO, ZDO, AM1, PM3and its applications	3.1	2	2	Lecture
Density Functional Methods: General Principles, Functional, Methodology and Development of DFT-Thomas Fermi Model	3.2	2	2	Lecture
Hohenberg-Kohn theorem, Kohn-sham model, Local Density Approximation	3.3	2	2	Lecture
Gradient Corrected Methods, Hybrid methods	3.4	2	1	Lecture
Module 4*:* Molecular Mechanics (10 Hrs)				
Basic Concept of molecular mechanics; Introduction to Force Field and its characteristics	4.1	3	2	Lecture
Parametrization and its components for bond stretching, bending, torsional motion, non-bonded and electrostatic interactions.	4.2	3	2	Lecture
Examples for force fields: MM, CFF, ECEPP, GROMOS, AMBER and CHARMM with their respective areas of applications	4.3	3	2	Lecture
Molecular Dynamics: General Principles of MD simulations	4.4	3	2	Lecture

Discussions on Design constraints; Applications and limitations of MD; Monte Carlo Simulations.	4.5	3	2	Lecture
Module 5: Computer Aided Drug Designing (10 Hrs)				
CADD-Computer aided drug designing and its theory highlighting its advantages and utility Rational drug designing	5.1	4	2	Lecture
Structure based drug deigning and Ligand based drug designing, High throughput screening, lead optimisation,	5.2	4	2	Lecture
structure activity relationship. Concept of ADMET modelling.	5.3	4	2	Lecture
Molecular Docking: Introduction and its importance; Categories- Flexible, semi flexible and Rigid Docking and various steps involved in docking	5.4	4	2	Lecture
Introduction to Python- Basic concepts and applications.	5.5	4	2	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. J. H. Jensen, E. G. Lewars, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Edn., Springer, 2011
2. F. Jensen, Introduction to Computational Chemistry, 2nd Edn., John Wiley & Sons, 2007
3. A. R. Leach, Molecular Modelling: Principles and Applications, 2nd Edn., Pearson Education Ltd., 2001

Reference

1. J. P. Fackler Jr., L. R. Falvello (Eds.), Techniques in Inorganic Chemistry: Chapter 4, CRC Press, 2011
2. K. I. Ramachandran, G. Deepa, K. Namboori, Computational Chemistry and Molecular Modeling: Principles and Applications, Springer, 2008
3. A. Hinchliffe, Molecular Modelling for Beginners, 2nd Edn., John Wiley & Sons, 2008
4. C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, 2nd Edn., John & Sons, 2004
5. D. C. Young, Computational Chemistry: A Practical Guide for Applying Techniques Real World Problems, John Wiley & Sons, 2001

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Quantum Calculations (16 Hrs)				
Concept of Geometry optimisation, single point energy, Koopmans Theorem, Electrostatic potential map.	7.1	5	2	Lab work
Problems based on geometry optimisation and identification of optimised parameters (bond length, bond angle, Milliken charges and dipole moment; (minimum 3 problems with ammonia, water and HF as examples) with suitable basis set and method	7.2	5	3	Lab work

Determination of correlation energies in molecules (minimum 3 problems with ammonia, water and HF as examples) with suitable basis set and method	7.3	5	2	Lab work
Calculations based on Raman and IR frequency of various systems (minimum 3 problems with ammonia, water and HF as examples) with suitable basis set and method	7.4	5	2	Lab work
Generation of energy profile diagram of ethane, butane and di halo ethane (3 problems) with suitable basis set and method	7.5	5	2	Lab work
Arranging the molecules in the order of increasing decreasing dipole moment (minimum 3 problems with o-, m- and p- derivatives of dichloro, difluoro and dimethyl benzene) with suitable basis set and method	7.6	5	2	Lab work
Determination of energetics of reactions (3 problems based on Haber Process, hydrogenation of ethane) with suitable basis set and method	7.7	5	3	Lab work
Module 8: Molecular Docking (14 Hrs)				
Introduction and installation of open-source software for drawing, molecular docking and visualisation	8.1	5	4	Lab work
Problems based on identification of disease and the corresponding protein, cleaning of protein, generation of drug molecules, setting up grid, docking and docking analysis. (minimum 5 problems)	8.2	5	10	Lab work

Textbooks

1. J. H. Jensen, E. G. Lewars, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Edn., Springer, 2011
2. D. C. Young, Computational Chemistry: A Practical Guide for Applying Techniques Real World Problems, John Wiley & Sons, 2001

Reference

1. A. Hinchliffe, Molecular Modelling for Beginners, 2nd Edn., John Wiley & Sons, 2008
2. Bender BJ, Gahbauer S, Luttens A, Lyu J, Webb CM, Stein RM, Fink EA, Balius TE, Carlsson J, Irwin JJ, Shoichet BK; A practical guide to large-scale docking, Volume 16, 4799–4832, Nature Protocols volume (2021)
3. Anna E. Lohning, Stephan M. Levonis, Billy Williams-Noonan and Stephanie S. Schweiker; A Practical Guide to Molecular Docking and Homology Modelling for Medicinal Chemists, Volume 17, 2023 - 2040, Current Topics in Medicinal Chemistry (2017)

Course designed by: Dr Aravind K

SBU24CH8DSC403: ADVANCED ORGANIC REACTIONS

Type of Course	Major		
Course Level	400 - 499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Organic reaction mechanism		

Course Outcomes

After the successful completion of the course, the students will be able to:

No.	Description	Cognitive Level
CO1	Understand the importance of physical organic chemistry principles in analysing reaction mechanisms, and comprehend the role of transition states and the significance energy surfaces in determining product distribution.	U
CO2	Understand and explain the effects of different types of strain and molecular interactions on the conformational stability of cyclic compounds and predict how conformation influences the reactivity and chemical behaviour of these compounds.	U
CO3	Classify and describe the mechanisms and outcomes of various aliphatic substitution reactions, such as S_N1, S_N2, and their variations, along with understanding the factors that influence each mechanism.	U
CO4	Apply the principles of steric and electronic effects to predict the regioselectivity and stereoselectivity of a reaction, and distinguish between different reaction pathways.	A
CO5	Understand the fundamental principles behind the synthesis and reactivity of organometallic reagents, and recognize their role in key organic transformations.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	2	1	-	1	3	1	-	3	3
CO2	1	2	1	-	1	2	1	-	3	3
CO3	1	2	1	-	1	2	1	-	2	2
CO4	1	2	1	-	1	2	1	-	3	2
CO5	1	2	1	-	2	2	1	-	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment/ Seminar	Viva	Written test	MCQ	
CO1	x	-	x	x	x	x
CO2	x	x	-	x	-	x
CO3	x	x	x	x	x	x
CO4	x	-		x	x	x
CO5	x	-	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fundamentals of Physical Organic Chemistry (15 Hrs)				
The scope and importance of physical organic chemistry in understanding reaction mechanisms. Analyse the methods used to elucidate reaction mechanisms, including product analysis, detection of intermediates, crossover experiments, isotopic labelling, kinetic isotope effects, stereochemical evidence, and kinetic evidence.	1.1	1	5	Lecture/Presentation
Examine potential energy surfaces and how reaction coordinate diagrams are used to visualize the progress of reactions. Explore the concept of the transition state and its role in chemical reactions. Introduce the Hammond Postulate and its implications for the structure of transition states. Distinguishing between the Kinetic vs. Thermodynamic control and their influence on product distribution. Understanding the Curtin-Hammett Principle and its applications to chemical reactions with competing pathways. Tunnelling and its effect on reaction rates.	1.2	1	7	Lecture/Presentation
Examine the general principles of catalysis, including thermodynamic cycle analysis, spatial-temporal approach, and an overview of different forms of catalysis.	1.3	1	3	Lecture/Presentation
Module 2: Advanced Conformational Analysis of Cyclic Compounds (15 Hrs)				
Introduction to Conformational Analysis-Factors affecting conformational stability of molecules: torsional strain, bond angle strain, dipole interaction and hydrogen bonding.	2.1	2	1	Lecture/Presentation
Conformational Analysis of Carbocyclic Rings-Conformations of carbocyclic rings from three to eight members. Detailed Study of Cyclohexane and Derivatives-Investigate the conformations of cyclohexane, including mono, di, and polysubstituted cyclohexanes. Discuss the importance of anchoring groups in assessing the reactivity of axial or equatorial substituents. Examine specific cases such as cyclohexanone, 2-halocyclohexanones, cyclohexene, and alkylidenecyclohexanes.	2.2	2	6	Lecture/Presentation
Analyse conformation of piperidine, N-Methylpiperidine and hexoses.	2.3	2	1	Lecture/Presentation
Study the conformation of fused and bridged bicyclic systems such as decalins, adamantane, congressane, and norborane.	2.4	2	2	Lecture/Presentation
Effect of Conformation on Reactivity-Examine how the conformation affects the reactivity of cyclohexane derivatives in various reactions: dehalogenation, dehydrohalogenation, semipinacolic deamination, pyrolytic elimination of esters, nucleophilic substitution reactions, formation and cleavage of epoxides,	2.5	2,4	5	Lecture/ Discussion/Problem Solving Section

esterification and hydrolysis, hydride reduction of cyclohexanones, and oxidation of axial and equatorial cyclohexanols to cyclohexanone.				
Module 3: Advanced Reaction Mechanism (15 Hrs)				
IUPAC naming of organic reactions. Detailed study of aliphatic substitution reactions- S_N1, S_N2, S_Ni, S_N2', S_N2' reactions- detailed study. Neighbouring group participation, competition between unimolecular and bimolecular substitution. Electrophilic aliphatic substitution reactions- detailed study.	3.1	3,4	8	Lecture/Presentation/ Problem Solving Section
E1, E2 and $E1_{CB}$ eliminations- Berdt's rule, regioselectivity and stereoselectivity, pyrolytic eliminations. Competition between elimination and substitution.	3.2	3,4	3	Lecture/Presentation/ Problem Solving Section
Steric effect in organic chemistry- steric retardation and acceleration. F Strain, B strain, Allylic strain.	3.3	3	1	Lecture/Presentation
Organic super bases and acids, concept of proton sponges.	3.4	3	1	Lecture/Presentation
Non trivial bonds weaker than covalent bond: Hydrogen bond, halogen bond, triel bond, tetral bond, 3C-2e bond.	3.5	3	2	Lecture/Presentation
Module 4: Synthetic Applications of Organometallic Reagents (15 Hrs)				
organolithium agents: Preparation, reactivity, lithium halogen exchange, transmetalation, metallation, chemoselectivity, benzilic and allylic metallation, metallation of alpha –heteroatom substituted alkenes and 1-alkynes, conjugate addition.	4.1	5	3	Lecture/Presentation
Organo magnesium reagents: Grignard Reagents- preparation and reactions.	4.2	5	2	Lecture/Presentation
Organocopper reagents: Preparation and reaction of organic cuprates. Preparations of enones. Conjugate addition, Tandem 1,4- addition by enolate trapping, O trapping, C trapping.	4.3	5	2	Lecture/Presentation
Organo zinc reagents: Preparation and reactions- Reactions of functionally substituted RZnI.	4.4	5	1	Lecture/Presentation
Organo boron reagents: carbonylation, synthesis of ketones and tertiary alcohols, cyanidation, dichloromethyl ether reaction.	4.5	5	2	Lecture/Presentation
Organo chromium reagents: Nosaki-Hiyama Reaction, Nozaki Takai Hiyama Kishi Coupling.	4.6	5	1	Lecture/Presentation
Palladium catalysed coupling reactions: General considerations, Mizoroki-Heck reaction, palladium catalysed cross coupling reactions like - Negishi coupling, Suzuki-Miyaura coupling, Stille coupling, Kumada coupling, Buchwald-Hartwig reaction.	4.7	5	4	Lecture/Presentation
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. E. V. Anslyn, D. A. Dougherty, Modern Physical Organic Chemistry, University Science Books, 2005.
2. N. S. Isaacs, Physical Organic Chemistry, 2nd Edition, ELBS/Longman, 1995.
3. D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, 4th Edition, New Academic Science Ltd., 2012.
4. P. S. Kalsi, Stereochemistry Conformation and Mechanism, 8th Edition, New Age International (P) Ltd., New Delhi, 2015.
5. M. B. Smith, J. March, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 7th Edition, Wiley, 2015.
6. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Edition, Oxford University Press, 2012.
7. G. S. Zweifel, M. H. Nantz, P. Somfai, Modern Organic Synthesis: An Introduction, 2nd Edition, John Wiley & Sons, 2017.

Reference

1. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and Mechanisms, 5th Edition, Springer, 2007.
2. E. L. Eliel, S. H. Wilen, Stereochemistry of Organic Compounds, John Wiley & Sons, 1994.
3. D. G. Morris, Stereochemistry, 1st Edition, RSC Tutorial Chemistry Text 1, 2001.
4. T. Okuyama, H. Maskill, Organic Chemistry: A Mechanistic Approach, Oxford University Press, 2014.
5. R. Bruckner, Advanced Organic Chemistry: Reaction Mechanisms, Academic Press, 2002.
6. T. H. Lowry, K. S. Richardson, Mechanism and Theory in Organic Chemistry, 2nd Edition, Harper & Row, 1981.
7. J. M. Coxon, R. O. C. Norman, Principles of Organic Synthesis, 2nd Edition, Springer, 2012.
8. P. Wyatt, S. Warren, Organic Synthesis Strategy and Control, John Wiley & Sons, 2013.

Course designed by Dr Shijo K Cherian

SBU24CH8PRJ400: PROJECT

Type of Course	Major		
Course Level	400-499		
Credit	12		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Design a research project in chemistry or allied subjects.	E
CO2	Perform the feasibility analysis and do a literature review.	An
CO3	Design a suitable methodology and execute the required experiments.	E
CO4	Analyse data and synthesize research findings.	A
CO5	Report research findings in written and verbal forms.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	2	2	2	2	2	2	-
CO2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	-	2	2	2
CO4	2	2	2	2	2	2	-	2	2	2
CO5	-	-	2	3	-	-	2	2	-	2

SIGNATURE COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24CH8DSG400	SGC	Modern Instrumental Techniques and Statistical Thermodynamics	4	60	4
SBU24CH8DSG401	SGC	Advanced Chemical Bonding: Theoretical Insights and Practical Applications	4	60	4
SBU24CH8DSG402	SGC	Advanced Course on Biological Inorganic Chemistry	4	60	4

SBU24CH8DSG400: MODERN INSTRUMENTAL TECHNIQUES AND STATISTICAL THERMODYNAMICS

Type of Course	Signature Course		
Course Level	400		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	To explain the theory, instrumentation and applications of sophisticated characterisation and analysis techniques	U
CO2	To interpret the results of modern characterisation and analysis techniques	An
CO3	To employ modern characterisation and analysis techniques for future research	A
CO4	To apply statistical thermodynamics as a modelling tool to get bulk properties from particle distribution	A
CO5	To explain the theory behind irreversible thermodynamics and bioenergetics	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	-	2	-	-	-	-
CO2	-	1	-	-	-	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	1
CO4	2	-	-	-	-	2	-	-	-	-
CO5	1	-	-	-	-	-	1	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva	Written test	MCQ	
CO1	-	x	-	x	x	x
CO2	-	-	x	x	x	x
CO3	x	-	-	x	x	x
CO4	-	x	-	x	x	x
CO5	-	x	-	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Characterization Techniques (15 Hrs)				
X-ray techniques for materials characterization X-ray diffraction: Principle, Crystallite size effect and Scherrer formula, EXAFS and XANES, Low energy electron diffraction (LEED), Wide-angle X-ray scattering (WAXS) Small-angle X-ray Scattering (SAXS)	1.1	1,2, 3	4	Lecture/PowerPoint
Microscopic techniques Principles, instrumentations and applications of Optical microscope, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM). Energy dispersive X-ray microanalysis (EDS), Basic aspects of atomic force microscopy (AFM).	1.2	1,2, 3	4	Lecture/PowerPoint
Electron spectroscopies: X-ray photoelectron spectroscopy (XPS), Ultra-violet photoelectron spectroscopy (UPS), Auger electron spectroscopy (AES)	1.3	1,2, 3	4	Lecture/PowerPoint
Nanomaterial characterization: Dynamic Light Scattering, Surface plasmon resonance spectroscopy, zeta potential analysis	1.4	1,2, 3	3	Lecture/PowerPoint
Module 2: Spectroscopic Techniques				
Spectroscopic methods UV-Visible Diffuse Reflectance (UV-Vis DRS) spectroscopy, FT-IR, Raman spectroscopy-resonance Raman scattering, Raman microscopy, Surface Enhanced Raman Scattering	2.1	1,2, 3	3	Lecture
Fluorescence spectroscopy- Confocal fluorescence microscopy, Fluorescence correlation spectroscopy, Single-molecule fluorescence spectroscopy, Pump probe spectroscopy, Time-resolved spectroscopy, Laser flash photolysis	2.2	1,2, 3	3	Lecture/PowerPoint
Electrochemical Impedance spectroscopy	2.3	1,2, 3	2	Lecture
Advanced NMR techniques Fourier Transform Nuclear Magnetic Resonance **(**FTNMR), Two-Dimensional NMR (2D-NMR)- Correlation Spectroscopy (COSY), Heteronuclear Correlation Spectroscopy (HETCOR)	2.4	1,2	4	Lecture/PowerPoint
Heteronuclear Single Quantum Coherence (HSQC), Heteronuclear Multiple Bond Correlation (HMBC), Nuclear Overhauser Effect (NOE), Distortionless Enhancement by Polarization Transfer (DEPT)	2.5	1,2	4	Lecture/PowerPoint
Module 3: Statistical Thermodynamics (15 Hrs)				
Types of particles- boltzons, bosons and fermions, Macrostates and microstates	3.1	4	1	Lecture/PowerPoint
Arrangements and respective distribution as per Boltzmann distribution law, Bose - Einstein statistics, and Fermi –	3.2	4	2	Lecture/PowerPoint

Dirac statistics (Derivation not expected), Comparison of the results of three statistics				
partition function and its physical significance, relation between partition function and thermodynamic functions – energy and entropy	3.3	4	1	Lecture/PowerPoint
separation of partition function- derivation of translational, rotational, vibrational and electronic partition functions. Problems based on them. Thermal de-Broglie wavelength	3.4	4	4	Lecture/PowerPoint
Sakur-Tetrode equation for entropy of monoatomic gas and its importance (Derivation not expected)	3.5	4	1	Lecture/PowerPoint
Statistical formulation of third law of thermodynamics, thermodynamic probability, and entropy	3.6	4	1	Lecture/PowerPoint
Residual entropy, phase space	3.7	4	1	Lecture/PowerPoint
Different ensembles- canonical, microcanonical, grand canonical	3.8	4	1	Lecture/PowerPoint
Heat capacity of gases - equipartition principle	3.9	4	1	Lecture/PowerPoint
Fundamentals of Bose – Einstein condensation and thermionic emission	3.10	4	1	Lecture/PowerPoint
Basic assumptions and results of Einstein's theory and Debye's theory and their limitations. (Derivation not expected)	3.11	4	1	Lecture/PowerPoint
Module 4: Irreversible Thermodynamics and Bioenergetics				
Thermodynamics of irreversible processes with examples.	4.1	5	1	Lecture
Uncompensated heat and its physical significance. Entropy production- rate of entropy production with derivation	4.2	5	2	Lecture/PowerPoint
Entropy production in chemical reactions, the phenomenological relations. The principle of microscopic reversibility,	4.3	5	2	Lecture/PowerPoint
The Onsager reciprocal relations (no derivation). Thermal osmosis. Thermoelectric phenomena.	4.4	5	2	Lecture/PowerPoint
Bioenergetics: Introduction; Standard states in biological systems with examples	4.5	5	2	Lecture/PowerPoint
ATP and its role in bioenergetics, high energy bond, free energy and entropy change in ATP hydrolysis; biological redox reactions, coupled reactions.	4.6	5	3	Lecture/PowerPoint
Thermodynamic aspects of metabolism, respiration, oxygen storage and transport.	4.7	5	3	Lecture/PowerPoint

Textbooks

1. D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 7th Edn., Cengage Learning, 2017
2. H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental Methods of Analysis, 7th Edition, CBS Publishers and Distributors, 2018
3. T. Pradeep, Nano: The Essentials: Understanding Nanoscience and Nanotechnology, 1st Edition, McGraw Hill Education, 2017
4. M. C. Gupta, Statistical Thermodynamics, 2nd Edn., New Age International, 2007

Reference

1. Emil Zolotoyabko, Basic Concepts of X-Ray Diffraction, 1st Edition, Wiley-VCH, 2014
2. Angus I. Kirkland, Sarah J. Haigh, Nanocharacterisation, 2nd Edition, Royal Society of Chemistry, 2015
3. D. A. McQuarrie, Statistical Mechanics, University Science Books, 2011
4. L. K. Nash, Elements of Statistical Thermodynamics, 2nd Edn., Dover Books, 2006

Course designed by: Prof. Dr. Tomlal Jose E

SBU24CH8DSG401: ADVANCED CHEMICAL BONDING: THEORETICAL INSIGHTS AND PRACTICAL APPLICATIONS

Type of Course	Signature course		
Course Level	400-499		
Credit	**4**		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Successful completion of quantum mechanics and computational chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the foundational theories and classical concepts of chemical bonding, encompassing valence, electronegativity, Lewis structures, and the VSEPR model.	U
CO2	Analyze electron density distribution and bonding interactions in molecules using Atoms in Molecules (AIM) theory, focusing on electron localization, bond properties, and the relationship between bond properties and AIM theory.	An
CO3	Apply Natural Bond Orbital (NBO) analysis to elucidate electron delocalization, resonance, and non-covalent interactions, enhancing understanding of σ and π bonding, hyperconjugation, and lone pair interactions.	A
CO4	Evaluate the significance of non-covalent interactions in molecular structure and stability through modern computational tools and theoretical models, highlighting the application of various methods including ELF, MEP, RDG, and SAPT.	A
CO5	Demonstrate proficiency in modeling chemical bonds and interactions, with an emphasis on practical applications in materials science, pharmaceuticals, and nanotechnology, including hands-on experience in cutting-edge laboratory techniques.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	-	2	-	-	-	-
CO2	2	2	-	-	-	2	-	-	-	-
CO3	2	2	-	-	-	2	2	-	-	-
CO4	-	2	-	2	-	-	2	-	-	-
CO5	-	-	-	2	2	2	-	2	2	2

Mapping of CO to Assessment Tools

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Journal Club	Mini project	MCQ	
CO1	x	-	-	-	x	x
CO2	x	-	-	-	x	x
CO3	-	x	-	-	x	x
CO4	-	x	-	x	-	x
CO5	-	-	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Chemical Bond: Classical Concepts, Theories and Properties (15 Hrs)				
Valence, periodic table of elements, The shell model, ionic model, covalent model, Lewis structures	1.1	1	1	Lecture
Polar bond and electronegativity	1.2	1	1	Lecture
Polyatomic anions and formal charges, oxidation number	1.3	1	2	Lecture
Donor acceptor bonds	1.4	1	1	Lecture
Exception to octant rule, hypervalent and hypo valent compounds, limitations of Lewis model	1.5	1	1	Lecture
Bond lengths, covalent radii, multiple bonds and bond order, ionic radii, polar bond lengths, back bonding, bond dissociation energies and enthalpies, force constants and dipole moments	1.6	1	2	Lecture
VSPER Model, electron pair domains, Two, three, four and six electron pair valance shells	1.7	1	2	Lecture
Multiple bonds, five electron pair valance shells, limitations and exceptions	1.8	1	2	Lecture
Ligand- ligand interactions and ligand close packing model, bond lengths and coordination number, molecules with different ligands, polyatomic ligands, comparison of LCP and VSEPR model	1.9	1	3	Lecture
Module 2: Atoms in Molecules Theory (10 Hrs)				
Hellmann-Feynman Theorem, representation of electron density, density difference and deformation function	2.1	2	3	Lecture
Topology of electron density, atomic properties, bond properties	2.2	2	3	Lecture
Laplacian of electron density, valance shell charge concentration. Laplacian and VSEPR Model, Electron pair localization and Lewis and VSEPR Models	2.3	2	3	Lecture
Relationship between bond properties and AIM theory	2.4	2	3	Lecture
Molecules with elements of period 2 and 3, AIM treatment Case studies: AIM analysis of simple organic molecules	2.5	2	3	Simulations
Module 3: Natural Bond Orbital Analysis (10 Hrs)				
Introduction to Natural Bond Orbital Analysis Overview of computational chemistry tools for electronic structure analysis. Principles of NBO analysis: from Lewis structures to natural orbitals. The significance of NBO analysis in modern chemistry.	3.1	3	1	Lecture
Quantum mechanical basis of natural bond orbitals. NBO vs. canonical molecular orbitals: Understanding the difference. The role of NBO in describing electron delocalization and resonance.	3.2	3	2	Lecture
Introduction to computational software for NBO analysis Step-by-step guide to performing NBO analysis: Input preparation, calculation settings, and execution.	3.3	3	2	Simulations

Understanding NBO output: Occupancy, stabilization energies, and donor-acceptor interactions. Analyzing σ and π bonding, hyperconjugation, and lone pair interactions through NBO. Case studies: NBO analysis of simple organic molecules, transition states and complexes.	3.4	3	2	Case study
Exploring the role of non-covalent interactions in molecular structure and stability through NBO analysis. Investigating conjugation and aromaticity using NBO. Future directions and advanced topics in NBO analysis: Second-order perturbation theory, NBO in excited states and dynamics.	3.5	3	3	Practicum/Simulations
Module 4 Modelling Non-covalent interactions (20 Hrs)				
Introduction to non-covalent interactions, types of NCI	4.1	4	2	Lecture
Theoretical models to study NCI- Use of NBO and QTAIM	4.2	4	1	Lecture
Basic idea of the following theoretical tools 1. Electron Localization Function (ELF) 2. Molecular Electrostatic Potential (MEP) 3. Reduced Density Gradient (RDG) and NCI Plot 4. Energy Decomposition Analysis (EDA) 5. Natural Energy Decomposition Analysis (NEDA) 6. Non-covalent Interaction (NCI) Index 7. Charge Decomposition Analysis (CDA) 8. Halogen Bonding Orbital Analysis 9. Symmetry-Adapted Perturbation Theory (SAPT)	4.3	4	10	Lecture/Demonstration/Simulation
Application of the following tools in the study of NCI 1. Density Functional Theory (DFT)-choice of functionals 2. Coupled Cluster Theory (CCT) 3. Møller-Plesset Perturbation Theory (MPPT) 4. Dispersion-Corrected DFT (D-DFT) 5. Choice of suitable basis sets 6. Wave Function Analysis 7. Topological Analysis of Electron Density 8. Multiwfn Software 9. Crystal Orbital Hamilton Population (COHP) 10. Fragment Molecular Orbital (FMO) Method 11. Molecular Dynamics (MD) 12. Different solvation models 12. Natural Resonance Theory (NRT)	4.4	4	10	Lecture/Demonstration/Simulation
Module 5: Case studies (5 Hrs)				
Halogen Bonding in Molecular Recognition and Self-Assembly Photochemistry and photo physics of bonding Non-covalent Interactions in Drug Design Molecular Design of Organic Light-Emitting Diodes Quantum Computing with Molecular Qubits Non-Covalent Interactions in Organic Electronic Devices Water clusters and network formation Machine learning in the study of Chemical Bond	5.1	5	5	Case studies/Journal club

Module 6: Teacher Specific Content

(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)

This content will be evaluated internally

Textbooks

1. R. J Gillespie, Paul L.A Popelier, Chemical Bonding and Molecular Geometry, Oxford University Press, 2001
2. P. Comba, T.W. Hambley, B. Martin, Molecular Modeling of Inorganic Compounds Wiley VCH, 2009
3. J. H. Jensen, E. G. Lewars, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Edn., Springer, 2011
4. F. Jensen, Introduction to Computational Chemistry, 2nd Edn., John Wiley & Sons, 2007
5. A. R. Leach, Molecular Modelling: Principles and Applications, 2nd Edn., Pearson Education Ltd., 2001

Reference

1. A. Hinchliffe, Molecular Modelling for Beginners, 2nd Edn., John Wiley & Sons, 2008
2. J. Cramer, Essentials of Computational Chemistry: Theories and Models, 2nd Edn., John & Sons, 2004
3. C. Young, Computational Chemistry: A Practical Guide for Applying Techniques Real World Problems, John Wiley & Sons, 2001

Course designed by: Dr. Renjith Thomas

SBU24CH8DSG402: ADVANCED COURSE ON BIOLOGICAL INORGANIC CHEMISTRY

Type of Course	Signature course		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Successful completion of any of the foundation courses in chemical or biological sciences		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the significance of metals in living systems	U
CO2	Interpret modes of electron transfer, and oxygen transport and storage in plants and animals	U
CO3	Describe the role of major metalloenzymes in living systems	U
CO4	Analyze various medical applications of metal complexes	An
CO5	Explain the principles and applications of chelation therapy	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	1	2	2	-	-	-
CO2	1	-	2	-	1	2	1	-	-	-
CO3	2	-	1	-	2	1	2	-	-	-
CO4	1	-	2	-	1	2	1	-	-	-
CO5	1	-	1	-	1	2	2	-	-	-

Mapping of CO to Assessment Tools

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva	Written Test	MCQ	
CO1	x	-	x	x	x	x
CO2	x	-	-	x	-	x
CO3	-	x	-	x	x	x
CO4	-	x	x	x	-	x
CO5	x	-	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Metals in living systems (20 Hrs)				
Inorganic composition of living organisms, metals in biological systems: major, trace and ultra-trace metals; metallomics and compartmentalization, flowcharts for metallomic investigations; biological roles of Na, K, Mg, Ca, Mn, Fe, Co, Ni, Cu, Zn, Mo, W and Si	1.1	1	2	Lecture

Biological metal coordination sites: amino acids as ligands, special ligands: porphyrins and pterin-dithiolenes, structures on inner and outer coordination shells	1.2	1	2	Lecture
Metal ions in transport and communication: ionophores, general principles of the action of the K^+ channel and Na^+/K^+-ATPase	1.3	1	2	Lecture
Calcium signaling proteins: troponin C and calmodulin	1.4	1	1	Lecture
Selective transport and storage of iron: siderophores, transferrins, ferritin, haemosiderin	1.5	1	2	Lecture
Oxygen transport and storage: myoglobin, haemoglobin, haemocyanin, haemerythrin, reversible O_2 binding by small molecule analogues, oxygen atom transfer by Mo and W enzymes: sulfite oxidase, structure and functions	1.6	2	2	Lecture
Electron transfer in biological systems: cytochromes, cytochrome c, cytochrome c oxidase; Iron-sulphur proteins: rubredoxins, ferredoxins, Rieske proteins	1.7	2	2	Lecture
Other storage and transport systems: Metallothioneins, phytochelatins, ceruloplasmin, vanadium storage and transport	1.8	1, 2	2	Lecture
Copper electron transfer centres: blue-copper proteins, plastocyanin; Coenzyme B_{12}: reactions of enzymes containing cobalamin B_{12}, methionine synthase, radical based rearrangements; structure and functions of radical S-adenosylmethionine enzyme and methyl coenzyme M reductase	1.9	1, 2	3	Lecture
Photosynthetic oxygen production: chemical features of chlorophyll, light and dark reactions, photosystems, photosynthetic electron transfer chain; role of Mn cluster, structure and functions	1.10	1, 2	2	Lecture
Module 2: Metalloenzymes in nature (25 Hrs)				
Introduction to metalloenzymes and related terms, Cofactors: inorganic ions and coenzymes; prosthetic groups and co-substrates, apoenzymes, holoenzymes	2.1	3	3	Lecture
Zinc enzymes: carbonic anhydrase, carboxy peptidases, alkaline phosphatase, and alcohol dehydrogenase. Mechanism of action of carbonic anhydrase	2.2	3	3	Lecture
Magnesium enzymes: endonucleases, rubisco and Calvin cycle, aminopeptidases	2.3	2	3	Lecture
Hydrolytic iron enzymes: acid phosphatases, mechanism of action; aconitase, active sites and mechanism of action	2.4	3	3	Lecture
Peroxidases: catalytic cycle, vanadium bromoperoxidase; oxidases, catalytic cycle of cytochrome c oxidase; blue copper oxidases: laccase, ascorbate oxidase; amine oxidases, galactose oxidase, catechol oxidase, catalases	2.5	3	3	Lecture
Oxygenases: cytochrome P-450, catalytic cycle; methane monooxygenase, active site and catalytic cycle; tyrosinases, dioxygenases, hydrogenases	2.6	3	3	Lecture

Superoxide dismutases: Cu-Zn BESOD, its action; Ribonucleotide reductase, biological nitrogen cycle, nitrogen fixation, nitrogenases: Fe-Mo nitrogenases, structure	2.7	3	3	Lecture
Transcription factors and the role of zinc, iron proteins as sensors: degradation of FeS clusters, operation of fumarate-nitrate regulatory system, O_2 sensing by prolyl oxygenases, CO sensing by CooA; proteins that sense Cu and Zn levels	2.8	3	3	Lecture
Oxotransfer molybdoenzymes, Nickel enzymes, Biomineralization: chemistry, control mechanisms	2.9	2	3	Lecture
Module 3: Inorganic Chemistry in Medicine (15 Hrs)				
Inorganic complexes in cancer treatment: cisplatin, mode of action. Carboplatin, oxaliplatin, Satraplatin, complexes based on Ru, Rh, Cu, Ga and As_4O_6, ferrocene based complexes	3.1	2	4	Lecture
Anti-arthritis drugs: Auranofin, myochrisin, solganol; metal drugs to release CO against post-operative stress	3.2	2	4	Lecture
Bismuth for gastric ulcers, lithium in the treatment of bipolar disorders	3.3	2	4	Lecture
Organometallic drugs in the treatment of malaria: haematin, ferroquine; metal complexes as antiviral agents	3.4	3	4	Lecture
Imaging agents: contrasting agents in MRI, dotarem, magnevist; Tc tracers: cardiolite, ceretec; nanoparticles in directed drug delivery	3.5	2	4	Lecture
Chelation therapy: principle and applications, examples of Lewisite, BAL, EDTA, penicillamine, DMPS, N-acetyl penicillamine, DMSA, hydroxypyridines, Deferoxamine, Deferasirox and Deferiprone	3.6	4	5	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. M. Weller, T. Overton, J. Rourke, F. Armstrong, Inorganic Chemistry International Edition, Oxford University Press, 2018
2. David E. Fenton, Biocoordination Chemistry, First Edition, Oxford University Press, 1996
3. J. E. Huheey, E. A. Keiter and R. L. Keiter, O. K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, 5th Edition, Pearson Education, 2022

Reference

1. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, 6th Edition, W.H. Freeman, 2012
2. K. Burger, Biocoordination Chemistry: Coordination Equilibria in Biologically Active Systems, Ellis Horwood Ltd, 1990
3. H. B. Gray, E. I. Stiefel, J. S. Valentine, I. Bertini, Biological Inorganic Chemistry: Structure and Reactivity, 1st Edition, University Science Book, 2006
4. D. Rehder, Bioinorganic Chemistry, Oxford University Press, 2014

Course designed by: Dr. Cyril Augustine V.

Rubrics For the Assessment of Theory Courses

Each course contains specific assessment tools. However, the faculty teaching the course has the freedom to alter these tools according to the course requirements, with prior permission from the respective Board of Studies.

The rubrics provided below serve as general guidelines and may require adjustments based on the specific requirements and focus areas of different theory courses in chemistry, including organic, inorganic, physical, environmental, theoretical chemistry etc. Adjustments may include placing more emphasis on certain criteria, adding specific requirements, or modifying the scoring scale to better reflect the expectations of the course.

Assignment

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Content Mastery	Thorough understanding with clear explanations and insightful analysis.	Solid understanding with mostly clear explanations and analysis.	Some understanding but lacks clarity or depth in explanations.	Little understanding with unclear or inaccurate explanations.
Organization	Logically organized with clear transitions, easy to follow.	Mostly organized with adequate transitions, generally easy to follow.	Somewhat unclear organization, disjointed transitions, flow could improve.	Unclear organization, little to no transitions, difficult to follow.
Writing Quality	Clear, concise, and engaging with few to no errors.	Mostly clear and concise, minor errors in grammar, punctuation.	Somewhat unclear or verbose, noticeable errors in grammar, punctuation.	Unclear, verbose, numerous errors in grammar, punctuation.
Critical Analysis	Provides insightful analysis, considers different perspectives.	Adequate analysis, reasonable conclusions, considers perspectives.	Limited analysis, some consideration of perspectives, conclusions may lack support.	Little to no analysis, minimal consideration of perspectives, unsupported conclusions.
References	Incorporates variety of credible sources with accurate citations.	Utilizes credible sources with mostly accurate citations.	Limited sources, some inaccuracies in citations.	Lacks credible sources, inaccurate or absent citations.

Penalty for Late submission:

If submitted within one week after the stipulated time 75% of the marks calculated as per the above rubrics will be awarded to the student. If submission is after one week of deadline but within the extended time fixed by the course in charge, only 50% of the marks determined as per rubrics will be awarded.

Seminar Presentation

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Content	Comprehensive, well-researched, relevant, and insightful.	Solid coverage of main points, well-researched, mostly relevant.	Adequate coverage of main points, lacking depth or relevance.	Minimal, inaccurate, or irrelevant content.
Organization	Clear structure, logical flow, seamless transitions.	Logical structure, clear sections, some transitions.	Basic structure, unclear transitions, some sections underdeveloped.	Disorganized, random structure, unclear sections.
Delivery	Confident, engaging, dynamic, clear articulation.	Mostly confident, engaging, occasional lack of clarity.	Hesitant, inconsistent, lacks enthusiasm.	Unclear, hesitant, monotone, lacks engagement.
Knowledge/ Understanding about the subject	Sound understanding about the subject and communicated it well.	Knowledge about the subject is good and tried to exhibit it to a certain extent.	Knowledge about the subject is fairly good but not exhibited through presentation.	Knowledge about the subject of presentation is not up to the mark.
Answering Questions	Answered all questions convincingly.	Answered majority of the questions.	Tried to answer some questions but not so successful.	Not able to answer any question.

Poster Designing and Presentation

Category	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Coverage of the Topic	Details on the poster capture the important information about the topic and increase the audience's understanding.	Details on the poster include important information but the audience may need more information to understand fully.	Details on the poster relate to the topic but are too general or incomplete. The audience needs more information to understand.	Details on the poster have little or nothing to do with the main topic.
Use of Graphics	All graphics are related to the topic and make it easier to understand.	All graphics are related to the topic and most make it easier to understand.	All graphics relate to the topic.	Graphics do not relate to the topic.
Organization	Content is clearly arranged so that the viewer can understand order without narration.	Content is arranged so that the viewer can understand order without narration.	Content arrangement is somewhat confusing and does not adequately assist	Content arrangement is somewhat confusing and does not adequately assist

			the viewer in understanding order without narration.	the viewer in understanding order without narration.
Layout & Design	All information on the poster is in focus and can be easily viewed and identified from 6 ft. away.	Most of the information on the poster is in focus and the content easily viewed and identified from 6 ft. away.	Most of the information on the poster is in focus and the content is easily viewed and identified from 4 ft. away.	Much of the information on the poster is unclear or too small.
Mechanics	No grammatical, spelling, or punctuation errors.	Almost no grammatical, spelling, or punctuation errors.	A few grammatical, spelling, or punctuation errors.	Many grammatical, spelling, or punctuation errors.
Presentation	Narration and/or answering of questions is engaging, thorough, and adds greatly to the presentation.	Narration and/or answering of questions is adequate and adds to the presentation.	Narration and/or answering of questions is somewhat lacking.	Narration and/or answering of questions is lacking.

Molecular Modeling

Students are supposed to learn how to draw and optimize simple molecules, and to find the possible conformers based on molecular mechanics. Any of the available software can be used. Evaluation is as follows.

A list of molecules will be given to the students. Each one can select any five from the list. They have to draw the selected molecules, optimize those using MM methods, and tabulate the energies of various conformers, if any. Students are free to select the software. However, assistance will be provided by the course coordinators.

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Evaluation of the Five Molecular Structures	Correct structures	Five Structures, but some with minor errors	Five Structures, but some with major errors	If some structures are missing or there are serious errors
Optimization & Conformer Analysis	If the task is done for all the five structures	If the task is done for all the five structures, but with minor faults	If the task is done for all the five structures, but with major errors	If there are serious errors in the optimization and conformer analysis
Presentation of Results as Tables in an MS Word Document	Data with properly labelled columns, units and alignment.	Data is presented, but the document is not properly prepared. There are missing units, disorder in	Partial presentation of the required data	Serious mistakes in both the data and in the presentation

		alignment, and columns are not labelled.		
Viva-voce	All answers are correct, answered with confidence and clarity.	Answers are correct. Lack of clarity and confidence.	Partially correct answers.	Wrong answers. However, attempted to answer.

Viva-Voce

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Knowledge	Deep and comprehensive understanding, clear, accurate, and insightful responses.	Solid understanding, mostly clear and accurate responses, occasional lack of depth.	Some understanding, responses lack depth or clarity.	Little understanding, struggles with clear or accurate responses.
Critical Thinking	Applies critical thinking effectively, analyzes and evaluates concepts, draws connections.	Demonstrates critical thinking skills but may need prompting, limited depth.	Limited critical thinking, responses lack depth or insight.	Little to no critical thinking, simplistic or superficial responses.
Communication	Clear, confident, and persuasive communication, appropriate language.	Effective communication, occasional lack of confidence or clarity, occasional language issues.	Communication is unclear or hesitant, inconsistent language use.	Unclear or hesitant communication, inappropriate language.
Engagement	Actively engages with enthusiasm, asks insightful questions, and contributes to the conversation.	Engages but may need encouragement, shows some enthusiasm.	Engagement is limited, minimal participation, lacks enthusiasm.	Little to no engagement, minimal participation, demonstrates disinterest.

Case Study

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Introduction	Clear, concise, and contextualized.	Adequate introduction, but may lack some clarity.	Brief introduction, lacking clarity or context.	Unclear introduction, missing purpose and context.
Problem Statement	Clearly identifies the problem with depth and specificity.	Identifies the problem, but lacks depth or specificity.	States the problem, but lacks clarity or specificity.	Fails to identify the problem clearly.

Analysis	Thorough and insightful analysis using relevant frameworks and evidence.	Solid analysis, but may lack depth in some areas.	Basic analysis, lacking depth or clarity.	Superficial analysis, lacking substance.
Recommendations	Well-supported and actionable recommendations addressing the problem.	Generally appropriate recommendations, but lack specificity.	Vague or impractical recommendations.	Absent or poorly supported recommendations.
Conclusion	Effective summary of key findings and insights.	Summary of key points, but lacks depth.	Brief conclusion, failing to summarize effectively.	Missing or ineffective conclusion.
Clarity & Coherence	Clear, well-organized, and coherent writing with logical flow.	Generally clear and organized writing, minor coherence issues.	Somewhat unclear or disorganized writing.	Unclear, disorganized writing hindering understanding.

Group Discussion

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Preparation	All members well-prepared, contributing relevant insights.	Most members prepared, offering relevant contributions.	Some members prepared, but contributions lack depth.	Few members prepared, with minimal or irrelevant contributions.
Collaboration	Active engagement, fostering a supportive environment.	Engagement present, but some may dominate or not actively listen.	Limited engagement, with minimal interaction.	Little to no engagement, each speaking independently.
Communication	Clear and respectful communication, articulating points effectively.	Generally clear communication, with some less effective points.	Somewhat unclear or ineffective communication.	Communication unclear or disrespectful, hindering understanding.
Critical Thinking	Strong critical thinking, analysing and offering insightful perspectives.	Adequate critical thinking, though some lack depth.	Limited critical thinking, with few challenging assumptions.	Lacks critical thinking, contributions lack analysis.
Contribution	Consistently valuable contributions, enriching the dialogue.	Generally, contributes, with occasional passivity.	Minimal contribution, with limited participation.	Rarely contributes, remaining passive or silent.

Research Paper Review/ Journal Club

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Introduction	Provides a clear and concise overview of the research topic and its significance.	Presents an adequate introduction to the research topic, but may lack some clarity.	Introduces the research topic, but lacks depth or fails to establish significance.	Fails to provide a clear introduction or context for the research topic.
Literature Review	Thoroughly reviews relevant literature, integrating and creating key findings.	Reviews literature effectively, but may lack some depth or creation of findings.	Addresses relevant literature, but lacks creation or may miss key studies.	Fails to adequately review relevant literature or lacks integration of findings.
Methodology	Clearly describes the research methodology, including sample, data collection, and analysis procedures.	Describes the research methodology adequately, but may lack some detail or clarity.	Describes the research methodology, but lacks specificity or may have some inconsistencies.	Fails to clearly describe the research methodology or lacks essential details.
Results	Presents research results clearly and concisely, with appropriate tables, figures, or statistical analysis.	Presents research results adequately, but may lack some clarity or organization.	Presents research results, but lacks clarity or may have inconsistencies.	Fails to present research results clearly or lacks appropriate analysis.
Discussion	Analyzes research findings effectively, relating them to the research question and discussing implications.	Analyzes research findings adequately, but may lack depth or insight into implications.	Discusses research findings, but lacks analysis or fails to connect them to the research question.	Fails to analyze research findings effectively or lacks discussion of implications.
Conclusion	Provides a clear and insightful conclusion, summarizing key findings and suggesting areas for future research.	Offers a conclusion that summarizes key findings, but may lack depth or insight.	Provides a conclusion, but lacks clarity or fails to suggest future research directions.	Fails to provide a clear conclusion or suggest future research directions.
Writing Clarity	Writing is clear, concise, and well-organized, with appropriate use of language and terminology.	Writing is generally clear and organized, but may have some minor issues.	Writing is somewhat unclear or disorganized, hindering understanding.	Writing is unclear, disorganized, or uses inappropriate language/terminology.

Project

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Project Objective	Clearly defined objective, demonstrating deep understanding.	Well-defined objective, though may lack some depth.	Objective stated, but lacks specificity.	Objective unclear or inadequately addressed.
Research	Thorough research, gathering relevant information effectively.	Adequate research, may overlook key information.	Basic research, limited depth or relevance.	Insufficient or irrelevant research.
Planning	Comprehensive plan outlining milestones, tasks, and timelines.	Plan outlines components, may lack detail.	Basic plan, lacks organization or realism.	Incomplete or disorganized plan.
Execution	Effective execution, demonstrating strong project management skills.	Adequate execution, may encounter challenges.	Partial execution, lacks consistency.	Ineffective execution, significant challenges.
Deliverables	High-quality deliverables meeting project objectives effectively.	Deliverables meet objectives, with minor issues.	Deliverables incomplete or not fully meeting objectives.	Incomplete, incorrect, or not meeting objectives.
Presentation	Clear and engaging presentation communicating objectives and outcomes effectively.	Presentation communicates objectives and outcomes, lacks some clarity.	Presentation lacks structure or fails to communicate outcomes effectively.	Unclear, disorganized, or fails to communicate effectively.

Online or Offline Quiz (MCQ)

It will be an online or offline test comprising 10 or 20 multiple choice questions of 15 or 30 minutes duration. Maximum marks will be 10 or 20. Each question will carry 1 mark. Online test will conduct via platform like Linways LMS, Google form, Quizizz etc.

Rubrics For the Assessment of Practical Courses

The rubrics provided below serves as general guidelines and may need to be adjusted based on the specific requirements and focus areas of different practical courses such as organic, inorganic, physical, environmental or theoretical chemistry. Adjustments may include placing more emphasis on certain criteria, adding specific requirements, or modifying the scoring scale to better reflect the expectations of the course.

Lab Involvement/ Laboratory Skills

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Preparation	Thoroughly prepared, reviewed procedures, and understood safety protocols.	Adequately prepared, with some review of procedures and awareness of safety protocols.	Basic preparation, lacking thorough review of procedures or safety protocols.	Little to no preparation, lacking understanding of procedures and safety protocols.
Participation	Actively engaged in lab activities, contributing ideas and collaborating effectively.	Participated in lab activities, may need encouragement to contribute or collaborate.	Minimally participated, showing limited collaboration with peers.	Rarely participated, preferring to work alone or not engaging with peers.
Safety	Demonstrated a strong commitment to safety, following protocols meticulously.	Followed safety protocols, with occasional reminders needed.	Showed limited awareness of safety protocols, with noticeable lapses.	Disregarded safety protocols, risking personal safety or the safety of others.
Accuracy	Executes lab procedures accurately, obtaining precise and reliable results consistently.	Performs lab procedures with acceptable accuracy, occasionally making minor errors or deviations.	Demonstrates inconsistent accuracy in executing lab procedures, resulting in noticeable errors or deviations.	Frequently makes significant errors in executing lab procedures, leading to unreliable results.
Clean up & waste disposal	Completes lab clean up promptly and thoroughly, leaving the workspace tidy and organized for the next group and disposed the wastes properly.	Participates in lab clean up, but may require reminders or supervision to ensure thoroughness and not disposed the wastes properly.	Shows limited initiative in lab clean up, leaving some tasks incomplete or the workspace disorganized and not disposed the wastes properly.	Often neglects lab clean up, leaving tasks unfinished and the workspace messy for the next group and not disposed the wastes properly.

Record Evaluation

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Clarity & Organization	Clear, well-organized, and easy to follow.	Mostly clear and well-organized.	Somewhat clear and organized.	Unclear and poorly organized.
Completeness & Detail	Thorough and detailed, covering all required elements.	Mostly complete and detailed.	Somewhat complete and detailed.	Incomplete and lacks detail.
Accuracy of Data	All data presented is accurate and reliable.	Most data presented is accurate.	Some data may be inaccurate.	Much of the data is inaccurate.
Analysis & Interpretation	Thorough analysis and interpretation with insightful discussions.	Solid analysis and interpretation.	Basic analysis and interpretation.	Lacks analysis and interpretation.
Number of experiments	Recorded all the experiments that are specified in the syllabus	Recorded less than 3 experiments that are specified in the syllabus.	Recorded less than 5 experiments that are specified in the syllabus.	Recorded less than 7 or no experiments that are specified in the syllabus.

Laboratory Test

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Preparation	Thorough preparation, understanding lab procedures and safety protocols.	Adequate preparation, some review of lab procedures and safety protocols.	Basic preparation, lacking thorough review of lab procedures or safety protocols.	Little to no preparation, lacking understanding of lab procedures and safety protocols.
Technique	Accurate execution of laboratory techniques with mastery of skills.	Acceptable execution of laboratory techniques, with some minor errors.	Basic proficiency in laboratory techniques, noticeable errors affecting results.	Poor technique, leading to significant errors and unreliable results.
Data Collection	Accurate and systematic data collection, recording all necessary measurements with precision.	Data collection with acceptable accuracy, minor overlooks or recording errors may occur.	Somewhat inaccurate or inconsistent data collection, noticeable gaps or errors.	Inaccurate or incomplete data collection, significant gaps or errors.
Analysis	Effective analysis of data, drawing appropriate	Analysis of data with some effectiveness,	Basic analysis, limited insight into trends.	Inadequate or incorrect analysis, failing to draw

	conclusions and identifying trends.	conclusions may lack depth.		appropriate conclusions.
Safety	Rigorous adherence to safety protocols, ensuring a safe laboratory environment.	Adequate adherence to safety protocols, occasional lapses.	Limited adherence to safety protocols, frequent lapses.	Disregard for safety protocols, putting oneself and others at risk.

Practical Assignment

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Experimental Procedure	Clear and detailed procedure with safety measures.	Well-written procedure with most steps included.	Procedure is present but lacks some details.	Procedure is unclear or incomplete.
Data Collection	Accurate and comprehensive data collection.	Mostly accurate data collection with minor errors.	Data collection may lack precision.	Data collection is inaccurate or incomplete.
Data Analysis	Thorough analysis with appropriate calculations.	Adequate analysis, may lack depth.	Basic analysis with errors or lack of detail.	Minimal or erroneous analysis.
Results Presentation	Clear presentation with well-labeled figures.	Mostly clear presentation, may lack some labels.	Somewhat disorganized presentation.	Unclear or disorganized presentation.
Conclusion	Concise and insightful conclusion summarizing key findings.	Adequate conclusion with some discussion.	Conclusion lacks depth or effective summarization.	Missing or ineffective conclusion.

Viva-Voce

Criteria	Excellent (4)	Proficient (3)	Satisfactory (2)	Needs Improvement (1)
Knowledge	Comprehensive understanding of practical concepts.	Solid understanding of practical concepts.	Some understanding of practical concepts.	Little understanding of practical concepts.
Experimental Skills	Expertly executes practical techniques.	Proficient execution with minor errors.	Some errors in execution or inconsistencies.	Inadequate or incorrect execution of techniques.
Interpretation	Insightful analysis of experimental results.	Reasonable interpretation with appropriate conclusions.	Basic interpretation with limited insights.	Ineffective interpretation, lacks meaningful conclusions.

Problem Solving	Proficient problem-solving ability.	Some ability to solve problems, may struggle with complexity.	Limited problem-solving skills, may require guidance.	Inadequate problem-solving skills, heavily reliant on guidance.
Communication	Clear, articulate, and confident communication.	Effective communication with occasional hesitation.	Somewhat unclear or hesitant communication.	Unclear, hesitant, or lacking confidence in communication.

Appendix

SHORT TERM COURSES

The main objective of the short term courses offered by the college is to supplement the students with various skills and technical know-how outside the structured academic curriculum, to produce quality citizens who are academically proficient, self-reliant and socially committed. The courses have compulsory components and optional components that equip the students to attain various programme objectives envisaged by the Vision and Mission statements of the college.

All Short-Term Courses (STCs) are coordinated by the Department of Short Term Courses, headed by a Director and is supervised by a Vice Principal nominated by the Principal. Each component of the STC is coordinated and managed by a Faculty Convener. The Advisory Board of the Department consists of the Vice-Principals, Director of the Short Term Courses and the various Conveners.

In case of any grievances, students can approach the Grievance Redressal Cell of the STC which consists of the Vice-Principal in Charge, Director and the concerned Convener. If the student feels that the issue was not adequately addressed, he/she can approach the Grievance Redressal Cell of the college. The grading pattern for all courses will be the same as in the UG regulations 2024. The courses offered by the department are given in the following table.

	Name	Semesters	Type	Credit
1	Value Education	I to VI	Compulsory	3
2	Basic Life Support System and Disaster Management (BLS & DM)	I	Compulsory	1
3	Social Awareness Course (SAC)	I and II	Compulsory	2
4	Skill Development Courses (SDC)	II and III	Optional	2
5	Finishing School	III and IV	Compulsory	1
6	Virtual Lab Experiments	V	Optional	1

REGULATIONS FOR SHORT TERM COURSES

VALUE EDUCATION

Value Education is a compulsory extra credit course with three (3) credits for all the students admitted to the undergraduate programmes.

Duration

The duration of the course shall be three academic years (six semesters). There shall be minimum 60 hours spread over three years with 20 hours every academic year.

Evaluation

The evaluation of each course shall contain two parts.

i. Continuous evaluation (every year)
ii. Final evaluation (every year)

There shall be a maximum of 50 marks comprising of forty (40) marks for final evaluation and ten (10) marks for continuous evaluation.

Continuous Evaluation

Component	Marks
Assignment	5
Attendance	5
Total	10

1. **Assignment**

   The students shall submit at least one assignment in every year. The marks for assignment is five (5).

2. **Attendance**

   The minimum requirement of aggregate attendance during a year for appearing the final examination shall be 75%.

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Final evaluation

Final evaluation shall be conducted by the course coordinator at the end of every year.

There shall be an annual written examination of one and a half hours (1½) duration with a maximum forty marks (40), every year.

The question paper shall be strictly on the basis of model question paper set by the Expert Committee.

A question paper consists of short answer type, short essay type and long essay type questions.

The total marks of the course (three years combined) shall be one hundred and fifty (150).

Award of certificate

A separate minimum 30% marks each for continuous evaluation and final evaluation and an aggregate minimum of 35% are required for a pass in the course.

If a student does not acquire minimum marks in first and second years, he/she can continue the course.

The student shall be eligible to get certificate only after completing the course with D Grade. On successful completion of the course, the grade awarded will be indicated in the Mark cum Grade Card.

The grading pattern will be the same as in UG Regulations 2024.

The course shall be completed during the tenure of the programme.

BASIC LIFE SUPPORT SYSTEM AND DISASTER MANAGEMENT (BLS & DM)

- The main objective of this course is to provide intensive training on Basic Life Support System and Disaster Management with the help of professional trainers and adequate numbers of mannequins and kits for imparting the training to students.
- This course is compulsory for all the undergraduate students of this college and has one (1) credit.
- The course on BLS & DM shall be conducted by a nodal centre created in the College.
- Each student shall undergo five (5) hours of hands-on training in BLS & DM organised by the Centre for BLS & DM.
- After the completion of the training, the skills acquired shall be evaluated using an offline/online test and grades shall be awarded.
- Nodal Centre for BLS & DM shall conduct an online test and publish the results.
- Students who could not complete the requirements of the BLS & DM training shall appear for the same along with the next batch.
- The grading of the course is as per the grading pattern in UG Regulations 2024.

SOCIAL AWARENESS COURSE (SAC)

- The aim of SAC is to make students aware of the problems that different societies and communities face on a day-to-day basis and to be conscious of the difficulties and hardships of society.
- This is a compulsory course with two (2) credits.
- Social Awareness Course shall be conducted by a nodal centre consisting of the convenor, other faculty members nominated by the Principal.
- The centre shall identify the areas where the students can serve the society through the course.
- During the first semester itself, the centre shall organise activities to sensitize the students about the significance and relevance of Social Awareness and publish a list of different areas where they can work as volunteers.
- The centre shall allot students to various areas based on their preference.
- Students shall carry out the voluntary work allotted to them after the regular class hours/weekends/holidays falling in the first and second semesters and the summer vacation following the second semester.
- Evaluation of the SAC activity shall be based on the hours of work put in by a student. A minimum of 50 hours of social work (corresponding to 50 marks) is required for the successful completion of the course. Every additional work beyond the minimum 50 hours shall fetch five (5) marks per hour. Maximum marks shall be 100.
- Students who donate blood during the first year shall be given 10 marks on production of the certificate from the medical officer. However, marks earned through blood donation shall not be counted for a pass in the course. Mark for blood donation shall be awarded only once during the SAC.
- Two credits shall be awarded to students who complete the requirements of SAC.
- The grading will be as per the grading pattern in the UG Regulations 2024.
- Students who could not complete the requirements of the SAC shall appear for the same with the next batch.
- The Director of Short-Term Courses and Convenor of SAC has the right to exclude students who are physically challenged from SAC, if requested.

SKILL DEVELOPMENT COURSES (SDC)

- This is a compulsory component of STC with two (2) credits.
- SDC's shall be completed within the first four semesters of the programme.
- Depending on the nature of the course, there will be a theory component and a skill development component.
- The credit will be awarded only if the student gets a D grade (35% marks) and above.
- A student can do a maximum of three skill Development Courses according to his/her choice, but pass in at least one course is compulsory.
- The Convenor of SDC will coordinate the course.
- The Head of the Department concerned in consultation with the faculty members may prepare a syllabus for the SDC, which will be approved by the Board of Studies concerned.

Evaluation of SDC

The evaluation the course shall be done internally and contain two parts.

i. Continuous evaluation
ii. Final evaluation

Both continuous evaluation and final evaluation shall be carried out using indirect grading. The marks for continuous evaluation is twenty (20) and that of the final evaluation is eighty (80).

Continuous evaluation

The components of the continuous evaluation and their marks are as below.

For all courses, without practical

There are two components for continuous evaluation, which include attendance and assignment. All the components of the continuous evaluation are mandatory.

Component	Marks
Attendance	5
Assignments	15
Total	**20**

Marks for attendance

Minimum 75% attendance is compulsory for attending the final examination.

% of Attendance	Marks
90 and above	5
85 - 89	4
80 – 84	3
76 – 79	2
75	1

(Decimals shall be rounded mathematically to the nearest whole number)

For all courses with practical

The components for continuous evaluation of courses with practical are given below.

Component	Marks
Attendance	5
Lab/skill work involvement	15
Total	**20**

Assignments

At least one assignment shall be submitted for the course.

Final evaluation

The final evaluation of theory and practical courses shall be conducted by the office of the Controller of Examinations. It can be in the form of 80 marks written examination or 80 marks project/practical examination or 80 marks written and project/practical examination combined, as decided by the Board of Studies concerned.

FINISHING SCHOOL

- It is a compulsory course with one (1) credit.
- The course provides compulsory training for all under graduate students of this college.
- The training is to help students develop their soft skills and interview skills.
- The training shall impart soft skills comprising of language skills, personal presentation and grooming, table manners, resume preparation, group discussion techniques, and interview skills among the undergraduate students.
- This course shall be conducted during the third and fourth semesters for all the undergraduate students.
- There will be a total of 20 contact hours which shall be handled by a team of professional members/faculty. In addition, a one-day outbound training session by a team of professional trainers that touches on the aspects of creativity, problem solving and team building shall also be organized.
- The students shall be assessed on the basis of the components given below.

Component	Marks
Attendance	5
Aptitude Test	10
Assignments	10
Group discussion	10
Interview	15
Total	**50**

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Grades will be awarded as per grading pattern in UG Regulations 2024.

VIRTUAL LAB EXPERIMENTS

- This is an optional course with one (1) credit.
- The main aim of the Virtual Lab Experiments is to provide remote-access to simulation-based Labs in various disciplines of Sciences which enthuse students to conduct experiments by arousing their curiosity.
- The Convenor will coordinate the Virtual Lab component and he may use the services available in different virtual lab platforms after the approval of the advisory body.
- Students have to do at least 36 hours of experiments and they get a maximum of one credit for this.
- Convenor and the mentor of the student shall oversee the progress and assign grades as per the grading pattern in UG Regulations 2024 after the completion of the programme.