Adamas University
School of Basic and Applied Sciences
Department of Chemistry

Programme Structure and Syllabus of B.Sc. Chemistry

Programme Code: CHM3403

Duration: 4 Years (Full Time)

Academic Year: 2024-25

Vision of the University

To be an internationally recognized university through excellence in inter-disciplinary education, research and innovation, preparing socially responsible well-grounded individuals contributing to nation building.

Mission of the University

- Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology
- Foster outcomes based education system for continuous improvement in education, research and all allied activities
- Instill the notion of lifelong learning through culture of research and innovation
- Collaborate with industries, research centers and professional bodies to stay relevant and up-to-date
- Inculcate ethical principles and develop understanding of environmental and social realities

Core Values

- Respect
- Positivity
- Commitment
- Accountability
- Innovation

Vision of the School

To be recognised globally as a provider of education in Basic and Applied Sciences, fundamental and interdisciplinary research.

Mission of the School

- Develop solutions for the challenges in sciences through value-based science education.
- Conduct research leading to innovation in sciences.
- Nurture students into scientifically competent professionals in the usage of modern tools.
- Foster in students, a spirit of inquiry and collaboration to make them ready for careers in teaching, research and corporate world.

Vision of the Department

The Vision of the Department of Chemistry is to generate and disseminate Chemistry education among its pupils such that at individual level, a Chemistry graduate should be inspired with a sense of curiosity and wonder about the fundamental nature of the world around the student; be empowered with the ability to make decisions about their own lives and critically evaluate scientific and technological developments that impact society and lastly be equipped them with the knowledge and skills to pursue further study and rewarding careers in the chemical sciences and a wide range of related fields.

Mission of the Department

- To represent a clear framework or narrative that gives a coherent 'big picture' of chemistry as a subject, explains why it matters, and shows how different areas of content are connected.
- To prepare competitive and professional graduates within an innovative and intellectually stimulating environment, support other academic programs at Adamas University by offering quality chemistry learning experiences, conduct basic and applied research of national and international impact.
- To advance knowledge platform that supports an invent-and-design culture in graduate and undergraduate chemistry education, and that empowers students to address and solve challenges of global significance.
- To reach out to our future thought leaders—students of all backgrounds from pre-college to doctoral candidates—to share the power of chemistry to create new knowledge directed at the major unmet needs of our time.

Programme Educational Objectives (PEO) of BSc Chemistry

PEO 01: To cultivate a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.

PEO 02: To appreciate the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.

PEO 03: To be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

PEO 04: To employ critical thinking and the scientific knowledge to design, carryout, record and analyse the results of chemical reactions.

PEO 05: To Create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community

Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) of BSc Chemistry:

PO1	**Chemoinformatics**	To apply contextual knowledge and modern tools of chemical research for solving problems
PO2	**Elementary knowledge**	To cultivate a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.
PO3	**Fundamental Knowledge**	To appreciate the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.
PO4	**Mechanistic and Analyzing knowledge**	Understands the background of organic reaction mechanisms, complex chemical structures, and instrumental method of chemical analysis, molecular rearrangements and separation techniques.
PO5	**Experimentalism**	To be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
PO6	**Instrumentation knowledge**	Upon completion of a BSc in Chemistry degree, students are able to understand theoretical concepts of instruments that are commonly used in most chemistry fields as well as interpret and use data generated in instrumental chemical analyses.
PO7	**Sustainable approach**	Find out the green route for chemical reaction for sustainable development.
PSO1	**Software knowledge**	Use modern chemical tools, Models, Chem-draw, Charts and Equipment's.
PSO2	**Applications**	Learns about the potential uses of analytical industrial chemistry, medicinal chemistry and green chemistry.
PSO3	**Ethics**	Understand the ethical, historic, philosophical, and environmental dimensions of problems and issues facing chemists. Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

Program Outcome vs Courses Mapping Table

Course Code	**Course Name**	**COs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO 2**	**PSO 3**
CHM101	Fundamental Chemistry I	CO1	2	3	3	2	2	2	1	1	1	1
		CO2	1	2	2	2	3	1	1	1	2	1
		CO3	2	3	3	2	2	2	1	1	1	1
		CO4	2	3	3	3	2	2	1	2	2	2
		CO5	1	3	3	3	2	1	1	1	2	2
		CO6	1	2	2	2	3	3	1	1	2	1
		CO										
CHM102	Fundamental Chemistry II	CO1	1	3	3	2	1	1	1	1	1	1
		CO2	1	3	3	3	2	2	1	1	1	1
		CO3	1	3	3	3	2	1	1	1	2	1
		CO4	1	3	3	3	2	1	1	1	2	1
		CO5	1	3	3	2	1	1	1	1	2	1
		CO6	1	3	3	3	3	2	1	1	2	1
		CO										
CHM105	General Chemistry I	CO1	2	3	3	3	1	1	1	1	2	1
		CO2	2	3	3	3	1	2	1	1	2	1
		CO3	2	3	3	2	1	1	1	1	2	1
		CO4	2	3	3	3	1	1	1	2	3	1
		CO5	2	3	3	3	2	1	1	1	3	1
		CO6	2	3	3	3	3	2	1	1	2	1
		CO										
CHM106	General Chemistry II	CO1	2	3	3	3	1	2	1	1	3	1
		CO2	2	3	3	3	2	2	2	1	3	1
		CO3	2	3	3	3	1	1	1	2	2	1
		CO4	2	3	3	3	1	1	2	2	3	1
		CO5	2	3	3	3	2	1	1	1	3	1
		CO6	1	3	3	2	3	3	1	1	2	1
		CO										
CHM109	Green Methods in Chemistry	CO1	1	3	3	2	1	1	3	1	3	3
		CO2	2	3	3	3	2	1	3	1	3	2

		CO3	2	3	3	3	2	1	3	2	3	2
		CO4	1	3	2	3	2	1	3	1	2	3
		CO5	2	3	3	3	3	1	3	2	3	2
		CO6	2	3	3	3	3	1	3	2	3	2
		CO										
CHM201	General Chemistry III	CO1	2	3	3	3	3	2	1	1	2	1
		CO2	2	3	2	2	2	1	1	1	3	1
		CO3	2	3	3	3	2	2	1	1	2	1
		CO4	2	3	3	3	3	2	1	1	2	2
		CO5	2	3	3	2	3	2	1	2	2	2
		CO6	2	3	3	3	3	2	1	1	2	1
		CO	**2**	**3**	**2.83**	**2.67**	**2.67**	**1.83**	**1**	**1.67**	**2.17**	**1.33**
CHM202	General Chemistry IV	CO1	2	3	3	2	3	2	1	1	2	1
		CO2	2	3	3	3	2	2	1	1	3	1
		CO3	2	3	3	2	1	2	1	1	2	1
		CO4	2	3	3	3	3	2	1	2	2	2
		CO5	2	3	3	3	3	2	1	2	2	2
		CO6	2	3	3	2	3	3	1	1	2	1
		CO	**2**	**3**	**3**	**2.5**	**2.5**	**2.17**	**1**	**1.33**	**2.17**	**1.33**
SEC107	Fuel Chemistry	CO1	1	3	3	2	1	1	3	1	2	2
		CO2	1	3	3	2	1	2	3	1	2	2
		CO3	1	3	3	2	1	2	3	1	2	2
		CO4	2	3	3	2	1	2	3	1	3	2
		CO5	2	3	3	2	3	2	2	1	3	2
		CO6	2	3	3	2	3	3	2	1	3	3
		CO	**1.5**	**3**	**3**	**2**	**1.67**	**2**	**2.67**	**1**	**2.5**	**2.17**
CHM205	Organic Chemistry I	CO1	2	3	3	3	2	1	2	2	3	2
		CO2	2	3	3	3	3	1	2	2	3	2
		CO3	2	3	3	3	3	1	2	1	3	2
		CO4	2	3	3	3	2	1	2	1	3	2
		CO5	3	3	3	3	2	1	1	1	3	3
		CO6	2	3	3	2	3	3	2	1	3	3
		CO	**2.17**	**3**	**3**	**2.83**	**2.5**	**1.33**	**2.17**	**1.3**	**3**	**2.33**
CHM206	Physical	CO1	2	3	3	3	2	2	1	1	3	2

	Chemistry I	CO2	2	3	3	3	2	2	1	1	3	2
		CO3	2	3	3	3	2	1	1	1	3	2
		CO4	2	3	3	3	2	1	1	1	3	2
		CO5	2	3	3	3	2	1	2	1	3	2
		CO6	2	3	3	3	3	3	1	1	3	3
		CO	**2**	**3**	**3**	**3**	**2.17**	**1.67**	**1.17**	**1**	**3**	**2.17**
CHM207	Inorganic Chemistry I	CO1	2	3	3	3	2	1	1	1	2	1
		CO2	2	3	3	3	2	1	1	1	2	1
		CO3	2	3	3	3	2	1	1	1	2	1
		CO4	2	3	3	3	2	1	1	1	2	1
		CO5	2	3	3	3	2	1	1	1	2	1
		CO6	2	3	3	3	3	3	1	1	2	2
		CO	**2**	**3**	**3**	**3**	**2.17**	**1.33**	**1**	**1**	**2**	**1.17**
SEC108	Pharmaceutical Chemistry	CO1	2	3	3	2	2	1	1	3	3	2
		CO2	2	3	3	3	3	2	1	3	3	2
		CO3	2	3	3	3	3	2	1	3	3	2
		CO4	2	3	3	3	2	1	1	3	3	2
		CO5	2	3	3	2	2	1	3	2	3	3
		CO6	2	3	3	2	3	2	3	3	3	3
		CO	**2**	**3**	**3**	**2.5**	**2.5**	**1.5**	**1.67**	**2.83**	**3**	**2.33**
CHM301	Organic Chemistry II	CO1	3	3	3	3	2	1	1	1	2	1
		CO2	2	3	3	3	2	1	1	1	2	1
		CO3	3	2	3	2	3	1	1	1	2	1
		CO4	3	2	3	3	3	1	1	1	2	1
		CO5	3	2	2	2	3	3	1	1	2	2
		CO6	2	2	2	2	3	3	1	1	2	2
		CO	**2.67**	**2.33**	**2.67**	**2.5**	**2.67**	**1.67**	**1**	**1**	**2**	**1.33**
CHM302	Physical Chemistry II	CO1	3	3	3	3	1	1	1	2	2	1
		CO2	3	3	3	3	1	1	1	2	2	1
		CO3	2	3	3	3	2	1	1	1	2	1
		CO4	2	3	3	3	2	1	1	1	2	1
		CO5	2	3	3	3	2	1	1	1	2	1
		CO6	3	2	3	3	1	1	1	2	2	1
		CO	**2.5**	**2.83**	**3**	**3**	**1.5**	**1**	**1**	**1.5**	**2**	**1**

CHM303	Inorganic Chemistry II	CO1	2	3	3	2	1	1	1	1	3	1
		CO2	2	3	3	3	2	1	1	1	2	1
		CO3	2	3	3	3	2	1	2	1	2	2
		CO4	3	3	3	3	2	3	1	1	3	1
		CO5	2	3	3	3	3	2	1	1	2	1
		CO6	1	2	2	3	3	3	1	1	2	1
		CO	**2**	**2.83**	**2.83**	**2.83**	**2.17**	**1.83**	**1.17**	**1**	**2.33**	**1.17**
	Mathematics for Chemistry	CO1	2	1	2	2	1	2	1	3	2	1
		CO2	2	3	2	2	1	1	1	2	2	1
		CO3	2	2	3	2	1	1	1	2	2	1
		CO4	2	3	2	2	1	1	1	2	2	1
		CO5	3	2	3	3	2	2	1	3	3	1
		CO6	3	2	3	3	2	2	1	3	3	1
		CO	**2.33**	**2.17**	**2.5**	**2.33**	**1.33**	**1.5**	**1**	**2.5**	**2.33**	**1**
CHM305	Internship	CO1	3	2	2	3	2	2	2	3	3	2
		CO2	3	3	2	3	2	2	2	2	3	2
		CO3	2	2	2	2	2	2	1	1	2	3
		CO4	1	2	1	2	1	1	3	1	2	3
		CO5	3	3	3	3	3	2	2	3	3	2
		CO6	1	2	2	2	2	1	2	2	2	3
		CO	**2.17**	**2.33**	**2**	**2.5**	**2**	**1.67**	**2**	**2**	**2.5**	**2.5**
CHM306	Spectroscopy	CO1	3	3	3	3	2	3	1	3	2	1
		CO2	3	3	3	3	2	3	1	3	2	1
		CO3	3	3	3	3	2	3	1	3	2	1
		CO4	2	2	2	3	2	3	1	2	3	1
		CO5	3	3	3	3	2	2	1	3	3	1
		CO6	2	2	2	2	3	3	1	2	3	1
		CO	**2.67**	**2.67**	**2.67**	**2.83**	**2.17**	**2.83**	**1**	**2.67**	**2.5**	**1**
CHM307	Organometallics and Reaction Kinetics	CO1	2	3	3	2	1	1	1	1	3	1
		CO2	3	3	3	3	2	3	1	2	3	2
		CO3	2	3	3	2	3	2	2	2	3	1
		CO4	3	3	3	3	3	3	2	2	3	2
		CO5	2	3	3	3	3	3	2	2	3	2
		CO6	3	3	3	3	2	3	2	2	3	2

		CO	**2.5**	**3**	**3**	**2.67**	**2.33**	**2.5**	**1.67**	**1.83**	**3**	**1.67**
CHM308	Solid State Chemistry	CO1	2	3	3	2	1	3	1	2	3	1
		CO2	3	3	3	3	2	3	1	2	3	2
		CO3	2	3	3	3	2	2	1	2	3	2
		CO4	2	3	3	3	2	2	1	2	3	2
		CO5	1	3	3	3	3	3	2	3	3	2
		CO6	2	3	3	3	3	3	1	3	3	2
		CO	**2**	**3**	**3**	**2.83**	**2.17**	**2.67**	**1.17**	**2.33**	**3**	**1.83**
CHM309	Materials of Industrial Importance	CO1	2	3	3	2	2	2	1	1	3	1
		CO2	2	3	3	2	2	2	2	2	3	3
		CO3	3	3	3	3	3	3	2	3	3	2
		CO4	2	3	3	3	3	3	1	3	3	2
		CO5	2	3	3	3	3	3	1	3	3	2
		CO6	2	3	3	3	3	3	2	3	3	2
		CO	**2.17**	**3**	**3**	**2.67**	**2.67**	**2.67**	**1.5**	**2.5**	**3**	**2**
CHM312	Project	CO1	2	3	2	2	2	2	1	2	3	2
		CO2	3	3	2	2	3	2	2	3	3	2
		CO3	2	3	3	3	3	3	2	2	3	2
		CO4	2	3	2	3	3	2	2	2	3	3
		CO5	1	3	2	1	2	1	1	2	3	3
		CO6	3	3	3	3	2	3	2	3	3	3
		CO	**2.17**	**3**	**2.33**	**2.33**	**2.5**	**2.17**	**1.67**	**2.33**	**3**	**2.5**
CHM401	Fundamentals of nanomaterials	CO1	2	3	3	2	1	1	1	2	2	2
		CO2	3	3	3	3	1	2	2	2	2	1
		CO3	3	3	2	3	3	3	2	3	3	1
		CO4	2	3	3	3	2	3	2	2	3	2
		CO5	3	2	2	3	3	3	2	3	2	1
		CO6	3	2	2	3	3	3	2	3	2	2
		CO	**2.67**	**3**	**2.83**	**2.83**	**2.2**	**2.5**	**1.83**	**2.5**	**2.33**	**1.5**
CHM407	Supramolecular Chemistry and its application	CO1	3	2	2	3	2	3	3	2	2	1
		CO2	3	3	2	3	1	2	2	2	3	1
		CO3	2	2	3	3	1	2	2	2	3	1
		CO4	2	2	3	2	1	3	2	3	2	1
		CO5	2	1	2	2	3	2	1	3	2	1

		CO6	3	3	3	3	2	3	2	3	3	2
		CO	**2.5**	**2.2**	**2.5**	**2.67**	**1.67**	**2.5**	**2**	**2.5**	**2.5**	**1.2**
CHM404	Inorganic Cluster and spectroscopic application	CO1	2	3	3	2	1	1	1	1	2	2
		CO2	2	3	3	2	1	1	1	1	2	2
		CO3	2	2	2	3	3	2	1	1	2	2
		CO4	2	3	3	3	2	2	2	2	3	2
		CO5	2	2	2	3	3	3	2	3	3	3
		CO6	3	3	3	3	2	3	3	3	3	3
		CO	**2.16**	**3**	**3**	**3**	**2**	**2**	**1.67**	**1.83**	**2.5**	**2.34**
	Polymer and Paints	CO1	2	3	3	2	1	1	2	2	1	2
		CO2	2	2	3	3	1	2	2	2	1	2
		CO3	2	2	3	2	2	3	1	2	2	1
		CO4	3	3	3	3	2	3	2	3	2	1
		CO5	2	3	2	2	3	3	3	2	3	3
		CO6	3	3	2	3	3	3	2	3	2	2
		CO	**2.33**	**3**	**3**	**2.5**	**2**	**2.5**	**2**	**2.33**	**1.83**	**1.67**
CHM106	Photochemical and pericyclic reactions	CO1	2	2	3	3	2	2	2	1	2	3
		CO2	2	2	3	3	1	1	1	2	3	2
		CO3	3	3	3	3	2	2	2	2	3	2
		CO4	3	3	3	3	1	2	1	2	2	3
		CO5	2	2	2	2	3	3	3	2	3	2
		CO6	3	3	3	3	3	2	2	3	3	2
		CO	2.5	2.5	2.84	2.84	2	1.66	1.66	2	2.6	2.45
CHM109	Research Methodology	CO1	2	3	2	1	1	1	1	2	1	2
		CO2	3	3	2	1	1	3	1	2	3	1
		CO3	3	3	2	2	2	3	2	3	3	1
		CO4	2	2	2	3	1	3	2	2	2	3
		CO5	1	2	1	2	3	1	2	1	1	1
		CO6	**3**	**3**	**3**	**2**	2	3	3	**3**	**3**	**2**
CHM409	Medical Nano-technology	**CO**	**2.34**	**2.67**	**2**	**1.89**	**1.66**	**2.34**	**1.89**	**2.11**	**2.12**	**1.67**
		CO2	2	1	1	-	2	1	2	1	1	1
		CO3	2	1	1	-	2	1	2	2	1	1
		CO4	2	1	1	-	2	1	2	1	1	1
		CO5	2	1	2	-	2	1	1	1	1	1

		CO6	1	1	1	-	2	1	3	0	0	1
		CO	**2**	**1.1**	**1.33**	**-**	**2**	**1**	**2**	**1**	**1**	**1.16**
	Analytical Methods in Industry	CO1	2	1	1	-	1	3	1	1	2	1
		CO2	2	1	1	-	1	2	1	-	1	1
		CO3	2	1	1	-	1	2	1	2	1	1
		CO4	2	1	1	-	1	1	1	1	-	1
		CO5	3	2	2	-	1	1	1	2	1	2
		CO6	3	2	2	-	1	1	1	1	1	2
		CO	**2.3**	**1.33**	**1.33**	**-**	**1**	**1.6**	**1**	**1.16**	**1**	**1.33**
CHM410	Reagent Chemistry	CO1	3	2	1	3	2	1	2	1	1	1
		CO2	3	2	1	3	1	2	1	1	2	2
		CO3	3	3	1	3	3	1	2	1	1	2
		CO4	2	2	1	3	3	1	1	1	2	2
		CO5	3	3	1	3	2	1	1	1	2	1
		CO6	2	3	1	3	2	1	1	2	2	1
		CO	**2.6**	**2.5**	**1**	**3**	**2.2**	**1.2**	**1.4**	**1**	**1.6**	**1.5**
CHM413	Natural Products and Bio-organic Chemistry	**CO1**	3	2	2	3	2	1	2	1	1	1
		CO2	3	2	1	3	1	2	1	1	2	2
		CO3	3	3	1	3	3	1	2	1	1	2
		CO4	2	2	2	2	3	1	1	1	3	2
		CO5	3	3	1	2	2	1	1	1	3	1
		CO6	3	3	1	2	2	1	1	1	3	1
		CO	3	2.5	1.33	2.5	2.1	1.1	1.3	1	2	1.5
CHM416	Project	CO1	3	2	2	1	2	1	2	1	1	2
		CO2	3	2	2	1	2	2	1	1	3	2
		CO3	3	3	2	1	3	1	2	1	1	2
		CO4	2	2	2	2	3	1	1	1	3	2
		CO5	3	3	1	1	2	1	1	1	3	1
		CO6	3	3	1	1	2	1	1	1	3	1
		CO	**2.8**	**2.5**	**1.6**	**1.1**	**2.3**	**1.1**	**1.3**	**1**	**2.6**	**1.6**

Correlation level 1, 2 and 3 as defined below:

“1” – Slight (Low)

“2” – Moderate (Medium)

“3” – Substantial (High)
“-” – No correlation

School of Basic and Applied Sciences
Department of Chemistry

BSc Chemistry
Batch: 2024-2028
Semester: I

S.No	Type of Course	Code	Title of the Course	Contact Hours Per Week				Remarks
				L	**T**	**P**	**C**	
1	CC	CHM101	Fundamental Chemistry-I	3	0	1	4	CC-1
2	CC	CHM102	Fundamental Chemistry-II	3	0	1	4	CC-2
3	MDC						3	
4	AEC	AEC101	Communicative English I	3	0	0	3	
5	Minor			3	0	1	4	
6	VAC	VAC101	Environmental Education I	2	0	0	2	
Semester Credits							**20**	

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	I
Course Title	Fundamental Chemistry I
Course Code	CHM101
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The course aims to provide students with a comprehensive understanding of key concepts in physical, atomic, and organic chemistry. It introduces the fundamental principles governing the behavior of gases, liquids, and atomic structures, and explores the molecular interactions that dictate chemical bonding and physical properties. Through theoretical learning and laboratory experiments, students will develop skills to analyze chemical reactions, reaction intermediates, and the physical characteristics of substances. Additionally, the course fosters an understanding of quantum mechanics, molecular orbitals, and reaction mechanisms essential for advanced studies in chemistry.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1:** Analyze the behavior of gases using the kinetic theory, Maxwell's distribution, and the van der Waals equation, and explain the deviations from ideal gas behavior. **CO2:** Apply the principles of liquid state properties, including viscosity, surface tension, and capillary rise, to explain fluid flow behavior and determine these properties experimentally. **CO3:** Describe the quantum mechanical model of the atom, including wave functions, orbital shapes, and the significance of quantum numbers, and use this to determine the electronic configuration of multielectronic systems.

	CO4: Compare and contrast various bonding theories, including Valence Bond Theory (VBT) and hybridization, and use these concepts to explain the structure and reactivity of organic molecules. **CO5:** Investigate reaction intermediates such as carbocations, carbanions, and radicals, and describe their stability, generation, and role in electrophilic and nucleophilic reactions. **CO6:** Conduct laboratory experiments to measure physical properties such as surface tension and viscosity, and apply qualitative analysis to detect specific acid radicals and elements in organic compounds.

Course Outline

Module	Description
I	**Gaseous state-** Arguments of Kinetic Theory of gas, Maxwell's distribution of speeds & energy. average, root mean square and most probable speed and energy, principle of equipartition of energy and molar heat capacity of gases, Collision of gas molecules and viscosity. Deviation of gases from ideal behaviour. Critical temperature and Boyle temperature. van der Waals equation of state; the law of corresponding states; virial equation. Continuity of state.
II	**Liquid State-** Vapour Pressure. Surface tension, surface energy, capillary rise. Spreading of liquid over surface. Viscosity: General features of fluid flow, Newton's equation, viscosity coefficient, Poiseuille equation, temperature dependence of viscosity coefficient and surface tension. Experimental determination of viscosity and surface tension.
III	**Atomic structure-** Bohr's atomic model and its limitation, wave mechanical model: de Brogile hypothesis and matter waves, Schrodinger's wave equation, wave function and the concept of probability, radial and angular probability distributions, shapes of *s*, *p*, *d* and *f* orbitals, Concept of quantum numbers and their significance, Aufbau principle, Hund's rule and Pauli's exclusion principle for determining electronic configuration of multielectronic systems. Concept of exchange energy**,** L-S coupling, Ground state Term symbols of atoms.
IV	**Bonding feature in organic molecules-** IUPAC nomenclature, Valance Bond Theory (VBT), DBE/IHD calculation, hybridisation, representation the gross structural formulae, factors influencing electron availability, intermolecular forces explaining physical properties (Dispersion Forces (also called London Forces), Dipole-Dipole Force, Hydrogen Bonds, Ion-Dipole Force, van der Waals forces, noncovalent interaction), aromaticity.
V	**Reaction intermediates-** carbocations, carbanions, carbon radicals, carbenes: structure

	using orbital picture, electrophilic/nucleophilic behaviour, stability, generation and fate (elementary idea).
VI	**Lab-** 1. Determine the surface tension by (i) drop number (ii) drop weight method. 2. Study the variation of surface tension of detergent solutions with concentration. 3. Study of viscosity of unknown liquid (glycerol, sugar) with respect to water. 4. Study of the variation of viscosity with the concentration of the solution. 5. *Qualitative analysis of acid radicals* Cl^-, Br^-, I^-, NO_3^-, SCN^-, S^{2-}, SO_4^{2-}, NO_2^-, PO_4^{3-}, $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{3-}$ 6. Detection of special elements (N, Cl, S) in organic molecules by Lassaigne's test.

Evaluation:

Mode of Evaluation	Theory + Practical	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Huheey, Keiter and Keiter, Principles of Inorganic Chemistry,
2. R. Sarkar, Vol. 1 Inorganic Chemistry,
3. Concise Inorganic Chemistry by J. D. Lee,
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education),
5. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988),
6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press,
7. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford UniversityPress (2014),
8. P.C. Rakshit, Physical Chemistry 7th Edition (2004),
9. Chatterjee, H. Physical Chemistry, Vol-1, Edition, Platinum publishers,
10. Das, S.C. Advanced Practical Chemistry, Sixth edition.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	I
Course Title	Fundamental Chemistry II
Course Code	CHM102
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The course aims to introduce students to fundamental concepts in thermodynamics, chemical kinetics, periodic properties, radioactivity, and stereochemistry, with an emphasis on their practical applications in chemistry. Students will develop a strong understanding of the laws of thermodynamics, chemical reactions, periodic trends, and molecular symmetry. Through theoretical lessons and laboratory experiments, students will gain proficiency in analyzing energy changes, reaction rates, radioactive decay, and the stereochemical properties of molecules. This course will provide a foundational knowledge required for advanced studies in physical and inorganic chemistry.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: Explain the fundamental concepts of thermodynamics, including system types, thermodynamic equilibrium, and the Zeroth law of thermodynamics, to understand the scope and importance of the subject. CO2: Apply the first law of thermodynamics to analyze isothermal, reversible, and irreversible processes, calculating work done, heat capacity, and Joules experiment, while distinguishing between state and path functions. CO3: Evaluate the heat changes in thermochemical processes at constant pressure and volume, using Kirchhoffs relations and bond dissociation energies to understand the thermodynamic changes during chemical reactions.

	CO4: Analyze chemical kinetics by deriving and interpreting rate laws for elementary and multistep reactions, and applying the Arrhenius equation to calculate the energy of activation for various reactions. CO5: Investigate periodic properties such as effective nuclear charge, atomic and ionic radii, ionization potential, and electronegativity, and understand their trends across groups and periods in the periodic table. CO6: Perform qualitative analysis of functional groups in organic compounds and basic radicals, and apply stereochemical concepts such as chirality, optical activity, and conformational analysis to predict molecular behavior and stability.

Course Outline

Module	**Description**
I	**Thermodynamics I** **a)** *Introduction to Thermodynamics***-** Importance and scope, definition of system and surroundings: type of systems; extensive and intensive properties; Thermodynamic equilibrium. The zeroth law of thermodynamics. b) *1^{st} law of thermodynamics and consequences***-** Isothermal reversible and irreversible workdone. 1^{st} law of thermodynamics, state functions and path functions. Concept of heat capacity. Joule's Experiment. Joule coefficient for vander Waal gas. Adiabatic process. **c)** *Thermochemistry*- Heat changes during physicochemical processes at constant pressure and constant volume; Kirchhoff's relations; bond dissociation energies; changes of thermodynamic properties in different chemical changes.
II	**Chemical Kinetics-I-** Differential rate law, idea of elementary and multistep reactions, order and molecularity, integrated rate law for zero, 1^{st} and 2^{nd} order reaction Arrhenius equation, energy of activation.
III	**Periodic properties-** Effective nuclear charge and Slater's rule, atomic, ionic and covalent radii and their group and periodic trends for *s*, *p* and *d* block elements, ionization potential, electron affinity and electronegativity and their group and periodic variation for *s* and *p* block elements. Relativistic and inert pair effect.
IV	**Radioactivity-** Radioactivity, radioactive displacement law, half-life and average life of radioactive elements, *n/p* ratio, nuclear binding energy. Liquid drop model, fission,

	fusion, spallation, and artificial transmutation reactions. Nuclear power generation and its application.
V	**Stereochemistry-** Symmetry elements, representation of molecules in different conformations and their inter-conversions, molecular chirality, stereogenicity, chirotopicity, Configurations, Optical activity (specific rotation, optical purity (enantiomeric excess), racemic compounds, racemisation, resolution), topicity of ligands and faces, Conformational analysis: nomenclature, dihedral angle, torsion angle, energy barrier of rotation, relative stability, dipole-dipole interaction, H-bonding, classification and stability, conformational analysis of small aliphatic acyclic (ethane, propane, n-butane, haloethane, 1,2-haloethane, 1,2- glycol, 1,2-halohydrin etc.) and cyclic molecules (3, 4, 5, 6-membered rings; mono- and di-substituted cyclohexane).
VI	**Lab** 1. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system, 2. Determination of heat of neutralization of a strong acid by a strong base, 3. Detection of the following functional groups in organic molecules: Aromatic -NH_2, aromatic -NO_2, -$CONH_2$, Phenolic –OH, -COOH, >C=O. 4. Qualitative analysis of basic radicals: Na^+, K^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Al^{3+},$Mn^{2+}Fe^{3+}$, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, NH_4^+, Mg^{2+}.

Evaluation:

Mode of Evaluation	Theory +Practical	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Huheey, Keiter and Keiter, Principles of Inorganic Chemistry,
2. R. Sarkar, Vol. 1 Inorganic Chemistry,
3. Concise Inorganic Chemistry by J. D. Lee,
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education),
5. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988),

6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press,
7. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014),
8. P.C. Rakshit, Physical Chemistry 7th Edition (2004),
9. Chatterjee, H. Physical Chemistry, Vol-1, Edition, Platinum publishers,
10. Das, S.C. Advanced Practical Chemistry, Sixth edition.

School of Basic and Applied Sciences
Department of Chemistry

BSc Chemistry
Batch: 2024-2028
Semester: II

S.No	Type of Course	Code	Title of the Course	Contact Hours Per Week				Remarks
				L	T	P	C	
1	CC	CHM105	General Chemistry-I	3	0	1	4	CC-3
2	CC	CHM106	General Chemistry-II	3	0	1	4	CC-4
3	MDC						3	
4	SEC	SEC106	Green Methods in Chemistry	1	0	1	2	
5	VAC	VAC105	Community Engagement and Social Responsibility	2	0	0	2	
6	AEC	AEC102	Communicative English II	3	0	0	3	
7	Minor						4	
Semester Credits							**22**	

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	II
Course Title	General Chemistry I
Course Code	CHM105
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The course aims to provide a comprehensive understanding of advanced thermodynamic principles, including the second law of thermodynamics, entropy, and various thermodynamic processes such as the Carnot cycle, Clausius inequality, and Joule-Thomson cooling. It also introduces students to the behavior of open systems, chemical potential, and the application of equations like Gibbs-Duhem and Euler's theorem in ideal and non-ideal systems. The course covers ionic and covalent bonding, emphasizing theories like the radius ratio rule, Born-Haber cycle, Valence Bond Theory, and Molecular Orbital Theory. It also focuses on the in-depth study of nucleophilic substitution and elimination reactions, exploring their mechanisms, stereochemistry, and reaction conditions. Through laboratory work, students will enhance their experimental skills by investigating chemical kinetics, adsorption isotherms, and optical activity, connecting theoretical knowledge with practical applications.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: Analyze the second law of thermodynamics, including the Clausius and Kelvin-Planck statements, Carnot cycle, and the concept of entropy, while applying the Gibbs-Helmholtz equation and Maxwell's relations to solve thermodynamic problems. CO2: Investigate the Joule-Thomson experiment, understanding Joule-Thomson cooling and the coefficient of the process, and

	calculate the effects for van der Waals gases. CO3: Apply the concepts of chemical potential, activity, and fugacity in open and non-ideal systems, and use the Gibbs-Duhem equation to analyze the behavior of substances under varying temperature and pressure conditions. CO4: Explain ionic and covalent bonding by applying the radius ratio rule, lattice energy, Born-Lande equation, and Fajans rule, and understand molecular orbitals through LCAO approach and MO diagrams for diatomic molecules. CO5: Evaluate nucleophilic substitution and elimination reactions by classifying different mechanisms (SN^1, SN^2, E1, E2), understanding their stereochemical features, and comparing substitution vs elimination processes in terms of reaction rate and product distribution. CO6: Conduct experiments to study chemical kinetics, such as the decomposition of H_2O_2 and acid-catalyzed hydrolysis of methyl acetate, while determining specific rotation of optically active compounds and verifying adsorption isotherms for acetic acid on activated charcoal.

Course Outline

Module	Description
I	**Thermodynamics II** a) *Second law of Thermodynamics & entropy*- Second law of thermodynamics: need for a second law, Clausius and Kelvin-Planck statements and their equivalence; Carnot‘s theorem, thermodynamic scale of temperature, concept of heat engine, Carnot cycle and refrigerator. Clausius inequality, entropy as a state function, calculation of entropy change for various transformation; auxiliary state function (G and A) Gibbs-Helmholtz equation; Maxwell‘s relation, thermodynamic equation of state. b) *Joule-Thomson Experiment*- Joule-Thomson cooling, co-efficient of Joule-Thomson process(μ_{JT}), evaluation of μ_{JT} for van der Waal’s gases. c) *Open system*- Chemical potential and activity. Variation of with temperature and pressure, Gibbs-Duhem equation; Euler‘s theorem; expression for ideal gas. Non-ideal system: idea of fugacity and activity; standard states.
II	**Ionic bonding-** Radius ratio rule and its applications; Packing of ions in crystals.

	Lattice energy and Born-Lande equation, Born-Haber cycle and its application.
III	**Unit-3: Covalent bonding-** a) Fajan's rule and its application, Valence Bond Theory, VSEPR theory, Bent's rule, hybridization, resonance. b) Concept of molecular orbitals in bonding through LCAO approach. MO diagrams of homonuclear diatomic molecules (H_2, B_2, C_2, N_2, O_2 , F_2) and heteronuclear diatomic molecules (CO, NO, NO^+, CN^-, HF, HCl).
IV	**Unit-4: Molecular Orbital Theory-** Concept of molecular orbitals in bonding through LCAO approach. MO diagrams of homonuclear diatomic molecules and heteronuclear diatomic molecules.
V	**Unit-5: Nucleophilic substitution reactions and elimination reactions:** a) Nucleophilic substitution reaction: Classification (SN^1, SN^2, $SN^{2'}$, SN^i, NGP), mechanism, Stereo-chemical features, effects of different parameter on reaction rate. b) Elimination reaction: Classification **(**E1, E1cB, E2, Syn, Anti), mechanism, geometrical features, effects of different parameter on reaction rate, Saytzeff and Hofmann products, stereoselectivity; substitution *vs* elimination.
VI	**Lab-** 1. Study of kinetics of decomposition of H_2O_2. 2. Study of kinetics of acid-catalyzed hydrolysis of methyl acetate. 3. Determination of specific rotation of optically active compound. 4. Inversion of cane-sugar. 5. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Evaluation:

Mode of Evaluation	Theory + Practical	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Huheey, Keiter and Keiter, Principles of Inorganic Chemistry,
2. R. Sarkar, Vol. 1 Inorganic Chemistry,
3. Concise Inorganic Chemistry by J. D. Lee,
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education),
5. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988),

6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press,
7. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10^{th} Ed., Oxford University Press (2014),
8. P.C. Rakshit, Physical Chemistry 7^{th} Edition (2004),
9. Chatterjee, H. Physical Chemistry, Vol-1, Edition, Platinum publishers,
10. Das, S.C. Advanced Practical Chemistry, Sixth edition.
11. Mukherjee, G.N. University handbook of undergraduate chemistry experiments.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	II
Course Title	General Chemistry II
Course Code	CHM106
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	This course is designed to provide an in-depth understanding of advanced topics in chemical kinetics, catalysis, acid-base theories, inorganic chemistry, and organic reactions, as well as to develop practical laboratory skills in titration techniques. It covers key aspects of chemical kinetics, including complex reaction mechanisms, the steady-state approximation, collision and transition state theories, and the behavior of different reactors. The course explores both homogeneous and heterogeneous catalysis, emphasizing adsorption isotherms, enzyme catalysis, and surface dynamics. Students will study various acid-base theories, including Bronsted-Lowry, Lewis, and solvent system concepts, and apply the HSAB principle to real-world examples. Additionally, the course delves into the structure, bonding, and properties of important compounds from the s- and p-block elements, as well as the mechanisms of addition reactions in alkenes and alkynes. The laboratory component reinforces theoretical concepts through acid-base titrations, enhancing students' analytical skills and their ability to quantify substances in chemical mixtures.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: Analyze the mechanisms of opposing, parallel, and consecutive reactions, and apply concepts like the rate-determining step, steady-state approximation, and collision theory

	to explain reaction kinetics in various systems. CO2: Evaluate catalytic processes by understanding the mechanisms of homogeneous and heterogeneous catalysis, including acid-base catalysis, autocatalysis, enzyme catalysis, and adsorption isotherms such as Langmuir and Freundlich. CO3: Apply the theories of acid-base chemistry, including Bronsted-Lowry, Lewis, and Lux-Flood concepts, and explain the acid-base behavior of different solvents and superacids using the HSAB principle and Paulings rule. CO4: Investigate the properties, bonding, and reactions of s- and p-block compounds, such as diborane, boron nitrides, borazine, and polyhalides, and understand their preparation, structure, and applications. CO5: Analyze the reaction mechanisms of alkenes and alkynes, focusing on addition reactions, regioselectivity, stereoselectivity, and specific reactions like hydroboration, ozonolysis, and electrophilic addition. CO6: Conduct experiments related to acid-base titration, including the standardization of different solutions and the estimation of carbonate, bicarbonate, and acetic acid in mixtures, demonstrating practical application of titration techniques in quantitative analysis.

Course Outline

Module	**Description**
I	**Chemical Kinetics-II -** Opposing, parallel and consecutive reactions, kinetic and thermodynamic control of reaction; idea of rate determining step; steady-state approximation. Collision theory, Outline of transition state theory; primary kinetic salt effect. Lindeman theory of unimolecular reaction. Basic concept of different reactors (CSTR, PFR, Batch etc.).
II	**Catalysed reactions** *Homogeneous catalysis:* Mechanism of catalytic action, acid-base catalysis, autocatalysis, chain reaction; enzyme catalysis - Michaelis-Menten equation, turnover number, Lineweaver-Burk plot; influence of temperature and pH.

	Heterogeneous catalysis: Adsorption**-** Surface dynamics: physical and chemical adsorption, Freundlich and Langmuir adsorption isotherm, multilayer and BET isotherm (outline) and applications, Gibbs adsorption isotherm and surface excess. Heterogeneous catalysis.
III	**Theories of Acid-Base Chemistry-** Different theories of acid-base including solvent system, Bronsted-Lowry's concept, Lux-Flood concept and Lewis concept. HSAB principle, gas phase acidity, leveling effects of solvents. Superacids, Pauling's rule.
IV	**s and p block elements-** Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses: diborane, boron nitrides, borazine, oxo- and peroxo acids of sulphur, sulphur-nitrogen compounds, polyhalides, pseudohalogens, fluorocarbons.
V	**Reactions of alkenes and alkynes-** a) Alkenes: mechanism of addition, reactivity, regioselectivity, stereoselectivity, halogenations, oxymercuration-demercuration, hydroboration, hydrogenation, epoxidation, hydroxylation, ozonolysis, addition. b) alkynes- Electrophilic and nucleophilic additions; dissolving metal, hydration, terminal alkylation.
VI	**Lab:** Acid base titration: 1. Standardization of sodium hydroxide solution 2. Standardization of HCl solution. 3. Standardization of acetic acid solution. 4. Estimation of carbonate and hydroxide present together in mixture. 5. Estimation of carbonate and bicarbonate present together in a mixture. 6. Estimation of acetic acid available in vinegar sample. 7. Estimation of alkali content of antacid tablet.

Evaluation:

Mode of Evaluation	Theory + Practical	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Huheey, Keiter and Keiter, Principles of Inorganic Chemistry,
2. R. Sarkar, Vol. 1 Inorganic Chemistry,
3. Concise Inorganic Chemistry by J. D. Lee,
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education),

5. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988),
6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press,
7. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014),
8. P.C. Rakshit, Physical Chemistry 7th Edition (2004),
9. Chatterjee, H. Physical Chemistry, Vol-1, Edition, Platinum publishers,
10. Das, S.C. Advanced Practical Chemistry, Sixth edition.
11. Mukherjee, G.N. University handbook of undergraduate chemistry experiments.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	II
Course Title	Green Methods in Chemistry
Course Code	SEC106
Credit	2
Contact Hours (L-T-P)	1-0-1
Course Type	Hybrid
Course Objective	The course aims to provide a comprehensive understanding of Green Chemistry, emphasizing its significance in developing sustainable chemical practices. The curriculum begins with an exploration of the foundational concepts of Green Chemistry, including its definition, necessity, goals, and the challenges faced in its implementation. Following this introduction, students will delve into the twelve principles of Green Chemistry, learning how to design chemical syntheses that prioritize waste prevention, toxicity reduction, and the efficient use of materials. Practical applications will be highlighted, including the calculation of atom economy and the evaluation of greener solvent alternatives, alongside discussions on energy-efficient reaction methods utilizing microwaves and ultrasound. The course will also address the importance of designing safer chemical processes and the development of analytical techniques to minimize hazardous waste. In the final unit, students will investigate real-world examples of green syntheses, showcasing innovative approaches to producing various compounds with reduced environmental impact. By the end of the course, participants will be equipped with the knowledge and skills to implement green practices in their chemical processes, contributing to a more sustainable future.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: Explain the concept of Green Chemistry, its need, goals, and

	limitations, and identify the obstacles in achieving the sustainable objectives of Green Chemistry. CO2: Apply the twelve principles of Green Chemistry in the design of chemical syntheses, including maximizing atom economy, minimizing waste and hazardous products, and calculating atom economy for various reactions. CO3: Evaluate green solvents and alternative energy sources for reactions, such as supercritical fluids, water, ionic liquids, and microwave or ultrasound energy, and compare their environmental benefits. CO4: Analyze the prevention of chemical accidents and the design of safer chemical processes by applying the principles of Inherent Safer Design (ISD), focusing on minimizing risks and ensuring the safety of industrial practices. CO5: Demonstrate examples of Green Synthesis, such as the synthesis of adipic acid, catechol, ibuprofen, and other environmentally friendly processes, while focusing on reducing waste and byproducts. CO6: Investigate real-world applications of Green Chemistry, such as the use of CO2 as a solvent, the development of recyclable materials, and environmentally safe alternatives for preservatives and antifoulants, promoting sustainable chemical practices.

Course Outline

Module	**Description**
I	**Introduction to Green Chemistry** What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.
II	**Principles of Green Chemistry and Designing a Chemical synthesis** Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following: a) Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts;maximum incorporation of the materials used in the process into the final products ,Atom Economy, calculation of atom economy of the

	rearrangement, addition, substitution and elimination reactions. b) Prevention/ minimization of hazardous/ toxic products reducing toxicity.risk = (function) hazard × exposure; waste or pollution prevention hierarchy. c) Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventlessprocesses, immobilized solvents and how to compare greenness of solvents. d) Energy requirements for reactions – alternative sources of energy: use of microwavesand ultrasonic energy. e) Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation. f) Strengthening/ development of analytical techniques to prevent and minimize thegeneration of hazardous substances in chemical processes.
III	**Examples of Green Synthesis and some real world cases** a) Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis). b) Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoicacid, oxidation of toluene and alcohols; microwave assisted reactions in organic solventsDiels-Alder reaction and Decarboxylation reaction. c) Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonicalternative to Iodine). d) A green synthesis of ibuprofen which creates less waste and fewer byproducts (Atom economy). e) Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. f) Environmentally safe antifoulant. g) CO_2 as an environmentally friendly blowing agent for the polystyrene foam sheet packaging market. h) Using a catalyst to improve the delignifying (bleaching) activity of hydrogen peroxide. i) A new generation of environmentally advanced preservative: getting the chromium and arsenic out of pressure treated wood. j) Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments. k) Development of a fully recyclable carpet: cradle to cradle carpeting.

Evaluation:

Mode of Evaluation	Theory + Practical	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Manahan S.E. (2005) Environmental Chemistry, CRC Press.
2. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole.
3. Mishra, A. (2005) Environmental Studies. Selective and Scientific Books, New.
4. Ahluwalia, V.K. &Kidwai, M.R.*New Trends in Green Chemistry*, AnamalayaPublishers (2005).
5. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, OxfordUniversity Press (1998).
6. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
7. Cann, M.C. &Connely, M.E. *Real-World cases in Green Chemistry*, AmericanChemical Society, Washington (2000).
8. Ryan, M.A. &Tinnesand, M. *Introduction to Green Chemistry*, American ChemicalSociety, Washington (2002).

School of Basic and Applied Sciences
Department of Chemistry

BSc Chemistry
Batch: 2024-2028
Semester: III

S.No	Type of Course	Code	Title of the Course	Contact Hours Per Week				Remarks
				L	T	P	C	
1	CC	CHM201	General Chemistry-III	3	0	1	4	CC-5
2	CC	CHM202	General Chemistry-IV	3	0	1	4	CC-6
3	MDC	CHM203		3			3	
4	VAC			2	0	0	2	
5	AEC						2	
6	SEC		Fuel Chemistry	2	0	0	2	
7	Minor						4	
Semester Credits							**21**	

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	III
Course Title	General Chemistry III
Course Code	CHM201
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The course aims to equip students with a thorough understanding of key principles in physical and organic chemistry, focusing on transport phenomena, colloidal chemistry, redox reactions, and aromatic substitution mechanisms. Students will explore the concepts of electrolytic conduction, including Kohlrausch's law and the Debye-Hückel theory, while gaining hands-on experience in conductometric titrations and the determination of transport numbers. The curriculum will also cover the characteristics and applications of colloids, as well as the fundamental aspects of redox chemistry, including standard potentials and titration techniques. Additionally, students will delve into electrophilic and nucleophilic substitution reactions, enhancing their knowledge of reaction mechanisms and kinetics. Practical laboratory sessions will reinforce theoretical concepts through the synthesis and characterization of organic compounds, including various derivatization techniques and redox titrations. Ultimately, students will develop a comprehensive skill set applicable to advanced studies in chemistry and related disciplines.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: Analyze the concepts of electrolyte conduction, ionization constants, and conductometric titration methods, and apply them to solve problems related to electrolytic behavior in solution.

	CO2: Evaluate the properties and behavior of colloids, including electrokinetic phenomena and micelles, and explain their applications in various scientific and industrial contexts. CO3: Interpret redox reactions using ion-electron methods, standard redox potentials, and Latimer and Frost diagrams, and apply these concepts to assess electrochemical cells and redox titration systems. CO4: Investigate the mechanisms and reactivity of electrophilic and nucleophilic aromatic substitution reactions, and predict the outcome of various organic synthesis reactions involving aromatic compounds. CO5: Synthesize and characterize organic compounds through derivatization reactions, and apply purification techniques, such as crystallization, to obtain pure products and determine their melting points. CO6: Perform redox titrations to estimate metal ions, such as Fe(II), Fe(III), and Ca(II), in mixtures using permanganometric and dichromatometric methods, and analyze the results to determine their concentrations.

Course Outline

Module	Description
I	**Transport Phenomena-** Concept of electrolyte, electrolytic conduction: Electronic versus electrolytic conduction. Cell constant; specific, equivalent and molar conductance. Kohlrausch‘s law, equivalent conductance at infinite dilution. Debye – Huckel theory of Ion atmosphere, asymmetric effect, relaxation effect and electrophoretic effect. Ostwald dilution law and determination of ionization constants for weak electrolytes from conductance measurements. Conductometric titration; transport number, Hittorf‘s rule, determination of transport number by the moving boundary method.
II	**Colloids-** Lyophobic and lyophilic sols, Schultz-Hardy rule, electrokinetic phenomenon. Surfactants and micelles and reverse micelles: applications
III	**Chemistry of redox reactions-** Ion electron method and elementary idea on standard redox potentials with sign conventions. Concept of electrochemical cells and different types of electrodes, standard redox potentials, Concept of formal potential and influence of different factors on formal potential. Latimer and Frost diagrams. Feasibility of redox titration and the significance of redox potential at the equivalence

	point, Use of redox indicators.
IV	**Electrophilic and nucleophilic aromatic substitution:** a) Electrophilic substitutiion reaction: Mechanisms, kinetics, reactivity, effect of substitution on arenes Reactivity and ortho-para ratio for arenes, different reactions (chloromethylation, Gatterman-Koch, Gatterman, Hoesch, Vilsmeier-Haack reaction, Reimer-Tiemann, Kolbe-Schmidt), diazonium salt, b) nucleophilic substitution reactions: mechanisms, kinetics, reactivity, benzyne.
V	**Lab-** **A. Derivatization of organic compounds:** 1. Nitration of aromatic compounds (methyl salisylate, phenol, nitrobenzene etc.), 2. Hydrolysis of amides (benzamide) and esters (methyl or ethyl benzoate derivatives) 3. Acetylation of aromatic alcohols (phenol, β-naphthol etc.) / aromatic amines (aniline derivatives), 4. Benzoylation of aromatic alcohols (phenol, β-naphthol etc.)/ aromatic amines (aniline derivatives), 5. Iodoform synthesis from acetone and ethanol. **B. Purification of the crude product by crystallization method and melting Point determination of the purified product.** **C. Redox titration:** 1. Estimation of Fe(II) present in Mohr's salt by permanganometric and dichromatometric titration. 2. Estimation of Fe(III) present in a sample by permanganometric and dichromatometric titration. 3. Estimation of Fe(II) and Fe(III) in a given mixture by permanganometric and dichromatometric titration. 4. Estimation of Fe(III) and Ca(II) in a given mixture by permanganometric method.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination

	50%	50%

Reference books:

11. Huheey, Keiter and Keiter, Principles of Inorganic Chemistry,
12. R. Sarkar, Vol. 1 Inorganic Chemistry,
13. Concise Inorganic Chemistry by J. D. Lee,
14. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education),
15. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988),
16. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press,
17. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10^{th} Ed., Oxford University Press (2014),
18. P.C. Rakshit, Physical Chemistry 7^{th} Edition (2004),
19. Chatterjee, H. Physical Chemistry, Vol-1, Edition, Platinum publishers,
20. Das, S.C. Advanced Practical Chemistry, Sixth edition.
21. Mukherjee, G.N. University handbook of undergraduate chemistry experiments.
22. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education),
23. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988),
24. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press,
25. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10^{th} Ed., Oxford UniversityPress (2014),
26. P.C. Rakshit, Physical Chemistry 7^{th} Edition (2004),
27. Chatterjee, H. Physical Chemistry, Vol-1, Edition, Platinum publishers,
28. Das, S.C. Advanced Practical Chemistry, Sixth edition.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	III
Course Title	General Chemistry IV
Course Code	CHM202
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The course aims to provide students with a comprehensive understanding of fundamental concepts in chemical equilibrium, coordination chemistry, noble gases, and the chemistry of alcohols and nitrogen compounds. Students will explore the criteria for spontaneity and equilibrium, including the applications of the equilibrium constant and Gibbs free energy, as well as Le Chatelier's principle and its implications for chemical systems. The course will introduce coordination compounds through Werner's theory and discuss ligand types, isomerism, and the chelate effect. In addition, students will investigate the properties and bonding of noble gases and examine the classification, nomenclature, and reactions of alcohols and nitrogen compounds, including amines and aromatic nitro compounds. Practical laboratory sessions will enhance theoretical knowledge through hands-on experiments, such as determining pH, solubility products, and titrations, fostering essential analytical skills in quantitative chemistry. Ultimately, this course will equip students with the necessary knowledge and skills to excel in advanced chemistry studies and applications.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1:** Analyze the principles of chemical and ionic equilibrium, including the application of Le Chatelier's principle, Nernst's distribution law, and solubility equilibria, to solve problems related to spontaneity, pH, and buffer solutions. **CO2:** Explain the theory, types of ligands, and isomerism in

	coordination compounds, and apply Werner's theory and the chelate effect to understand the properties and applications of coordination complexes. **CO3:** Evaluate the preparation, properties, and bonding of noble gases and their compounds, such as XeF2, XeF4, and XeO2F2, and describe the nature of their chemical bonding. **CO4:** Investigate the synthesis, reactions, and mechanisms of alcohols, including monohydric, vicinal glycols, and trihydric alcohols, and apply these concepts to their reactivity in organic synthesis. **CO5:** Synthesize and identify nitrogen-containing compounds such as amines, diazonium salts, and nitriles, and apply techniques like E. Clarke reaction and enamines in organic chemistry. **CO6:** Perform laboratory experiments to determine pH, solubility products, partition coefficients, and equilibrium constants, and apply titrimetric methods to estimate metal ions in mixtures using permanganometric, dichromatometric, and iodometric titrations.

Course Outline

Module	Description
I	**Chemical equilibrium & Ionic Equilibrium** – Criteria for spontaneity and equilibrium**.** Equilibrium constant and standard Gibbs free energy change; definition of K_p, K_c, K_x Van't Hoff's reaction isobar and isochore. Le Chatelier principle and its application, Nernst's distribution law; Application. Concept of pH, Acid and base hydrolysis. Hydrolysis of salts, Buffer solution. Acid-base indicators, titration curve. Solubility equilibria and influence of common and indifferent ions there on.
II	**Introduction to Coordination Compounds-** Werner's theory and applications, types of ligands, chelate effect and macrocyclic effect, IUPAC nomenclature of coordination complexes and Isomerism.
III	**Noble gases-** Preparation, properties and nature of bonding in XeF_2, XeF_4, XeF_6, $XeOF_4$ and XeO_2F_2.
IV	**Chemistry of alcohols-** Classification, nomenclature, monohydric alcohols-nomenclature, synthesis, chemical reaction of vicinal glycols, oxidation, oxidative cleavage, trihydric alcohols: nomenclature and synthesis, glycerols: reactivity and mechanism.
V	**Nitrogen compounds-** amines: preparation, separation and identification, E. Clarke reaction, enamines, diazomethane, diazoacetic ester, aromatic nitro compounds,

	aromatic diazonium salts, nitrile and isonitrile.etc.) and cyclic molecules (3, 4, 5, 6-membered rings; mono- and di-substituted cyclohexane).
VI	**Lab** **A. Physico-chemical experiments:** 1. Find out the pH of an unknown solution by colorimetric method. 2. Determination of solubility product for sparingly soluble salt. 3. Determination of partition coefficient of iodine between water and organic solvent. 4. Equilibrium Constant determination of $KI + I_2 \rightleftharpoons KI_3$ system. **B. Permangometric, Dichromatometric and Iodometric titration:** 1. Estimation of Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$solution 2. Estimation of Fe(III) and Cr(III) in a mixture using $K_2Cr_2O_7$. 3. Standardization of sodium thiosulfate solution 4. Estimation of Cu(II) by standardized sodium thiosulphate solution.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Huheey, Keiter and Keiter, Principles of Inorganic Chemistry,
2. R. Sarkar, Vol. 1 Inorganic Chemistry,
3. Concise Inorganic Chemistry by J. D. Lee,
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education),
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press,
6. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford UniversityPress (2014),
7. P.C. Rakshit, Physical Chemistry 7th Edition (2004),

8. Chatterjee, H. Physical Chemistry, Vol-1, Edition, Platinum publishers,
9. Das, S.C. Advanced Practical Chemistry, Sixth edition.
10. Mukherjee, G.N. University handbook of undergraduate chemistry experiments.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	III
Course Title	Fuel Chemistry
Course Code	SEC107
Credit	2
Contact Hours (L-T-P)	1-0-1
Course Type	Hybrid
Course Objective	The course aims to provide students with a comprehensive understanding of energy sources, focusing on both renewable and non-renewable fuels. Students will explore the classification of fuels and their calorific values, with a particular emphasis on coal, its composition, and its diverse applications in various industries, including its carbonization processes and gasification techniques. The curriculum will also cover the petroleum and petrochemical industry, detailing the composition and refining of crude petroleum, as well as the production and applications of various petroleum products. Additionally, students will study key petrochemicals, including vinyl acetate and propylene oxide, and examine the classification and properties of lubricants, including their viscosity and performance characteristics. Through this course, students will gain essential knowledge about the energy landscape and the chemical processes involved in fuel production and utilization, preparing them for advanced studies and careers in energy and chemical industries.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1:** Classify energy sources as renewable and non-renewable, and evaluate the calorific values of different fuels for various applications. **CO2:** Analyze the composition, uses, and carbonization processes of coal, and explain the techniques of coal gasification and

	liquefaction, including their applications in energy production. **CO3:** Examine the composition and refining processes of crude petroleum, and evaluate the production and application of petroleum products, including synthetic and non-petroleum fuels. **CO4:** Identify and describe key petrochemicals such as vinyl acetate, propylene oxide, and toluene, and explain their industrial uses and derivatives. **CO5:** Classify different types of lubricants, and analyze their properties such as viscosity index, cloud point, and pour point, along with methods for their determination. **CO6:** Evaluate the role of lubricants in various industries, and apply knowledge of synthetic and natural lubricants in practical applications, considering factors like conductivity and lubrication efficiency.

Course Outline

Module	Description
I	**Review of energy sources (renewable and non-renewable):** Classification of fuels and their calorific values. *Coal:* Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.
II	**Petroleum and Petrochemical Industry:** Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation, Cracking, Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.
III	**Petrochemicals:** Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and Xylene its derivatives.
IV	**Lubricants:** Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Evaluation:

Mode of Evaluation	Theory

Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference Books:

1. Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. *Engineering Chemistry* DhanpatRai& Sons, Delhi.
3. Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut(1996).
4. Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut(1996).

School of Basic and Applied Sciences
Department of Chemistry

BSc Chemistry
Batch: 2024-2028
Semester: IV

S.No	Type of Course	Code	Title of the Course	Contact Hours Per Week				Remarks
				L	T	P	C	
1	CC	CHM205	Organic Chemistry-I	3	0	1	4	CC-7
2	CC	CHM206	Physical Chemistry-I	3	0	1	4	CC-8
3	CC	CHM207	Inorganic Chemistry-I	3	0	1	4	CC-9
4	SEC		Pharmaceutical Chemistry	2	0	0	2	
5	VAC						2	
7	Minor						4	
Semester Credits							**20**	

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	IV
Course Title	Organic Chemistry I
Course Code	CHM205
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The course aims to provide students with a comprehensive understanding of the chemistry of carbonyl compounds, encompassing their synthesis, mechanisms, and reactivity in various chemical reactions. Students will explore characteristic reactions of carbonyl compounds, including the Cannizzaro and aldol condensations, as well as the behavior of carboxylic acids and their derivatives, focusing on their preparation, physical properties, and reaction mechanisms. The curriculum will also cover a variety of rearrangement reactions, equipping students with the ability to understand and predict reaction pathways and outcomes. Additionally, the course will introduce biomolecules, including carbohydrates, amino acids, peptides, and nucleic acids, emphasizing their synthesis, degradation, and structural properties. Through lectures and practical applications, students will develop a solid foundation in organic chemistry, enabling them to tackle more advanced topics in the field.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1:** Synthesize and explain the reactivity and mechanisms of various carbonyl compounds, including reactions with alcohols, amines, thiols, and the Wittig reaction, and apply reduction methods like Wolff-Kishner and Clemmensen reduction. **CO2:** Analyze the characteristic reactions of carbonyl compounds, such as Cannizzaro, aldol condensation, and Michael addition, and apply these reactions in the synthesis of complex

	organic molecules. **CO3:** Describe the preparation, properties, and reactions of carboxylic acids and their derivatives, and explain the mechanism of ester group hydrolysis in the context of organic synthesis. **CO4:** Investigate various rearrangement reactions, such as the Wagner-Meerwein, Beckmann, and Baeyer-Villiger oxidation, and apply these transformations in the synthesis of organic compounds. **CO5:** Analyze the structure and properties of biomolecules like carbohydrates, amino acids, peptides, proteins, and nucleic acids, and describe their synthesis and degradation processes. **CO6:** Perform laboratory syntheses of drug molecules, dye derivatives, and other organic compounds, applying various synthetic techniques such as azo coupling and photophysical studies, and characterize the products formed.

Course Outline

Module	Description
I	**Chemistry of carbonyl compounds:** Synthesis, mechanism, reactivity, reactions with alcohols, amines, thiols, HCN, bisulfate, Wittig reaction, hydride addition, Wolff-Kishner reduction, Bouveault-Blanc reduction, Clemmensen reduction, reduction with metal hydrides.
II	**Characteristic reactions of carbonyl compounds-** Cannizzaro reaction, Tischenko reaction, aldol condensation, benzoin condensation, acyloin Condensation, Mannich reaction, oxidation, michael addition and robinson annulation.
III	**Carboxylic Acids and their Derivatives-** Preparation, physical properties and reactions of monocarboxylic acids; acid derivatives, mechanism of ester group hydrolysis.
IV	**Rearrangement reactions:** Wagner-Meerwein, pinacol, Dienone-phenol, Wolff, benzil-benzilic acid rearrangement, Beckmann, Schmidt, Hofmann, Lossen, Curtius, Baeyer-Villiger oxidation, Dakin, Fries, Claisen, dienone-phenol, Hofmann-Martius, Fischer-Hepp, Bamberger, Orton, Benzidine, Radical coupling: pinacol, acyloin, McMurry etc.
V	**Biomolecules:** Carbohydrates, amino acids, peptides (synthesis and degradation), proteins (elementary idea), nucleic acids (Basic introduction to the structure and properties of DNA and RNA).
VI	**Lab-**

	Drug molecules: ▪ Paracetamol from p-amino phenol, ▪ Aspirin synthesis from salicylic acid, ▪ Phenytoin from benzil and urea, ▪ Hippuric acid from glycine, ▪ Cholesterol benzoate from cholesterol (liquid crystal), ▪ P-Methoxy benzamide (mosquito repellent) from p-methoxy benzyl chloride etc. **Dye derivatives:** ▪ Azo dye from aniline and β-naphtol, ▪ Azo dye from sulphanilic acid and β-naphtol, ▪ Extended azo dye and their photophysical study etc. **Others:** ▪ Benzoic acid from benzaldehyde, ▪ p-Iodo nitrobenzene from p-nitro aniline, ▪ Synthesis of dibenzalacetone from benzaldehyde etc.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

<u>Reference Books:</u>

1. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
2. Norman &Coxon Principles of Organic Synthesis (CRC Press)
3. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
6. March, J. Advanced Organic Chemistry.
7. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

8. Das, S.C. Advanced Practical Chemistry, Sixth edition.
9. Mukherjee, G.N. University handbook of undergraduate chemistry experiments.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	IV
Course Title	Physical Chemistry I
Course Code	CHM206
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	This course aims to provide a comprehensive understanding of key principles in quantum mechanics, thermodynamics, and physical chemistry, with a focus on their application in real-world scenarios. Students will explore the origins and foundational concepts of quantum mechanics, including wave-particle duality and the Schrödinger equation, enabling them to analyze complex systems and evaluate expectation values. The course will also cover the phase rule and colligative properties, allowing students to derive phase diagrams and understand their significance in both theoretical and practical contexts. Additionally, the thermodynamics of electrochemical cells will be examined, including the Nernst equation and the relationship between free energy and cell potential. Through hands-on laboratory experiences, such as conductometric titrations and the study of reaction equilibria, students will develop practical skills and a deeper appreciation for the intricate behaviors of chemical systems. By integrating theoretical knowledge with experimental techniques, the course prepares students to tackle challenges in

	both academic and industrial settings.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1:** Explain the origin and key principles of quantum mechanics, including wave-particle duality, the uncertainty principle, and the photoelectric effect, and apply these concepts to analyze quantum phenomena. **CO2:** Solve the time-dependent and time-independent Schrödinger equations for various systems, interpret the wave function, and use operator algebra to evaluate expectation values and commutation relations in quantum mechanics. **CO3:** Apply the principles of quantum mechanics to solve the particle in a box problem, extending the solution to two- and three-dimensional systems, and analyze the significance of degenerate energy states. **CO4:** Derive and solve the Schrodinger equation for a simple harmonic oscillator, and connect the solutions with classical turning points and the uncertainty principle, considering the effect of anharmonicity. **CO5:** Apply the phase rule and colligative properties to analyze phase diagrams for one-, two-, and three-component systems, and explain the concepts of first-order phase transitions and liquid-vapor equilibrium. **CO6:** Perform conductometric experiments to study acid-base titrations, saponification, and equilibrium reactions, and apply the Oswald dilution law and distribution method to determine transport numbers and analyze chemical equilibria.

Course Outline

Module	Description
I	**Quantum Mechanics -I** **a)** Origin of quantum mechanics- Black body radiation, de Broglie hypothesis, wave-particle duality, Uncertainty principle. Photoelectric effect, Compton effect. **b)** Time-dependent and time -independent Schrödinger equation; probabilistic interpretation of the wave function, stationary state. Elementary idea of operator, operator algebra, eigen value equation, expectation value. Postulates

	of quantum mechanics. Commutation relation. c) Application to Particle in a box problem- Construction of Schrödinger equation for 1 D box problem and its solution. Evaluation of expectation values of x, x^2, p_x, p_x^2 for 1-D box and their significance. Extension of the particle in one-dimensional box to two- and three- dimensional cases, idea of degenerate energy states. Free particle. **d)** Simple harmonic Oscillator- Schrödinger equation, series solutions of differential equation: Hermite equation. Expressions for energy and wave functions. Connection with the uncertainty principle, classical turning points. Limitation, introduction of anharmonicity.
II	**Phase Rule and colligative properties-** **a)** Definition of phase, number of components and degrees of freedom, Derivation of phase rule and its applications. One component system and its phase diagram. First order phase transition and Clapeyron equation. Clausius-Clapeyron equation: derivation and its use; liquid vapor equilibrium for two component systems. **b)** Colligative property- Ideal solutions, ideally dilute solutions and Raoult‘s law, Colligative properties of solution: Lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure. Abnormal colligative properties, van‘t Hoff factor; biomedical application: osmosis and dialysis. **c)** Phase diagram for two and three component system- Liquid vapor equilibrium for two component systems, Fractional distillation. Phenol-water system. Three component systems, water-chloroform-acetic acid system, triangular plots.
III	**Thermodynamics of electrochemical cell-** Electrochemical cells: representation, EMF and relation of ΔG, ΔH and ΔS with EMF. Thermodynamic derivation of Nernst equation. Standard cells, different types of electrode, standard electrode potential and principle of its determination; concentration cells. Activity coefficient, Debye-Hückel model limiting law, applications. Determination of transport number by EMF method, glass electrode and determination of pH, applications of EMF measurement: potentiometric titrations: acid-base, redox and precipitation.
IV	**Lab-** Conductometric method 1. Conductometric titration of an acid (strong, weak/ monobasic, dibasic, and acid mixture) against strong base. 2. Study of saponification of ester conductometrically 3. Oswald dilution law 4. Study the equilibrium of at least one of the following reactions by the

	distribution method: (i) $I_2(aq) + I^-(aq) \rightarrow I_3^-(aq)$ (ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 10th Ed., Oxford University
2. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
3. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
4. McQuarrie, D. A & Simon, J. D, Physical Chemistry: A molecular approach, University Science Books, Sausalito, California.
5. N. K. Bera, Physical Chemistry, 1st Edition, Techno World Pub.
6. Levitt, B. P. edited Findlay's Practical Physical Chemistry Longman Group Ltd.
7. University Hand Book of Undergraduate Chemistry Experiments, University of Calcutta.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	IV
Course Title	Inorganic Chemistry I
Course Code	CHM207
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The objective of this course is to provide students with a comprehensive understanding of coordination chemistry, focusing on the bonding theories that underpin coordination complexes, including valence bond theory and crystal field theory. Students will explore the effects of ligand field strength and Jahn-Teller distortion, while also engaging with modified ligand field theory and its implications for ML6 and ML4 complexes. The course will delve into the electronic spectra of coordination complexes, emphasizing selection rules, L-S coupling, and Orgel diagrams for various d-block ions. Additionally, students will examine the magnetic properties of coordination complexes, assessing magnetic moments and the role of exchange interactions. A comparative analysis of d and f block elements will enhance their understanding of electronic configurations, oxidation states, and coordination chemistry across different series. Practical laboratory sessions will reinforce theoretical concepts, enabling students to conduct iodometric and complexometric titrations for estimating metal ions and analyzing water hardness, thereby integrating hands-on experience with theoretical knowledge.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1:** Analyze the bonding in coordination complexes using valence bond theory and crystal field theory, and evaluate the effects of weak and strong field ligands, J-T distortion, and OSSE in these systems.

	CO2: Apply modified ligand field theory to explain the electronic structure and behavior of ML6 and ML4 complexes, including the Nephelauxetic effect and its implications for coordination chemistry. **CO3:** Interpret the electronic spectra of coordination complexes by applying selection rules, L-S coupling, hole formalism, and Orgel diagrams, and analyze charge transfer spectra for various metal ions. **CO4:** Evaluate the magnetic properties of coordination complexes, including the calculation of spin-only magnetic moments, the role of orbital contributions, and the effects of spin-orbit coupling and exchange interactions. **CO5:** Compare the chemistry of d-block and f-block elements in terms of electronic configuration, oxidation states, redox properties, and coordination chemistry, and analyze the spectral and magnetic properties of lanthanides and actinides. **CO6:** Perform iodometric and complexometric titrations to estimate metal ions such as Zn(II), Fe(III), Cu(II), and Ca(II), and analyze the hardness of water through complexometric methods.

Course Outline

Module	Description
I	**Bonding in Coordination complexes-** Valence bond theory and its limitations, Concept of crystal field theory, Effect of weak and strong field ligands in crystal field splitting, J-T distortion and OSSE and its application.
II	**Modified Ligand Field Theory of Coordination Complexes-** MO energy diagram for ML_6 and ML_4 complexes, Nephelauxetic effect.
III	**Electronic Spectra of Coordination Complexes-** Selection rules for electronic spectral transitions, L-S coupling, hole formalism principle, Orgel diagrams for $d^1 – d^9$ ions, Charge transfer spectra.
IV	**Magnetic property of coordination complexes-** Magnetism and magnetic moments, Spin only magnetic moments and their correlation with effective magnetic moments, Orbital contribution towards magnetic moment and its quenching in crystal field, Exchange interaction in metal complexes, Spin-orbit coupling.
V	**Chemistry of *d* and *f* block elements-** General comparison of chemistry of 3d, 4d and 5d elements in term of electronic configuration, atomization energy, oxidation states,

	redox properties, coordination chemistry, spectral and magnetic properties. Spectral and magnetic properties of *f*-block elements and comparison between lanthanides and actinides.
VI	**Unit-6: Lab Iodometric and Complexometric titration** 1. Estimation of Zn(II) by complexometric titration. 2. Estimation of Fe(III) and Cu(II) in a mixture. 3. Estimation of Cu(II) and Zn(II) present in a mixture by iodometric titration. 4. Estimation of Ca(II) by EDTA complexometry. 5. Estimation of Ca(II) and Mg(II) in a given mixture. 6. Estimation of permanent and temporary hardness of water

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Huheey, Keiter and Keiter, *Principles of Inorganic Chemistry*
2. R. Sarkar, Vol. 2 *Inorganic Chemistry*
3. Chemistry of elements by Greenwood and Earnshaw
4. Handbook of Practical Chemistry by Subhas C Das.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	IV
Course Title	Pharmaceutical Chemistry
Course Code	SEC108
Credit	2
Contact Hours (L-T-P)	1-0-1
Course Type	Hybrid
Course Objective	The course objective is to provide students with a comprehensive understanding of drug discovery, design, and development, emphasizing the retrosynthetic approach to synthesizing key pharmaceutical agents. Students will explore the various classes of drugs, including analgesics, antipyretics, antibiotics, and antiviral agents, gaining insights into their mechanisms of action and therapeutic applications. The course will also cover the production processes of important biopharmaceuticals through aerobic and anaerobic fermentation, focusing on the synthesis of antibiotics and essential vitamins. By integrating theoretical knowledge with practical applications, this course aims to equip students with the skills necessary to analyze and develop pharmaceutical compounds and to appreciate the role of fermentation in the biotechnology sector.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1:** Explain the drug discovery, design, and development processes, and apply the basic retrosynthetic approach to the synthesis of representative drugs from various therapeutic classes. **CO2:** Synthesize and evaluate the chemical structures and mechanisms of action of analgesic, antipyretic, anti-inflammatory agents, and antibiotics, including drugs like aspirin, paracetamol, ibuprofen, and chloramphenicol. **CO3:** Analyze the synthesis, pharmacology, and clinical

	applications of antibacterial, antifungal, antiviral, and central nervous system agents, including sulphonamides, acyclovir, phenobarbital, diazepam, and HIV-related drugs such as zidovudine. **CO4:** Investigate the chemical synthesis and mechanism of action of cardiovascular drugs like glyceryl trinitrate and antilaprosy drugs such as dapsone, and understand their therapeutic applications. **CO5:** Evaluate the processes and products of fermentation, including the production of ethyl alcohol, citric acid, antibiotics (penicillin, cephalosporin), and essential vitamins (B2, B12, C). **CO6:** Demonstrate the industrial production of amino acids, vitamins, and antibiotics through aerobic and anaerobic fermentation techniques, and assess the biotechnological significance of these products in pharmaceuticals.

Course Outline

Module	Description
I	**Drugs & Pharmaceuticals** Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol);
II	**Types of drugs** Antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryltrinitrate), antilaprosy (Dapsone), HIV-AIDS relateddrugs (AZT- Zidovudine), 7-Fluoroquinoline based drugs, Remdesivir, Tamiflu etc.
III	**Fermentation** Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetinand Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous	End Semester Examination

	Assessment	
	50%	50%

Reference Books:

• G.L. Patrick: Introduction to *Medicinal Chemistry, Oxford University* Press, UK.

• Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, VallabhPrakashan, Pitampura, New Delhi.

• William O. Foye, Thomas L., Lemke, David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

5.

School of Basic and Applied Sciences
Department of Chemistry

BSc Chemistry
Batch: 2024-2028
Semester: V

S.No	Type of Course	Code	Title of the Course	Contact Hours Per Week				Remarks
				L	T	P	C	
1	CC	CHM301	Organic Chemistry-II	3	0	1	4	CC-10
2	CC	CHM302	Physical Chemistry-II	3	0	1	4	CC-11
3	CC	CHM303	Inorganic Chemistry-II	3	0	1	4	CC-12
4	SEC		Mathematics and Computation in Chemistry	1	0	1	2	
5	INT	CHM305	Internship	0	0	4	4	
6	Minor			3	0	1	4	
Semester Credits							**22**	

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	V
Course Title	Organic Chemistry II
Course Code	CHM301
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	This course aims to provide a comprehensive understanding of advanced organic synthesis techniques, focusing on carbocyclic and heterocyclic chemistry, enolate chemistry, and retrosynthetic analysis. Students will explore the thermodynamic and kinetic factors influencing carbocycle formation, the application of Baldwin's rules, and methods of synthesizing polycyclic aromatic compounds. The course also covers the synthesis and reactivity of key heterocyclic structures such as pyrrole, pyridine, and indole, as well as strategies for carbonyl chemistry and ring synthesis. Additionally, students will delve into retrosynthetic analysis, learning to apply disconnection approaches, protection-deprotection strategies, and rearrangement reactions in complex molecule synthesis. Lab sessions will emphasize practical chromatographic techniques, including thin-layer and column chromatography, alongside the use of rotary evaporators.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: Analyze the thermodynamic and kinetic factors involved in the synthesis of carbocycles, applying Baldwin's rules, and understanding the reactivity of polycyclic aromatics such as naphthalene, anthracene, and phenanthrene. CO2: Evaluate the structure, aromaticity, reactivity, and synthesis methods of heterocycles like pyrrole, pyridine, indole, furan,

	thiophene, and quinoline, focusing on their functional properties. CO3: Apply enolate chemistry techniques, including alkylation, acylation, conjugate addition, and ring synthesis strategies, for the preparation of carbonyl and di-carbonyl derivatives. CO4: Design and perform retrosynthetic analysis using disconnections, synthons, and synthetic equivalents, while applying protection-deprotection strategies and large-ring synthesis via rearrangement reactions. CO5: Synthesize organic compounds using the disconnection approach to organic synthesis, incorporating functional group interconversions and bond disconnections involving C-heteroatom and C-C bonds. CO6: Demonstrate the application of chromatographic techniques (TLC, column chromatography) and rotary evaporation in organic sample analysis and purification in the laboratory.

Course Outline

Module	Description
I	**Carbocycles:** Thermodynamic and kinetic factors, Baldwin rules, Synthesis of carbocycles through alkylation, condensation, cycloaddition, rearrangement and their reactivity, synthesis of polycyclic aromatics (naphthalene, anthracene and phenanthrene).
II	**Heterocycles:** Classification, nomenclature**,** aromaticity**,** reactivity and synthesis (Pyrrole, pyridine, indole, furan, thiophene, quinoline)
III	**Enolate chemistry:** Alkylation, acylation and conjugate addition at of carbonyls, di-carbonyl derivative synthesis, strategies of ring synthesis.
IV	**Retrosynthetic analysis:** Disconnections, synthons, synthetic quivalents, functional group interconversion, bond disconnection (C-hetero atom and C-C), protection-deprotection strategy, **s**ynthesis through rearrangement reactions, synthesis of large rings (high dilution technique)
V	**Application to illustrate the disconnection approach to organic synthesis.**
VI	**Lab: Chromatographic methods** 1. Theory and application of chromatography in sample analysis (TLC, column chromatography) 2. Theory and application of rotatory evaporator.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Joule and Mills, Heterocyclic Chemistry- 4th edition(Wiley)
2. Gilchrist, T.L. Heterocyclic Chemistry (Pearson),
3. Organic Synthesis - The Disconnection Approach – S. Warren,
4. Designing Organic Synthesis – S. Warren,
5. Tactics of Organic Synthesis - T.-L. Ho,
6. Das, S.C. Advanced Practical Chemistry, Sixth edition,
7. Mukherjee, G.N. University handbook of undergraduate chemistry experiments.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	V
Course Title	Physical Chemistry-II
Course Code	CHM302
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The course provides a comprehensive understanding of fundamental principles in quantum mechanics, statistical thermodynamics, group theory, and their applications in chemical bonding and spectroscopy. Students will explore the quantum mechanical treatment of systems like the harmonic oscillator and hydrogen atom, developing familiarity with angular momentum and Schrödinger equation solutions. The course introduces covalent bonding models, contrasting molecular orbital (MO) and valence bond (VB) theories. Through statistical thermodynamics, students will learn to calculate partition functions and apply them to chemical equilibria. Group theory concepts are applied to molecular symmetry, spectroscopy, and bonding analysis. Lab work focuses on titrations to reinforce theoretical concepts through practical experimentation.
Course Outcome (CO)	After completion of this course, students will be able to:

	CO1: Apply the quantum mechanical approach to the simple harmonic oscillator by solving Schrodinger′s equation, analyzing the series solutions of the Hermite equation, and understanding the energy and wave functions in relation to the uncertainty principle and classical turning points. **CO2:** Explain the principles of angular momentum and the hydrogen atom using commutation relations, ladder operators, and spherical polar coordinates, and analyze the concept of quantum numbers and the radial and orbital distributions of the hydrogen atom. **CO3:** Compare and contrast covalent bonding theories such as the Born-Oppenheimer approximation, LCAO-MO, and VB methods, and evaluate their application and limitations in the context of diatomic molecules, particularly H_2. **CO4:** Derive the Maxwell-Boltzmann distribution and apply the concepts of partition function and entropy to calculate thermodynamic properties and equilibrium constants for various molecular systems, including chemical equilibria and ionization processes. **CO5:** Apply statistical thermodynamics to calculate the rotational, translational, vibrational, and electronic partition functions for diatomic molecules, and evaluate their relevance to chemical and ionization equilibria, the equipartition principle, and quantum statistics. **CO6:** Utilize group theory to analyze molecular symmetry, apply character tables, and interpret selection rules in molecular spectroscopy, normal modes, IR and Raman activities, crystal field theory, and vibronic coupling for various molecular systems.

Course Outline

Module	Description
I	**Quantum mechanical approach to Simple harmonic Oscillator-** Schrödinger equation, series solutions of differential equation: Hermite equation. Expressions for energy and wave functions. Connection with the uncertainty principle, classical turning points. Limitation, introduction of anharmonicity.
II	**Angular Momentum and H-atom-** Commutation rules, quantization of square of total

	angular momentum and z-component; Ladder operator method to solve Schrödinger equation; Rigid rotator model of rotation. Hydrogen atom: Transforming the Schrödinger equation to spherical polar coordinates. Separation of variables; Spherical harmonics. The idea of the quantum numbers, degenerate states, orbital, radial density distributions.
III	**Covalent bonding-** Born-Oppenheimer approximation; LCAO-MO treatment of H_2^+; Bonding and antibonding orbitals; Qualitative extension to H_2; Comparison of LCAO MO and VB treatments of H_2 and their limitations; Covalent bonding, valence bond and molecular orbital approaches.
IV	**Introduction to Statistical Thermodynamics-** Concept of probability. Microscopic and microstates, thermodynamic probability. Entropy Derivation of Maxwell-Boltzmann distribution. Concept of partition function (PF). Relevance to thermodynamics.
V	**Application of Statistical Thermodynamics-** Rotational, Translational, Vibrational and Electronic PF for diatomic molecules, Calculation of equilibrium constants in term of partition function. Application to chemical/ionization equilibrium, Equipartition principle. Gibbs paradox, and quantum statistics. Third law and residual entropy.
VI	**Introduction to Group Theory-** Introduction to group theory, symmetry elements, point group. Reducible and irreducible representations of point group. Classes and character, statement of grand orthogonality theorem, character tables, concept of character projection operator.
VII	**Application of Group Theory-** Selection rules in molecular spectroscopy. Normal modes, their symmetry properties, IR and Raman activity. Electronic spectroscopy. Crystal field theory. SALC – Hückel theory, Hybridization, Vibronic coupling.
VIII	**Lab-** pH-metric and potentiometric titration: 1. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures. 2. pH metric titration of i) strong acid vs. strong base ii) weak acid vs. strong base 3. Potentiometric titration of Mohr's salt solution against standard $K_2Cr_2O_7$ solution. 4. Determination of K_{sp} for AgCl by potentiometric titration of $AgNO_3$ solution against standard KCl solution.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 10^{th} Ed., Oxford University
2. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
3. Castellan, G. W. *Physical Chemistry* 4^{th} Ed. Narosa (2004).
4. McQuarrie, D. A & Simon, J. D, Physical Chemistry: A molecular approach, University Science Books, Sausalito, California.
5. N. K. Bera, Physical Chemistry, 1^{st} Edition, Techno World Pub.
6. Levitt, B. P. edited Findlay's Practical Physical Chemistry Longman Group Ltd.
7. University Hand Book of Undergraduate Chemistry Experiments, University of Calcutta.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	V
Course Title	Inorganic Chemistry II
Course Code	CHM303
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The course offers an in-depth exploration of the role of metal ions in biological systems, focusing on their involvement in essential processes such as ion transport, oxygen transport, and enzymatic functions. Students will study the mechanisms of metal-containing enzymes and proteins, such as hemoglobin and cytochromes, and their significance in biological pathways, including photosynthesis and nitrogen fixation. The course also covers the toxicity of metal ions and therapeutic applications like chelation and MRI contrast agents. In addition, it addresses analytical techniques such as absorption spectroscopy and chromatography for the quantitative analysis of metal ions. Laboratory work emphasizes inorganic synthesis and characterization of metal complexes, providing hands-on experience to complement theoretical knowledge.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: Understand the role of metal ions in biological systems, including their functions in processes such as oxygen transport, electron transport, and nitrogen fixation. CO2: Analyze the function and mechanisms of metal-containing enzymes like carbonic anhydrase, catalase, and peroxidase in biological systems. CO3: Evaluate the toxicity of metal ions and apply chelation

	therapy techniques, including the use of metal complexes as drugs and MRI contrast agents. CO4: Apply principles of absorption spectroscopy and chromatographic techniques for the quantitative estimation of trace metal ions and the removal of chemical interferences. CO5: Synthesize inorganic compounds, such as tetraamminecopper(II) sulfate and potassium tris(oxalate) ferrate(III), and perform their characterization using laboratory techniques. CO6: Investigate the principles and methods of error, accuracy, and precision in experimental data, and apply statistical analysis to ensure the reliability of results.

Course Outline

Module	Description
I	**Roles of metal ions in biological systems-** Basic chemical reactions in biological system and roles of metal ions, Na^+-K^+ ion pump and ionophores.
II	**Oxygen transport and electron transport protein-** Biological functions of haemoglobin, myoglobin, hemocyanin and hemerythrin. Cytochromes and ferredoxins, Chlorophyll: PS-I and PS-II, Z-scheme of electron transport, Cytochrome C oxidase and its function in mammalian respiratory chain. Biological nitrogen fixation by Nitrogenase.
III	**Functions of Metal Enzymes-** Metal containing enzymes (carbonic anhydrase, carboxypeptidase, catalase, peroxidase) and their roles in biological system
IV	**Toxicity of metal ions-** Toxicity of metal ions, Chelation therapy and its applications, use of Gd-complex as MRI contrast reagent, uses of metal complexes as various drugs (Pt and Au complexes as drugs)
V	**Errors, accuracy and precision-** Errors**,** accuracy and precision, methods of their expression and normal law of distribution if indeterminate errors.
VI	**Absorption Spectroscopy-** Chemical interferences and sources of chemical interferences and their method of removal. Techniques for quantitative estimation of trace level of metal ions from different samples.
VII	**Chromatographic techniques-** Classification, principle and efficiency of different chromatographic techniques, Qualitative and quantitative aspects of chromatographic methods.

VIII	**Lab-Inorganic synthesis and characterization** Inorganic Preparations: 5. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$ 6. *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III) 7. Tetraamminecarbonatocobalt (III) ion 8. Potassium tris(oxalate) ferrate(III) and its photochemistry 9. Synthesis of porphyrin and complexation with Zn metal. 10. Synthesis of Schiff bases and its complexation. 11. Determination of K_{sp} for AgCl by potentiometric titration of $AgNO_3$ solution against standard KCl solution.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Bioinorganic Chemistry by G. N. Mukherjee and A. Das
2. Bioinorganic Chemistry by Stephen J Lippard
3. Bioinorganic Chemistry by Asim K Das
4. Analytical Chemistry by Daniel C Harris
5. Analytical Chemistry by G. D. Christian
6. Analytical Chemistry by Skoog

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	V
Course Title	Mathematics and Computation in Chemistry
Course Code	SEC
Credit	2
Contact Hours (L-T-P)	1-0-1
Course Type	Theory
Course Objective	The course provides a foundational understanding of key mathematical concepts and their applications in scientific analysis. Students will explore essential topics such as functions, partial differentiation, extremum principles, and series expansions like Taylor and Fourier series. The course covers vector spaces and matrix theory for structural determination, as well as probability, statistics, and error analysis techniques to evaluate data reliability. Additionally, students will gain proficiency in numerical methods, including techniques for solving equations, differentiation, integration, and Monte Carlo methods, while learning to apply search algorithms for complex problem-solving scenarios.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: Apply programming concepts in languages such as FORTRAN, C++, and Python to translate formulas, implement decision-making statements, loops, arrays, and subroutines for problem-solving in chemistry. CO2: Demonstrate understanding of basic mathematical principles relevant to chemistry, including partial differentiation, extremum principles, and power series, as well as their applications in chemical calculations. CO3: Analyze vectors, matrices, and linear vector spaces, and use these mathematical tools for solving chemical problems involving linear systems and determinants. CO4: Solve problems in probability statistics, including the application of probability distribution functions, variance,

	standard deviation, and error analysis in chemical data interpretation. CO5: Implement numerical analysis techniques such as root-finding, numerical differentiation and integration, and solving simultaneous equations, for practical applications in chemistry and chemical engineering. CO6: Develop solutions for differential and partial differential equations using appropriate numerical methods to model and analyze chemical systems and processes.

Course Outline

Module	Description
I	**Programming Languages (FORTRAN/C_{++}, Python)** Syntax for formula translation, Decision making statement, loop, array, subroutine.
II	**Basic Mathematics for Chemistry** Numbers, functions, partial differentiation, extremum principles, constrained extremization, Power series: Convergence and divergence, Taylor series and Fourier series. Vectors and linear vector space: matrices and determinant. Probability statistics: Probability distribution function, variance, standard deviation, error analysis.
III	**Numerical Analysis:** Numerical techniques for roots of equations, numerical differentiation, numerical integration, simultaneous equations, interpolation, extrapolation, differential equation, partial differential equation.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Modern Fortran in Practice, Arjen Markus, Cambridge Univrsity Press (2012).
2. Numerical Recipe in Fortran77, The art of scientific computing. W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery, 2nd Edition, Cambridge Univrsity Press.
3. Mathematics for Chemists, N. K. Bera, S. Ghosh, P. Ghosh. TechnoWorld.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	V
Course Title	Internship
Course Code	CHM305
Credit	4
Contact Hours (L-T-P)	0-0-4
Course Type	Practical
Course Objective	This course aims to provide students with hands-on experience in applying chemical knowledge and laboratory techniques in a real-world setting. Through direct engagement with industry or research environments, students will enhance their practical skills, including experimental design, data analysis, and problem-solving in chemical processes. The course also emphasizes the development of professional skills such as teamwork, communication, and safety practices. By the end of the internship, students will have gained valuable insights into the application of chemistry in professional contexts, preparing them for future careers in research, industry, or advanced studies.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: Apply theoretical knowledge gained in the classroom to real-world problems in a professional setting. CO2: Analyze industry practices and compare them with academic learning to identify areas for improvement. CO3: Demonstrate effective communication skills through presentations, reports, and discussions in a professional environment. CO4: Evaluate the ethical, social, and environmental implications of the projects undertaken during the internship. CO5: Synthesize information from various sources to solve complex problems encountered during the internship. CO6: Reflect on personal and professional development

	throughout the internship and set goals for future career growth.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

School of Basic and Applied Sciences
Department of Chemistry

BSc Chemistry
Batch: 2024-2028
Semester: VI

S.No	Type of Course	Code	Title of the Course	Contact Hours Per Week				Remarks
				L	T	P	C	
32	CC	CHM306	Spectroscopy	3	1	0	4	CC-13
33	CC	CHM307	Organometallics and reaction kinetics	3	1	0	4	CC-14
34	CC	CHM308/ CHM309/ CHM310	Advanced special chemistry-1 1. Solid state chemistry 2. Materials of Industrial Importance	3	0	1	4	CC-15
35	SEC		AI in Chemistry	2	0	0	2	
36	Minor			3	1	0	4	
37	Project	CHM312	Project	0	0	4	4	
Semester Credits							**20**	

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VI
Course Title	Spectroscopy
Course Code	CHM306
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	This course aims to develop a comprehensive understanding of light-matter interactions, including the fundamental principles of spectral line formation and their characteristics. Students will gain theoretical skills in rotational and vibrational spectroscopy, enabling them to analyze molecular structures and dynamics, including bond length determination and isotopic effects. Students will also learn the principles governing electronic transitions, including the Franck-Condon principle, photophysical processes, and the Jablonski diagram, to analyze absorption and emission spectra. Students will be introduced to the fundamentals of laser action, including characteristics, types, and applications, as well as advanced concepts like Q-switching and harmonic generation. Introduction to group theory will help students to develop the concepts of symmetry, point groups, and their applications in spectroscopy to facilitate a deeper understanding of molecular vibrations and electronic transitions. Finally, student will be able to develop hands-on experience in conducting experiments, including verification of Lambert-Beer’s law, UV-Vis spectrophotometry, and fluorescence studies, to reinforce theoretical knowledge.

Course Outcome (CO)	After completion of this course, students will be able to: **CO1: Understand** the principles of molecular spectroscopy, including light-matter interaction, rotational and vibrational spectroscopy, and the impact of isotopic substitution and anharmonicity on spectral features. **CO2: Analyze** the characteristics and conditions of Raman activity, including the rotational and vibrational Raman spectra, and apply the rule of mutual exclusion to molecular systems. **CO3: Apply** the Franck-Condon principle and photophysical processes to understand absorption, emission spectra, and the laws of photochemistry, including quantum yield and fluorescence quenching. **CO4: Investigate** the principles of laser action, laser characteristics, and various types of lasers, including pulsed lasers, Q-switching, and nonlinear effects, in both theoretical and practical contexts. **CO5: Examine** the fundamentals of group theory, including symmetry elements, point groups, and irreducible representations, and apply them to molecular spectroscopy, crystal field theory, and molecular orbital theory. **CO6: Conduct** laboratory experiments to verify the Lambert-Beer law, study absorbance spectra using UV-Vis spectrophotometry, and measure emission spectra and fluorescence quenching using fluorimetry.

Course Outline

Module	Description
I	**Molecular Spectroscopy:** Light matter interaction. Characteristic features of spectral lines: intensity, broadening Rotational spectroscopy of diatom: rigid rotor model, selection rules, characteristic features of spectral lines (spacing and intensity); determination of bond length, effect of isotopic. Substitution Concept of non-rigid rotor. Vibrational spectroscopy- SHO approximation. selection rules, spectral analysis, fundamental line, overtones, hot bands; anharmonicity. Raman effect- Characteristic features, and conditions of Raman activity. Rotational and vibrational Raman spectra,

	the rule of mutual exclusion with examples.
II	**Electronic Spectroscopy:** The Franck Condon principle, Photophysical processes, Jablonski diagram. Absorption and emission spectra, Beer-Lambert law. Difference between thermal and photochemical processes, photochemical reaction. Laws of photochemistry: Grotthuss - Draper law, Stark - Einstein law, Quantum yield. Fluorescence Quenching (static and Dynamics), Fluorescence lifetime measurement.
III	**Laser:** Principles of laser action, laser characteristics, pulsed lasers, laser cavity modes, Q-switching, mode locking, non-linear effects, harmonic generation, examples of lasers: He-Ne, Nd-YAG, titanium-sapphire, dye lasers.
IV	**Group Theory and application-** Introduction to group theory, symmetry elements, point group. Reducible and irreducible representations of point group. Classes and character, statement of grand orthogonality theorem, character tables, concept of character projection operator. Selection rules in molecular spectroscopy. Normal modes, their symmetry properties, IR and Raman activity. Electronic spectroscopy. Crystal field theory. SALC – Hückel theory (butadiene, benzene, naphthalene), Hybridization, Vibronic coupling.
V	**Lab** i)Verification of Lambert-Beer's law ii) Absorbance spectrum study by UV-Vis spectrophotometer. iii) Emission spectrum study by Fluorimeter, Fluorescence quenching.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

<u>Reference books:</u>

1. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, McGraw Hill Education, 4th Edition 2016
2. Molecular structure and spectroscopy, G. Aruldhas, 2nd Edition, Practice – Hall of India, Pvt Ltd., New Delhi – 110001, 2007.
3. Introduction to Spectroscopy, D. L. Pavia, G. L. Lampman, G. S. Kriz, Thompson Learning Inc, 5th Ed 2015.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VI
Course Title	Organometallics and Reaction Kinetics
Course Code	CHM307
Credit	4
Contact Hours (L-T-P)	3-1-0
Course Type	Theory
Course Objective	This course offers an in-depth study of organometallic chemistry and the principles of reaction kinetics. It covers the structure, bonding, and reactivity of organometallic compounds, including metal carbonyls, nitrosyls, cyanides, and ferrocene. Key topics include the 18-electron rule, fluxional molecules, and the role of organometallic complexes in homogeneous catalysis. The course also provides a detailed exploration of reaction kinetics, thermodynamic and kinetic aspects, and electron transfer reactions. Special focus is given to reaction mechanisms in square planar complexes and the application of Marcus theory in understanding electron transfer. Laboratory sessions and problem-solving exercises are integrated to reinforce theoretical concepts. **Prerequisites**: Introductory courses in inorganic chemistry and physical chemistry are recommended.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1: Define** the basic concepts of organometallic compounds, including the 18-electron and 16-electron rules, and their significance in the structure and stability of complexes. **CO2: Analyze** the structure, bonding, and IR spectra of metal carbonyls, metal nitrosyls, and metal cyanides, and understand the stereochemical control in metal nitrosyl complexes. **CO3: Synthesize** ferrocene and explore its reactions, such as acetylation, alkylation, and metallation, to understand its chemical reactivity and applications.

	CO4: Evaluate the mechanisms of organometallic reactions, including hydrogenation, hydroformylation, and polymerization of alkenes, and their roles in homogeneous catalysis. **CO5: Investigate** the thermodynamic and kinetic aspects of reactions, particularly in square planar complexes, and apply these concepts to nucleophilic substitution mechanisms such as solvent exchange and base hydrolysis. **CO6: Apply** the principles of electron transfer reactions, using the Marcus expression to understand their mechanisms and practical applications in organometallic chemistry.

Course Outline

Module	Description
I	**Introduction to Organometallic compounds-** Basic idea of organometallic compounds, 18 electron and 16 electron rules for organometallic complexes.
II	**Structure and bonding of organometallic compounds-** Structures and bonding of metal carbonyls, IR spectra of metal carbonyls, metal nitrosyls, stereochemical control of valence of metal nitrosyls, metal cyanides, Zeise's salt, fluxional molecule.
III	**Structure and reactivity of Ferrocene-** Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation).
IV	**Organometallic Reactions** - Reactions of organometallic complexes. Homogeneous catalysis by organometallic compounds: hydrogenation, hydroformylation and polymerization of alkenes.
V	**Introduction to reaction kinetics-** Thermodynamic and Kinetic aspects of reactions.
VI	**Reactions in square planar complexes-** Mechanism of nucleophilic substitution in square planar complexes. Solvent exchange, aquation, anation, base hydrolysis, acid catalyzed hydrolysis.
VII	**Electron Transfer Reactions-** Mechanism of electron transfer reactions, applications of Marcus expression (simple form).

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

Reference books:

a) F. Basolo and R.C. Pearson, *Mechanisms of Inorganic Chemistry*
b) B. D. Gupta and A. J . Elias, *Organometallic Chemistry*
c) Greenwood, N.N. &Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
d) Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
e) Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry*

SYLLABUS

Advanced special chemistry-1

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VI
Course Title	Solid State Chemistry
Course Code	CHM308
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	This course provides an in-depth exploration of solid-state chemistry, focusing on the structural, electronic, and physical properties of solid materials. Topics include chemical crystallography, characterization techniques, electronic properties, defects, phase transitions, and preparative methods. Students will engage in hands-on laboratory experiments, synthesizing and characterizing metal nanomaterials, semiconductors, and single crystals, while employing advanced techniques such as X-ray diffraction, electron microscopy, and thermal analysis. Emphasis will be placed on the relationship between structure and properties, preparing students for research and industry applications in materials science.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1: Explain** the fundamental concepts of chemical crystallography, including space lattice, point groups, space groups, and crystal energetics, and apply these principles to characterize crystal structures of various materials like silicates,

	zeolites, and nanostructures. **CO2: Evaluate** the various characterization techniques for solids, such as X-ray diffraction, electron microscopy, and thermal and spectroscopic methods, and apply them to analyze the physical properties and structure of materials. **CO3: Analyze** the electronic properties and defects in solids, including the free electron model, point defects, dislocations, and diffusion mechanisms, and understand their impact on the behavior of metals, semiconductors, and insulators. **CO4: Investigate** phase transitions in materials, including ordered-disorder transitions, martensite-austenite transformations, and liquid crystals, and relate these transitions to the material's structure and properties such as magnetic, electrical, and optical behaviors. **CO5: Apply** preparative techniques for the synthesis and processing of solids, including powder synthesis, sintering, diffusion processes, and thin film deposition, and tailor materials for specific applications through solid-state ionics and crystal growth methods. **CO6: Perform** laboratory experiments to synthesize and characterize materials, such as metal nanomaterials, semiconductors, and thin films, and utilize techniques like X-ray diffraction, band gap calculation, and single crystal structure determination to analyze their properties.

Course Outline

Module	**Description**
I	**Chemical crystallography**- Space lattice, Crystal point groups, space group, Stereographic projections, Packing in solids, Crystal structures of representative systems, Silicates and Zeolites, Cements, Glasses, Quasicrystals, Nanostructures. Crystal classifications, Crystal energetics. Madelung constant and Lattice energy.
II	**Characterization techniques for solids-** X-ray diffraction, Electron microscopy (SEM, TEM, AFM), Thermal techniques (TG, DTA, DSC), Spectroscopic techniques (Mossbauer, IR, UV-VIS) and Physical property measurement techniques (Magnetic moments-VSM /SQUID, Electrical resistivity – Two / Four probe methods and thermal conductivity, Optical band gap, XPES, XAS).
III	**Electronic properties and defects:** Free electron model, Metals, semiconductors and insulators, doped semiconductors

	Solid state Ionics. Point defects, Dislocations, Extended defects, Clusters and aggregates, Color centers, non-stoichiometry of compounds, Diffusion mechanisms, Fick's law, Kirkendall effect.
IV	**Phase transitions-** Critical phenomena, variety of phase transitions (Ordered- disorder, Martensite-austenite, Spinodal decompositions etc.), Liquid crystals, Structure-property relations (magnetic, electrical, superconductivity, optical and thermal).
V	**Preparative techniques-** Powder synthesis by conventional and modern chemical methods, Reactivity of solids, Decomposition mechanisms, Powder processing (sintering and diffusion processes), Tailoring of solids, Special methods for single crystal growth and thin films depositions.
VI	**Lab:** 1. Synthesis of metal nanomaterials and determine their plasmon band 2. Synthesis of semiconductor materials and check the effect of size. 3. X-ray data analysis and determine the phase of the material 4. Estimation of lattice strain (Williamson-Hall Effect) on doping nanomaterials from the powder x-ray data. 5. Different techniques to grow single crystals. 6. Band gap calculation of materials from UV-VIS data. 7. Metal based nano-thin film preparation. 8. Single crystal structure determination by different software packages

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. West, A. R., Solid State Chemistry and Its Applications, John Wiley & Sons, 1984
2. Chakrabarty, K., Solid State Chemistry, New Age Publishers, 1996.
3. Introduction to Solid State Physics, C. Kittle. Wiley India.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VI
Course Title	Materials of Industrial Importance
Course Code	CHM309
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	This course explores the properties, synthesis, and industrial applications of materials crucial to modern technology and manufacturing, including glass, ceramics, pesticides, surface coatings, battery technology, catalysis, and dyes. Students will gain insight into the environmental and societal impacts of materials and industrial processes, with practical lab sessions focusing on material preparation, spectroscopic analysis, and industrial applications.
Course Outcomes (CO)	After completion of this course, students will be able to: **CO1: Describe** the properties, classification, and manufacturing processes of various types of glass and ceramics, including silicate and non-silicate glasses, and understand their applications in materials like bio-glass, safety glass, and superconducting oxides. **CO2: Examine** the dynamics of pesticide residues in the atmosphere, water, and soil, and assess their effects on human health, the environment, and agricultural systems, with a focus on the impact on ecosystems and food security. **CO3: Evaluate** the principles and functioning of different battery technologies, such as lithium batteries, solid-state electrolyte batteries, fuel cells, and solar cells, and analyze their

	characteristics and applications in energy storage and renewable energy systems. **CO4: Analyze** the mechanisms of catalysis, including homogeneous, heterogeneous, and electrocatalysis, and apply these principles to industrial applications, reactor design, and optimization of catalytic processes. **CO5: Conduct** laboratory experiments to prepare and characterize materials such as metallic coatings on ceramics and plastics, bioglasses, and dyes, and use spectroscopic techniques to identify pesticide residues in different environments. **CO6: Apply** the concepts of phase transfer catalysts and the use of zeolites in catalytic processes, and investigate methods for deactivating, regenerating, and optimizing catalysts for industrial reactions.

Course Outline

Module	Description
I	**Glass and Ceramics-** Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass and bio-glass. Important clays and feldspar, ceramic, Raw materials-their composition, occurrence, properties and classification. Manufacture of white ware, drying and firing of ceramic products and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.
II	**Pesticides:** a) Pesticides Residues in the Atmosphere: Pesticides into the atmosphere and their fate, Transport of vapours, Precipitation, effect of residues on human life, b) Pesticides residues in Water system: Nature and origin of pollution of aquatic systems, Point and Non-Point pollution. Dynamics of pesticides in aquatic environment. c) Pesticides residues in the Soil: Absorption, Retention, Transport and Degradation of pesticides in the soil, Effect on microorganisms and Consequent effect on the soil condition, Fertility, Interaction in the soil, d) Effect of pesticide residues on the quality of human life. Model ecosystem, In general and consequent effect on human life. The Cases of & affected societies and starving populations facing problems of health and nutrition, Traditional wisdom and Food security.
III	**Battery technology:** Primary and secondary batteries, battery components and their

	role, Characteristics of Battery. Working of following batteries: Li-Battery, Solid state electrolyte battery &Fuel cells, Solar cell, dye sensitized solar cell, polymer cell.
IV	**Catalysis-** General principles and properties of catalysts, homogenous catalysis, heterogenous catalysis and electrocatalysis and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Leaching and soxlet washing. Catalytic process design and optimization: reactor type and configuration, kinetic modelling and reactor design.
VII	**Materials of industrial importance lab-** 1. Metallic coatings on ceramic and plastic material. 2. Preparation of bioglasses. 3. Identification of pesticides by different spectroscopic techniques 4. Preparation of dye.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

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

B. K. Sharma: *Engineering Chemistry,* Goel Publishing House, Meerut.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VI
Course Title	Project
Course Code	CHM312
Credit	4
Contact Hours (L-T-P)	0-0-4
Course Type	Practical
Course Objective	1. To foster independent research skills by guiding students through the process of formulating research questions, developing hypotheses, and designing experiments or studies related to their field of study. 2. To enhance problem-solving and critical thinking abilities by encouraging students to analyze complex problems, evaluate potential solutions, and apply theoretical knowledge to practical scenarios. 3. To develop project management skills, including time management, resource allocation, and collaboration, while working on long-term research or development projects. 4. To provide hands-on experience in data collection, analysis, and interpretation, using appropriate research methodologies, tools, and techniques specific to their discipline. 5. To improve scientific communication and presentation skills, enabling students to effectively convey their research findings in written reports, presentations, and discussions with peers and faculty. 6. To encourage innovation and creativity, allowing students to explore new ideas, technologies, or methodologies in addressing current issues or challenges in their field.

	7. To prepare students for future professional or academic pursuits, by giving them exposure to research environments and the opportunity to produce a substantial piece of independent work.
Course Outcomes (CO)	After completion of this course, students will be able to: CO1: **Develop** a comprehensive project proposal by identifying a relevant research problem, formulating objectives, and planning methodologies for data collection and analysis. CO2: **Implement** the project plan by applying appropriate research techniques, tools, and technologies to execute the tasks outlined in the project scope. CO3: **Analyze** the collected data critically, interpreting the results in the context of the project objectives, and identifying trends, patterns, and implications. CO4: **Evaluate** the effectiveness of the project's outcomes, assessing its success in meeting the objectives, and suggesting improvements or modifications based on feedback and results. CO5: **Demonstrate** effective communication skills by preparing and presenting a detailed project report, showcasing the findings, methodology, and conclusions to both technical and non-technical audiences. CO6: **Synthesize** information from various sources to develop innovative solutions, integrate multidisciplinary approaches, and propose future directions for the project or research.

Course Outline

Module	Description
	The students will be assigned to Supervisor for research work in a recent field of research.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

School of Basic and Applied Sciences
Department of Chemistry

BSc Chemistry
Batch: 2024-2028
Semester: VII

S.No	Type of Course	Code	Title of the Course	Contact Hours Per Week				Remarks
				L	T	P	C	
1	CC	400-499	Advanced special chemistry -2 1. Fundamentals of nanomaterials 2. Polymer and Paints	3	0	1	4	CC-16
2	CC	400-499	Inorganic Cluster and spectroscopic application	3	0	1	4	CC-17
3	CC		Photochemical and pericyclic reactions				3	CC-18
4	CC	400-499	Research Methodology	3	0	0	3	CC-19 (Research)
5	Minor			3	0	1	4	CC-19(without Research)
Semester Credits							**20**	

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2023-27
Semester	VII
Course Title	Fundamentals of nanomaterials
Course Code	
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The objective of this course is to provide students with a comprehensive understanding of nanomaterials, encompassing their historical development, structural organization, and the principles of quantum confinement that govern their properties. Students will explore various synthesis techniques, including physical, chemical, and bio-inspired methods, to produce a range of nanomaterials, such as metal nanoparticles and carbon-based structures. The course will also cover the diverse properties and functions of nanomaterials, including mechanical, magnetic, electrical, and optical characteristics, as well as considerations of biocompatibility and toxicity. Through hands-on laboratory experiences, students will synthesize and characterize different types of nanoparticles using advanced techniques, fostering a deep appreciation of the practical applications and emerging technologies in the field of nanotechnology.
Course Outcome (CO)	After completion of this course, students will be able to: After completion of this course, students will be able to: **CO1:** Analyze the historical development and organization of nanomaterials, including atomic, molecular, cluster, and supramolecular structures, and explain their significance in nanotechnology. **CO2:** Describe the principles of quantum confinement, surface reconstruction, and the relationship between dimensionality, density of states, and bandgap in nanomaterials. **CO3:** Synthesize various nanomaterials using physical, chemical, and bio-inspired methods, and evaluate their structure, size, and properties

	through appropriate characterization techniques. **CO4:** Investigate the mechanical, magnetic, electrical, optical, and biocompatibility properties of nanomaterials, emphasizing their toxicity and emergent quantum behavior. **CO5:** Employ advanced characterization techniques such as XRD, DLS, FTIR, SEM, TEM, UV-Vis, and AFM to analyze the size, surface characteristics, and structural integrity of synthesized nanomaterials. **CO6:** Conduct laboratory experiments to synthesize nanoparticles (e.g., copper, silver, iron oxide, ZnO) using various methods, and demonstrate their size-dependent properties and confirm synthesis through appropriate analytical techniques.

Course Outline

Module	Description
I	Historical development of nanomaterials, organization of matter-atoms, molecules, clusters and supramolecules.
II	Quantum Confinement, Structure and Bonding, Intermolecular forces, Molecular and crystalline structures-Bulk to surface transition, density of states, bandgap and dimensionality of nanomaterials, surface reconstruction.
III	Synthesis of Nanomaterials. Physical methods, Chemical methods and Bio inspired methods—1D-2D nanomaterials, carbon based materials, aerogels, zeolites, self-assembled nanomaterials, core shell particles, Metal, Metal Oxide, semiconductor nanoparticles, Carbon Nanotubes.
IV	Structure, function and properties of nanomaterials: mechanical, magnetic, electrical, optical, biocompatibility, toxicity and emergent quantum properties.
V	Characterization of nanomaterials: Size and Surface Characterization using powder XRD analysis, dynamic Light Scattering, zeta Potential Analysis, FT-IR, SEM, UV-Vis, photoluminescence, TEM, FESEM and AFM studies.
VI	**Lab-** 1. Synthesis of Copper/ Silver/ Gold nanoparticles by simple chemical reduction method and confirm the synthesis of size dependent nanomaterial by surface plasmon resonance analysis. 2. Synthesis of Iron oxide nanoparticles by wet chemical method and confirm the synthesis by band gap analysis. 3. Synthesis of mixed ferrite nanoparticles by co-precipitation method and characterize the product by FTIR analysis. 4. Synthesis of CdS nanoparticles by simple wet chemical method and demonstrate the size variation. 5. Synthesis of ZnO quantum dots by simple solvothermal synthesis and confirm the size dependent variation in band gap. 6. Bio-inspired synthesis of nanoparticles from plant materials.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. C. N. R. Rao, A. Muller, A. K. Cheetham, *The Chemistry of Nanomaterials: Synthesis, Properties and Applications*, Volume 1, Wiley-VCH, Verlag GmbH, Germany (2004).
2. Guozhong Cao, *Nanostructures &Nanomaterials Synthesis, Properties G;Z: Applications*,World Scientific Publishing Private, Ltd., Singapore (2004).
3. Carl C. Koch, *Nanostructured Materials: Processing, Properties and Potential Applications,N*oyes Publications, William Andrew Publishing Norwich, New York, U.S.A (2002).
4. T. Pradeep, ―*Nano: The Essentials*‖, McGraw – Hill education, (2007).
5. Udo H. Brinker, Jean-Luc Mieusset (Eds.), *Molecular Encapsulation: Organic Reactions inConstrained Systems,*Wiley Publishers (2010). Jennifer Kuzma and
6. Peter VerHage, *Nanotechnology in agriculture and food production*, Woodrow Wilson International Center, (2006).
7. Fundamentals of Molecular Spectroscopy by C. N. Banwell, McGraw-Hill
8. Handbook of Thin Film Deposition, Hartmut Frey, Hamid. R. Khan Editors.
9. Elements of X-ray diffraction, B. D. Cullity, Creative Media Partners, LLC.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2023-27
Semester	VII
Course Title	Polymer and Paints
Course Code	CHM40
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The objective of this course is to provide a comprehensive understanding of polymeric materials, covering their fundamental properties, classification, and molecular interactions. Students will explore the mechanisms and kinetics of various polymerization processes, including step growth, radical chain growth, ionic chain polymerizations, and copolymerization, along with thermodynamic considerations. The course delves into the preparation and nomenclature of polymers, emphasizing addition and condensation polymerization mechanisms, and introduces advanced synthesis methods for polymers and their applications. It covers the synthesis and structural aspects of key rubbers and plastics, such as polyethylene, polypropylene, and natural and synthetic rubbers, as well as engineering plastics like nylon and polycarbonate. Additionally, the course addresses the science and application of paints and dyes, including surface coatings, pigments, special paints, and organic pigments, alongside the principles of color origin and chromatic behavior in organic molecules. Overall, the course equips students with a strong foundation in polymer science and its industrial applications, preparing them for advanced studies and professional practice.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1**: **Understand** the classification, nomenclature, and functionality of polymers, including the relationship between molecular forces, chemical bonding, and polymer properties. **CO2**: **Analyze** the kinetics and mechanisms of polymerization processes, including step growth, chain growth, ionic, and

	coordination polymerizations, and their thermodynamic aspects. **CO3**: **Evaluate** the methods for determining molecular weight, molecular weight distribution, degree of crystallinity, and crystalline melting points of polymers using various techniques. **CO4**: **Apply** the principles of polymer synthesis to prepare and characterize different polymers, including addition, condensation, and Ziegler-Natta polymerizations. **CO5**: **Design** surface coatings and polymeric applications by synthesizing rubbers, plastics, and specialty paints, considering their structural and functional properties. **CO6**: **Perform** polymer synthesis, characterization, and analysis using laboratory techniques such as viscometry, IR studies, and mechanical testing to validate polymer properties.

Course Outline

Module	Description
I	**Unit-1: Introduction to polymeric materials, its functionality-** Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.
II	**Kinetics and thermodynamical aspects of Polymerization-** Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques. - Determination of molecular weight of polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.
III	**Unit-3: Preparation of Polymers** Nomenclature - Classification of Polymers - Homo and hetero chain polymers - Addition polymerization - Condensation polymerization. Mechanism of Addition Polymerization - Cationic - Anionic polymerization - Free radical and Co-ordination or Ziegler-Natta polymerization.
IV	**Unit-4: Application: Rubbers and Plastics** Synthesis and structural aspect of Polyethylene, Polypropylene, Polystyrene, Polyvinyl Chloride, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, Polycarbonate, Polyphenylene oxide. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, Styrene Butadiene rubber, Polychloroprene rubber, Nitrile rubber, Butyl rubber, Ethylene-propylene-Diene Terpolymer, Silicone, Thermoplastic Elastomer.
V	**Unit-5: Paint & Dye-** Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints. Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints: Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint, Dyes, Wax polishing, additives, Metallic coatings, metal spraying and anodizing. Origin of colour in organic molecules, chromatic and achromatic colours,

<table>
<tr><td></td><td>solvatochromism, halochromism; Chromophores, auxochromes, chromogens, basic fluorophores; organic pigments (Anthraquinone, Benzimidazolone-dioxazines, Diazo lakes).</td></tr>
<tr><td>VI</td><td>Unit-6: Lab-

A. Polymer synthesis:
1. Free radical solution polymerization of styrene (St)
2. Preparation of nylon 6,6,
3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC)and phenolphthalein
4. Preparation of urea-formaldehyde resin,</td></tr>
<tr><td>VII</td><td>B. Polymer characterization:
1. Determination of molecular weight by viscometry:
2. Testing of mechanical properties of polymers.

C. Polymer analysis
1. Instrumental Techniques,
2. IR studies of polymers,

<u>Reference Books:</u>
1. L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley &Sons(2005)
2. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford UniversityPress (2005)
3. Seymour/ Carraher’s Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).
4. 1. K.J. Saunders: Organic Polymer Chemistry, Chapmann & Hall, London.
5. P.J. Flory: Principles of Polymer Chemistry, Cornell University Press, NY.
6. G. Odian: Principles of Polymerization, John Wiley & Sons Inc, NY.
7. James E. Mark, Hary Allcock, Robert West, Inorganic Polymers, Prentice Hall Englewood.</td></tr>
</table>

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

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Reference Books:

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

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. Chemistry
Batch	2024-28
Semester	VII
Course Title	Research methodologies
Course Code	CHM406
Credit	4
Contact Hours (L-T-P)	2-1-1
Course Type	Hybrid
Course Objective	The objective of this course is to provide students with comprehensive knowledge on sourcing and utilizing both print and digital scientific information effectively. Students will gain familiarity with primary, secondary, and tertiary resources such as journals, abstracts, and databases like Chemical Abstracts and Beilstein, as well as digital tools like SciFinder, Google Scholar, and Scopus. The course also emphasizes methods of scientific research, writing, and communication, equipping students with skills to conduct literature surveys, present findings, and write scientific papers while maintaining ethical standards. Additionally, it covers chemical safety protocols and the ethical handling of hazardous substances, ensuring students understand safe lab practices, waste disposal, and chemical recycling.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1: Identify** and categorize various types of information sources, including primary, secondary, and tertiary sources, along with their respective indices and journals. **CO2: Summarize** key features and functionalities of digital resources such as e-journals, citation indexes, and databases (e.g., SciFinder, Google Scholar) that are essential for conducting effective scientific research. **CO3: Demonstrate** the ability to locate and utilize relevant print and digital information resources for writing literature surveys, conducting research, and compiling bibliographies for scientific papers. **CO4: Evaluate** scientific papers and research articles for their methodological soundness and ethical adherence, including the assessment of potential plagiarism and proper citation practices. **CO5: Design** and present a scientific poster that effectively communicates research findings, employing appropriate visual and textual elements while adhering to ethical standards in scientific reporting and writing. **CO6: Develop** comprehensive research strategies by integrating information from primary, secondary, and tertiary sources to support scientific inquiry and innovation.

Course Outline

Module	**Description**
I	**Print:** Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current

	contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.
II	**Digital:** Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus, WoS, CCDC and ICSD.
III	**Methods of Scientific Research and Writing Scientific Papers:** Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.
IV	**Chemical Safety and Ethical Handling of Chemicals:** Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals.

Evaluation:

Mode of Evaluation	Practical	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2023-27
Semester	VII
Course Title	Inorganic Cluster and spectroscopic application
Course Code	CHM404
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	The course focuses on advanced concepts in inorganic chemistry, covering both theoretical and practical aspects. It begins with borane chemistry, exploring metallaboranes, metallacarboranes, and heteroboranes through the application of the Polyhedral Skeletal Electron Pair Theory (PSEPT) and the principle of isolobality. Further, the course delves into inorganic rings, clusters, and metal-metal bonding, with an emphasis on compounds exhibiting single and multiple bonds, including carbonyl clusters. Advanced topics in inorganic catalysis, particularly catalysis and photocatalysis by metal complexes, are introduced, followed by an in-depth study of Electron Paramagnetic Resonance (EPR) spectroscopy, Nuclear Magnetic Resonance (NMR), and Nuclear Quadrupole Resonance (NQR) spectroscopy and their applications in structural elucidation. Additionally, the course includes hands-on laboratory training in spectrophotometric analysis for the estimation and analysis of metal ions, fostering both theoretical understanding and practical skills in the study of inorganic compounds.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1: Analyze** the structure, bonding, and applications of metallaboranes, metallacarboranes, and heteroboranes, with an emphasis on the principle of isolobility in understanding their chemical properties. **CO2: Explain** the concepts of metal-metal bonding, including the molecular orbital approach, and apply these concepts to understand the bonding in dimolybdenum, dirhenium complexes, and carbonyl clusters. **CO3: Investigate** the mechanisms of inorganic catalysis and photocatalysis by metal complexes, demonstrating their applications in advanced chemical reactions. **CO4: Interpret** advanced EPR spectra and apply the knowledge to

	analyze the electronic environments and bonding in different inorganic molecules. **CO5: Apply** the principles of NMR spectroscopy to analyze the chemical shifts, splitting patterns, and structural information in organic and coordination compounds, including those with paramagnetic metal ions. **CO6: Conduct** spectrophotometric analysis of metal ions, determining concentration, coordination numbers, and elemental composition through various spectrophotometric methods in laboratory experiments.

Course Outline

Module	Description
I	**Unit-1: Borane Chemistry-** Metallaboranes, Metallacarboranes, Applications of PSEPT over heteroboranes. Principle of Isolobility: Development and formulation of the concept of isolobility and its applications in the understanding of structure and bonding of heteroboranes.
II	**Unit-2: Inorganic Rings and Clusters-** Metal-metal bonding (MO approach), metal-metal single and multiple bonded compounds. Bonding in dimolybdenum and dirhenium complexes, carbonyl clusters.
III	**Unit-3: Advanced inorganic catalysis:** Catalysis and photocatalysis by inorganic metal complexes
IV	**Unit-4: EPR spectroscopy and its applications-** Advanced EPR spectroscopy and its applications in different inorganic molecules.
V	**Unit-5: NMR:** Nuclear spin, NMR active nuclei, principle of nuclear magnetic resonance,equivalent and non-equivalent carbons and protons, chemical shift δ), shielding / deshielding, upfield and downfield shifts. NMR peak area (integration for PMR), diamagnetic anisotropy, relative peak positions of different kinds of protons (alkyl halides, olefins, alkynes, aldehyde, acid, alcohol, amine etc.), substituted benzene derivatives, first order coupling (splitting of the signals: ordinary ethanol, bromoehane, dibromoehanes), coupling constants, elementary idea of 13C, splitting pattern in presence of heteroatoms (P, F), structure analysis. ^{1}H-NMR spectra of coordination compounds of paramagnetic metal ions.
VI	**Unit-6: NQR spectroscopy-** Principle, nuclear quadrupole coupling constant, structural information from NQR spectra.
VI	**Unit-7: Lab-Spectrophotometric Analysis of Metal Ions** 8. Spectrophotometric estimation of Fe in alloy. 9. Determination of coordination number of complexes by Job's method

	10. Spectrophotometric estimation of Mn as MnO_4^- 11. Spectrophotometric estimation of Cr as CrO_4^{2-} 12. Spectrophotometric estimation of Fe in multivitamin tablets. 13. Spectrophotometric estimation of Mn and Cr in a mixture.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
2. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
3. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry*.
4. Sathyanarayana, D. N., *Handbook of Molecular Spectroscopy*
5. Das, A. K., Vol. 7. *Inorganic Chemistry*

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2023-27
Semester	VII
Course Title	Photochemical and Pericyclic reactions
Course Code	CHM405
Credit	2
Contact Hours (L-T-P)	1-0-1
Course Type	Hybrid
Course Objective	The course on "Photochemical and Pericyclic Reactions" aims to provide students with a comprehensive understanding of the mechanistic aspects and synthetic applications of photochemical and pericyclic reactions in organic chemistry. Through detailed study of photochemical reactions such as the Norrish reactions, photorearrangements, and photoreductions, students will explore the role of light in driving chemical transformations. The course will further delve into radical chemistry, focusing on the generation, detection, and reactivity of radicals in organic synthesis. A significant portion of the course is devoted to understanding pericyclic reactions, including cycloadditions, electrocyclic reactions, and sigmatropic rearrangements, with an emphasis on symmetry principles, Frontier Molecular Orbital (FMO) theory, and their applications in complex organic synthesis. Practical sessions will enhance students' laboratory skills through the extraction of natural products and the synthesis of various heterocyclic compounds, integrating theoretical knowledge with experimental techniques.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1:** Analyze and explain the mechanisms of photochemical reactions, including photolysis, photoexcitation, photoreduction, and photorearrangement, focusing on specific reactions like Norrish Type I and II, Barton reaction, and cycloadditions. **CO2:** Demonstrate an understanding of radical chemistry by explaining the generation, detection, and reactivity patterns of radicals, and by describing single electron transfer reactions and the role of radical intermediates in organic transformations. **CO3:** Apply the Frontier Molecular Orbital (FMO) theory and symmetry principles to predict the behavior and outcome of pericyclic reactions, including cycloadditions, electrocyclic reactions, and

	sigmatropic rearrangements. **CO4:** Evaluate the selection rules, particularly Woodward-Hoffmann rules, to understand and classify pericyclic reactions, and apply this knowledge to design synthetic strategies for complex molecules. **CO5:** Synthesize various small heterocycles and natural products by utilizing appropriate laboratory techniques for extraction and chemical transformations, including the synthesis of benzoxazole, phthalazine, pyrazolone, coumarin, indole, and barbituric acid derivatives. **CO6:** Investigate the use of pericyclic reactions in organic synthesis and apply symmetry principles and orbital correlation diagrams to predict reaction outcomes and synthetic strategies for target molecules.

Course Outline

Module	Description
I	**Unit-1: Photochemical reaction-** Photolysis of carbonyl compounds and nitrites: Norrish Type I, Norrish Type II, α-cleavage, Barton reaction, photoreduction, photoexcitation, photorearrangement reactions (Photorearrangemnt reaction of cyclohexanones, cyclohexadienone and α-tropolone methyl, Di-π-methane, photoisomerisation and photodimerisation), cycloadditions of benzene and its derivatives.
II	**Unit-2: Radical Chemistry:** Generation and detection of radicals, radical initiators, reactivity pattern of radicals, radical reaction intermediates, single electron transfer reactions
III	**Unit-3: Pericyclic reactions:** Frontier Molecular Orbital (FMO) approach and concept of aromaticity of transition states). Symmetry principles in pericyclic reactions, Orbital and state correlation diagram for 4nπ, (4n+2)π systems, selection rules (Woodward-Hoffmann selection rules and general rules), Classification (Cycloaddition reactions, Electrocyclic reactions, Sigmatropic rearrangements, Ene reactions), application in synthesis.
IV	Unit-4: Lab- Extraction, small heterocycle Synthesis: 1. Natural product extraction (caffeine, nicotine, casein etc.) etc. 2. Heterocycle Synthesis: a) Synthesis of benz-oxazole from o-amino phenol derivatives, b) Synthesis of phthalazine derivative from phthalic anhydride, c) Synthesis of pyrazolone derivative from phenyl hydrazine, d) Synthesis of coumarin derivative from resorcinol, e) Synthesis of indole and carbazole derivative from phenyl hydrazine, f) Synthesis of barbituric acid etc.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference books:

1. Stereochemistry of Organic Compounds - E. L. Eliel and S. H. Wilen,
2. Stereochemistry of Organic Compounds - D. Nasipuri,
3. Organic Photochemistry - J. W. Coxon& B. Halton,
4. Elements of Organic Photochemistry - D. O. Cowan & K. L. Drisco,
5. Pericyclic Chemistry – S. M. Mukherjee.
6. Frontier Orbitals and Organic Chemical Reactions – I. Fleming
7. Das, S.C. Advanced Practical Chemistry, Sixth edition,
8. Mukherjee, G.N. University handbook of undergraduate chemistry experiments.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2023-27
Semester	VII
Course Title	**Supramolecular Chemistry and Its Application**
Course Code	CHM407
Credit	2
Contact Hours (L-T-P)	1-0-1
Course Type	Hybrid
Course Objective	The course aims to provide a comprehensive understanding of the principles and applications of supramolecular chemistry, focusing on the intricate roles of non-covalent interactions and their implications in molecular recognition and self-assembly. Students will explore the fundamentals of hydrogen bonding, ion pairing, and aromatic interactions, along with their significance in biological systems such as DNA, coenzymes, and neurotransmitters. Emphasis will be placed on the design and functionality of biomimetic systems and artificial receptors, including cation and anion binding hosts, neutral receptors, and co-receptor systems. Additionally, the course will delve into dynamic supramolecular processes like molecular transport and chirality imprinting, solid-state chemistry including MOFs and COFs, and the cutting-edge field of crystal engineering to develop supramolecular devices with diverse applications in logic gates, energy conversion, and molecular design. Through these topics, students will gain theoretical insights and practical skills essential for advancing research and innovation in supramolecular chemistry and materials science.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1: Identify** the fundamental principles of molecular recognition and self-assembly, and explain the role of hydrogen bonding and secondary electrostatic interactions in supramolecular chemistry. **CO2 : Analyze** the various types of non-covalent interactions, such as ion pairing, van der Waals forces, and aromatic interactions, and their relevance to supramolecular systems. **CO3**: **Interpret** the structure and function of biological supramolecular systems, including ionophores, porphyrins, DNA,

	and biochemical self-assembly mechanisms. **CO4**: **Design** biomimetic systems and artificial receptors for cation, anion, and neutral species, incorporating concepts such as selectivity, solution behavior, and host-guest interactions. **CO5: Evaluate** the dynamics of supramolecular chemistry, including transport processes, combinatorial chemistry, and chirality imprinting, in molecular design and application. **CO6: Construct** advanced solid-state and supramolecular devices, applying principles of crystal engineering, structure-property correlations, and molecular logic gates for innovative solutions.

Course Outline

Module	Description
I	**Unit-1: Basic concept and principles**- Molecular recognition and self-assembly, Hydrogen Bonds: Definition, Structure and Stability, strength, Secondary Electrostatic Interactions in Hydrogen Bonding Arrays.
II	**Unit-2: 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, Closed shell interactions, Aromatic-Aromatic Interactions.
III	**Unit-3: Biological supramolecular systems-** Ionophores, Porphyrin and other Tetrapyrrolic Macrocycles, Coenzymes, Neurotransmitters, DNA and Biochemical Self-assembly.
IV	**Unit-4: Biomimetic systems and Artificial receptors-** (i) Cation Binding Hosts - Podand, Corand, Cryptand, Spherand; Nomenclature, Selectivity and Solution Behaviour; (ii) Anion binding hosts - Challenges and Concepts, Biological Receptors, Conversion of Cation Hosts to Anion Hosts, Neutral Receptors, Metal-Containing Receptors, (ii) Co-receptors –Zwitter ionic, Cascade Complexes, Ion-pair, remote anion and cation binding sites, (iv) Hosts for Neutral Receptors: Clathrates, Inclusion Compounds, Zeolites, Intercalates, Coordination Polymers, Cavitands, Clathrands, resorcicarene, Cyclodextrins and cucurbituril.
V	**Unit-5: Dynamics of supramolecular chemistry-** Transport processes, Dynamic Combinatorial chemistry, Supramolecular chirality and chirality imprinting, molecular extraction
VI	**Unit-6: Solid-State Chemistry-** Catenation, poly-catenation, Rotaxane, molecular knots, molecular rotors, Organic Crystal Structures, Metal Organic Frameworks (MOFs), Covalent Organic Frameworks.
VII	**Unit-7: Crystal Engineering & Supramolecular devices-** Supramolecular Synthons, Structure-Property Correlation, structure directing agents, design of Solids, phase transformations, Chemonics and semiochemistry, pH induced molecular devices, light induces molecular devices, energy converting molecular devices, supra-molecular logic gates.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference Books:

1. Lehn, J.-M. *Supramolecular Chemistry: Concepts and Perspectives.*
2. Das, A. K., *An Introduction to Supramolecular Chemistry*.

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SCHOOL OF BASIC AND APPLIED SCIENCES								
UNDERGRAGUATE COURSE STRUCTURE								
B.SC (HONS) CHEMISTRY								
BATCH 2024-28								
SEMESTER VIII								
44	CC	CHM409/CHM410	Advanced special chemistry -3 1. Medical Nano-technology 2. Analytical Methods in Industry	3	0	1	4	CC-20
45	CC (For Without Research)	CHM412	Reagent Chemistry	3	1	0	4	CC-21
46	CC (For Without Research)	CHM413	Natural Products and bio-organic chemistry	3	1	0	4	CC-22(without Research)
47	Minor			3	1	0	4	
48	Minor			3	1	0	4	
49	Dissertation	CHM416	Project/Dissertation	0	0	12	12	
Total Semester Credit							**20**	

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VIII
Course Title	Medical Nanotechnology
Course Code	CHM409
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	Understand nanoscale materials and their unique properties in medical applications. Explore nanomedicine techniques for targeted drug delivery and disease treatment. Learn advanced diagnostic tools using nanotechnology. Study therapeutic approaches, including nanorobots and biosensors. Develop skills for designing innovative medical devices and treatments at the nanoscale.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: **Remembering**: Students will be able to **define** key terms and concepts related to nanomaterials and their role in medicine, such as nanoparticles, nanosensors, and drug delivery systems. CO2: **Understanding**: Students will be able to **explain** the fundamental principles of nanotechnology and its applications in diagnostics and therapeutics. CO3: **Applying**: Students will be able to **apply** nanotechnology techniques in designing solutions for drug delivery and disease detection. CO4: **Analyzing**: Students will be able to **analyze** the advantages and limitations of nanotechnology in current

	healthcare practices and research. CO5: **Creating**: Students will be able to **design** innovative nanotechnological solutions for complex medical problems, integrating multidisciplinary approaches to develop new diagnostic and therapeutic tools.

Course Outline

Module	**Description**
I	Medical Nanotechnology- Concept of a living cell; Unicellular and multicellular organisms; Types of tissues; Microorganisms (Structure, types and clinical significance); Viruses (structure, types and clinical significance).
II	Preparation, Characterization of biocompatible nanomaterials—nanospheres, nano shells, nano capsules, nanomicelles and their potential use in therapy (Antibiotics, photodynamic therapy).
III	Magnetic nanoparticles and their applications in magnetic hyperthermia as MRI contrasting agents.
IV	Nanoparticle-Based Drug Delivery using Inorganic Nanoparticles and organic nanoparticles (e.g., cyclodextrin, polymer, dendrimers etc) for targeted- site specific, and non-targeted drug delivery, nanoencapsulation of water-insoluble drugs for intracellular drug delivery.
V	Application of biomimetic hydroxyapatite nanocrystals or bioactive polymer nanoparticles in bone substitutes and dentistry.
VI	Application of inorganic nanoparticles for detection of various pollutants and biomaterials.
V	**Lab-** 1. To identify an analyse the given nanomaterial by FTIR spectroscopy. 2. To analyse and confirm the crystal structure of given sample by X-ray diffraction technique. 3. To perform the time resolved photoluminescence study on nanoparticles/ quantum dots. 3. To carryout Photoluminescence study of the given nanoparticles.

Evaluation:

Mode of Evaluation	Theory

Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference Books:

1. Yoseph Bar Cohen, Biomimetics: Biologically Inspired Technologies‖, CRC Press, Boca Raton,
2. Reza Arshady and Kenji Kono, ―Smart Nanoparticles in Nanomedicine‖, MML series volume 8, Knetus Books, London, 2006
3. Ramakrishna S, MuruganRamalingam, and Kumar T. S. S., ―Biomaterials: A Nano Approach‖, CRCPress, London, 2010.
4. BikramjitBasu and Ashok Kumar K., ―Advanced Biomaterials: Processing and Applications‖, John Wiley, New Jersey, 2009.
5. Hari Singh Nalwa, ―Handbook of Nanostructured Biomaterials and Their Applications In Nanobiotechnology‖, American Scientific Publishers,2005.
6. Cato T. Laurencin, Temenoff J. S. and Mikos A. G., ―Biomaterials: The Intersection of Biology and Materials Science‖, Pearson, New Delhi, 2009.
7. Astrid Sigel, Helmut Sigel and Roland K. O. Sigel, ―Bi
8. Instrumental Methods of Analysis, Hobart H. Willard, John A. Dean, Lynne L. Merritt D. Van Nostrand Company.
9. Fundamentals of Molecular Spectroscopy by C. N. Banwell, McGraw-Hill.

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VIII
Course Title	Analytical Methods in Industry
Course Code	CHM410
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid

Course Objective	**Understand** the principles and techniques of key analytical methods used in industrial processes, such as spectroscopy, chromatography, and mass spectrometry. **Learn** how to apply these analytical techniques for quality control, process optimization, and product validation in various industries. **Develop** the ability to critically evaluate and interpret analytical data for decision-making in industrial settings. **Gain** practical experience in using modern analytical instruments and software for accurate measurement and analysis. **Explore** the role of analytical methods in ensuring regulatory compliance, safety, and sustainability in industrial operations.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: **Remembering**: Students will be able to **identify** and describe fundamental analytical techniques such as chromatography, spectroscopy, and mass spectrometry used in industry. CO2:**Understanding**: Students will be able to **explain** the operational principles and applications of various analytical instruments in quality control and process analysis. CO3: **Applying**: Students will be able to **apply** appropriate analytical methods to solve real-world industrial problems, such as material composition analysis and product validation. CO4: **Analyzing**: Students will be able to **analyze** industrial data from different analytical techniques to assess product quality and troubleshoot manufacturing processes. CO5: **Evaluating**: Students will be able to **evaluate** the performance and reliability of different analytical methods in industrial settings, ensuring adherence to safety, regulatory, and quality standards.

Course Outline

Module	Description
I	**Physical Methods of Separation:** Boiling and distillation, vapor-liquid equilibria, Rault's law & Henry's law, relative volatility, azeotropic mixtures. Different distillation processes. Classification of filters, Sand filters, filter press, plates & frame press, filter aids, principles of leaf filters. General Principles (Significance, moisture content), Rate of drying (Constant & falling rate period, factors affecting drying), Types of evaporators, jacketed, horizontal and vertical tube evaporators, forced circulation evaporations, entrainment separators (upturned, deflector type, tangential type).
II	**Thermal Methods of Analysis:** Thermal Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetery (DSC), Thermal Mechanical Analysis (TMA). Flow of Heat- Introduction, Conduction (Fourier law, Thermal conductivity, thermal diffusivity thermal insulation & problems), Heat Exchange Equipment.
III	**Electro Analytical Techniques:** Theory and application of Potentiometery, Voltametry, Polarography, Amperometry, Coulometry and Conductometry
IV	**Analytical Separation techniques:** Definition and importance. Different type of separation technique, Solvent extraction. Distillation (simple, fractional and vacuum distillation), Crystallization. Chromatographic separation: Thin layer chromatography (TLC), Column chromatography, Paper chromatography; principle, methodology and application.
V	**Advance method of separation and analysis:** Principle methodology and application of High-performance thin layer chromatography (HPTLC), High-performance liquid chromatography (HPLC), Liquid chromatography-mass-spectrometry (LC-MS), Gas chromatography (GC), Gas chromatography-mass-spectrometry (GC-MS), Inductively coupled plasma mass spectrometry (ICP-MS), Lyophilizer, X-ray fluorescence (XRF), Single crystal X-ray diffraction (SCXRD), Super conducting quantum interference device (SQUID).
VI	**Lab** **1.** Separation with ion-exchange chromatography **2.** Gravimetric analysis **3.** Experiment with Gas chromatography

Evaluation:

Mode of Evaluation	Theory

Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Reference:

1. H.H. Willard, L.L. Merrit, J.A. Dean, F. A. Settle*: Instrumental Methods of Chemical Analysis*, Wadsworth Publishing Company, California.
2. G. D. Christian: *Analytical Chemistry*, John Wiley
3. N. Y. S.M. Khopkar: *Basic Concepts of Analytical Chemistry*, Wiley Eastern Ltd, New Delhi.
4. F. A. Henglein: Chemical Technology (Pergamon).
5. R.N. Shrove: The Chemical Process Industries (MGH).
6. W.L. Badger and J.T. Bandchero: Introduction to Chemical Engineering (MGH).
7. G.H. Morrison & H. Freiser: Solvent extraction in Analytical Chemistry (John Wiley)

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VIII
Course Title	Reagent Chemistry
Course Code	CHM412
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	**Understand** the properties, classifications, and functions of chemical reagents in various chemical reactions. **Learn** the role of reagents in organic, inorganic, and analytical chemistry, focusing on reaction mechanisms and outcomes. **Explore** the selection and application of appropriate reagents for synthesis, catalysis, and analysis in laboratory and industrial processes. **Develop** practical skills in handling reagents safely, including preparation, storage, and disposal, in compliance with safety regulations. **Analyze** the reactivity and efficiency of different reagents to optimize chemical reactions and processes for improved yield and selectivity.
Course Outcome (CO)	After completion of this course, students will be able to: **CO1: Remembering**: Students will be able to **identify** and recall the classifications and characteristics of various chemical reagents used in organic, inorganic, and analytical chemistry. **CO2: Understanding**: Students will be able to **explain** the mechanisms by which reagents influence chemical reactions and their role in reaction pathways. **CO3: Applying**: Students will be able to **apply** appropriate reagents to design and carry out chemical reactions for

	synthesis and analysis in laboratory settings. CO4: **Analyzing**: Students will be able to **analyze** the efficiency, selectivity, and safety of different reagents, comparing their performance in various chemical processes. **CO5: Evaluating**: Students will be able to **evaluate** reagent choices in chemical processes to optimize reactions for industrial or research applications, ensuring safety and environmental compliance.

Course Outline

Module	Description
I	**Modern Reagents in Organic Synthesis-** Complex metal hydrides, Gilman's reagent, Li-reagents, 1,3-dithiane, trimethylsilyl iodide, tri-n-butyltin hydride, Woodward and Prevost hydroxylation, OsO_4, $NaIO_4$, DDQ, SeO_2, SmI_2, coupling reagents (DCC, HOBT, EDC.HCl, HATU etc.), phase transfer catalysts, crown ethers, Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker yeast, Lipase, organo-boron reagents, organo-phosphorus reagents, organo-silicon reagents, organo-sulphur reagents, ylides.
II	**Cross-coupling reactions:** Cross coupling reactions (Heck, Suzuki, Sonogashira, Kumada, Negeshi, Stille, Hiyama coupling reactions) and their application in synthesis.
III	**Translational Metal Reagents in Organic Synthesis-** Application of organotransition metals in organic synthesis, Structural and mechanistic aspects (with special thrust on Pd), Davies rule., cross-coupling reactions, Ziegler Naata reaction, Olefin metathesis, Grubbs reagent, Tebbe's reagent, Pauson-Khand reactions, Volhardt co-trimerisation, nontransition metal reagents.
IV	**C-H bond activation-** Basic introduction (ortho-, meta-, para-C-H bond activation) and its application in organic synthesis.

Reference Books:

1. Hydroboration - H. C. Brown
2. Borane Reagents - H. C. Brown, A. Pelter, K. Smith.
3. Relevant parts from Advanced Organic Chemistry - F.A. Carey and R.J. Sandberg; Vols. I & II.
4. Relevant parts from Comprehensive Organic Synthesis - B. M.Trost& I. Fleming
5. Principles of Organic Synthesis - RO.C. Norman and J. M. Coxon-Blackie.

6. C-H Bond Activation in Organic Synthesis - Jie. J. Lee

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VIII
Course Title	Natural Products and Bio-organic Chemistry
Course Code	CHM413
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	**Understand** the fundamental concepts of natural products, including their structures, classifications, and biosynthetic pathways. **Explore** the chemical properties and biological activities of natural compounds, emphasizing their roles in medicine, agriculture, and ecology. **Learn** techniques for the extraction, isolation, and characterization of natural products using modern analytical methods. **Investigate** the principles of bio-organic chemistry to understand enzyme mechanisms and the interaction of biomolecules. **Develop** skills in synthesizing and modifying natural products, focusing on their potential applications in drug development and therapeutic strategies

Course Outcome (CO)	After completion of this course, students will be able to: CO1: **Remembering**: Students will be able to **identify** and classify various natural products based on their chemical structures and functional groups. CO2: **Understanding**: Students will be able to **explain** the biosynthetic pathways and mechanisms involved in the formation of key natural products. CO3: **Applying**: Students will be able to **apply** techniques for the extraction, isolation, and characterization of natural products in laboratory settings. CO4: **Analyzing**: Students will be able to **analyze** the biological activities and pharmacological potential of natural compounds through case studies and literature reviews. CO5: **Creating**: Students will be able to **design** synthetic routes for natural product derivatives, considering their structural modifications and potential applications in drug development.

Course Outline

Module	Description
I	**Basic introduction to Natural Products-** Familiarity with methods of structure elucidation, biosynthesis, synthesis and biological activity of alkaloids, terpenoids and steroids.
II	**Total synthesis of few of the natural products-** Strychnine, Strychnine, Penicillin V, Reserpine, Vitamin B12, Progesterone, Prostaglandins F2-alpha and E2, Prostaglandins A2 and F2-alpha, Carpanone, Biotin, Periplanone B etc.
III	**Basic Introduction to Bio-organic Chemistry-** Molecular models of biological receptors, biomimetic chemistry, design, chemistry behind coagulation, vision, electron transport, biological decarboxylation, biological methylation, synthesis and binding studies of synthetic receptors.
IV	**Chemistry of enzymatic activity-** Enzyme catalyzed reactions (examples of nucleophilic displacement on a phosphorus atom), enzymatic action of some common enzymes (chymotrypsin, lysozyme, ribonuclease, carboxypeptidase etc.), coupling of ATP cleavage to endergonic processes.

V	**Application of enzymes-** Use of enzymes in organic synthesis (biocatalysis), biotechnological applications of enzymes: Enzyme purification, immobilization of enzymes, enzyme therapy, enzyme and recombinant DNA technology.

Reference Books:

1. Natural Product Biosynthesis: Chemical Logic and Enzymatic Machinery- Christopher T. Walsh
2. The Organic Chemistry of Biological Pathways (2nd Edition)- John E. McMurry; Tadhg P. Begley
3. Bioorganic Chemistry- Dugas
4. Classics in Total Synthesis: Targets, Strategies, Methods (1st Edition)-Nicolaou, Sorensen.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

SYLLABUS

School	School of Basic and Applied Sciences (SOBAS)
Programme/Discipline	B.Sc. (H) Chemistry
Batch	2024-28
Semester	VIII
Course Title	Project/Dissertation
Course Code	CHM416
Credit	4
Contact Hours (L-T-P)	3-0-1
Course Type	Hybrid
Course Objective	**Develop** critical research skills by designing and conducting independent research projects on a relevant topic in the field of study. **Enhance** analytical thinking and problem-solving abilities through the evaluation of existing literature and

	data collection methods. **Apply** theoretical knowledge and practical skills to real-world challenges, demonstrating the ability to integrate concepts learned throughout the program. **Communicate** research findings effectively through written reports and oral presentations, adhering to academic standards and ethical guidelines. **Foster** self-directed learning and time management skills by managing project timelines, resources, and collaboration with supervisors or peers.
Course Outcome (CO)	After completion of this course, students will be able to: CO1: **Remembering**: Students will be able to **identify** and define key research methodologies and concepts relevant to their chosen project topic. CO2: **Understanding**: Students will be able to **explain** the significance of their research question and the context within the existing body of literature. CO3: **Applying**: Students will be able to **apply** appropriate research methods and techniques to collect and analyze data effectively for their project. CO4: **Analyzing**: Students will be able to **analyze** research findings critically, drawing meaningful conclusions and implications from the data collected. CO5: **Evaluating**: Students will be able to **evaluate** the strengths and limitations of their research, providing recommendations for future studies or practical applications based on their findings.

Course Outline

Module	Description
I	The students will be assigned to Supervisor for research work in a recent field of research.
II	They will prepare a review note and synopsis for the projected work
III	They will carry out research work and record the data
IV	They will analyse and report the data to supervisor
V	They will write thesis/paper at the end of the work

Reference Books:

1. Natural Product Biosynthesis: Chemical Logic and Enzymatic Machinery- Christopher T. Walsh
2. The Organic Chemistry of Biological Pathways (2nd Edition)- John E. McMurry; Tadhg P. Begley
3. Bioorganic Chemistry- Dugas
4. Classics in Total Synthesis: Targets, Strategies, Methods (1st Edition)-Nicolaou, Sorensen.

Evaluation:

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%