PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR

Center for Basic Sciences

CURRICULUM & SYLLABI
(Based on LOCF)

Five Year Integrated M. Sc.: Chemistry Stream
Semester System

(Semester- I to X)

SESSION 2024-25 & onwards

Approved by:	Board of Studies	Academic Council
Date:		

Objectives

The CBS model of education is concept-based and inquiry-driven, as opposed to the more traditional content-based models. There is a strong emphasis on the interdisciplinary nature of today's science, and recognition of the importance of research experience in undergraduate education.

Courses offered in the Int. M. Sc. program at CBS form part of a comprehensive program that will enable the students-

- To understand the basic laws of nature and develop necessary skills to apply them to any desired area or discipline.
- To undertake projects to solve field base problems.
- To provide student centric learning facilities for the development of overall personality of learner. The program is planned as student-centric collaborative learning.
- Students get trained for a career in basic sciences or any related applied science or technology.

Integrated Master of Science in Chemistry

Courses offered during the first year (Semesters I to II) are meant as basic and introductory courses in Biology, Chemistry, Mathematics, Physics and Environmental Science. These are common and mandatory for all students. These courses are intended to give a flavor of the various approaches and analyses and to prepare the students for advanced courses in later years of study. In addition, there will be Interdisciplinary Courses for computational skills and mathematical methods. Students are also given training to develop skills in Communication, Creative & Technical Writing and History of Science through courses in Humanities and Social Sciences.

In the second year (Semester - III), students have the freedom to choose their stream for masters program on the bases of their interest. Courses offered in the first two years would help them make an informed judgment to determine their real interest and aptitude for a given subject.

One of the important features that the CBS has adopted is semester-long projects called Lab Training / Theory projects, which are given the same weightage as a regular course. By availing this, a student can work in an experimental lab or take up a theory project every semester. This is meant to help the student get trained in research

methodology, which will form a good basis for the 9th semester project work in the fifth year. The subjects/courses are described further with their credit points. Few courses are common to different streams.

:Program Outcomes:

The program's outcomes goals can be realized by engaging with the diverse components integrated into the curriculum, as outlined below. Each of these components is meticulously crafted to yield particular outcomes sought upon the successful conclusion of the program.

PO-1	**Knowledge:** Demonstrate the basic understanding of concepts, theories and principles of chemical sciences
PO-2	**Critical Thinking and Reasoning:** Exhibit advanced critical thinking and reasoning skills, enabling them to critically evaluate and analyze complex chemical arguments, theories, and experimental data.
PO-3	**Problem Solving:** Applying their chemical knowledge and problem-solving skills to tackle intricate scientific and real-world issues.
PO-4	**Advanced Analytical and Computational Skills:** Proficient in employing advanced analytical techniques and computational tools to conduct in-depth chemical analyses and research.
PO-5	**Effective Communication**: Effectively communicate complex scientific concepts and research findings to both technical and non-technical audiences, using written reports, presentations, and teaching.
PO-6	**Social/Interdisciplinary Interaction**: Integrate chemical concepts and methodologies into interdisciplinary contexts, collaborating effectively with professionals from various fields to address complex scientific and societal challenges.
PO-7	**Self-directed and Life-long Learning**: Recognize the importance of ongoing professional development and lifelong learning in the dynamic field of Chemistry and acquire knowledge and skills in chemistry throughout their professional careers.
PO-8	**Effective Citizenship**; **Leadership and Innovation:** Capable to identify, formulate, investigate and analyze the scientific problems and innovatively to design and create products and solutions to real life problems
PO-9	**Ethics**: Maintain the highest ethical standards in research and professional conduct within the field of chemistry
PO-10	**Further Education or Employment:** Pursue for Ph.D. program and get employment in academia, research institutions, industry, government, and other related sectors.
PO-11	**Global Perspective**: Recognize the global nature of scientific research in Chemistry and its impact, appreciating diverse cultural perspectives in scientific practices and considering international contexts in their work.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the program the student will be able to:

PSO1	Comprehensive understanding of fundamental theoretical principles and practical aspects of chemistry.
PSO2	Apply the knowledge of chemistry concepts in interdisciplinary fields to address and solve societal issues.
PSO3	Apply the analytical instruments and computation programs ensuring precision, efficiency, and innovation in scientific research, industry, healthcare, and education.
PSO4	Proficiently convey and promote ideas in the field of chemical sciences to disseminate knowledge and enhance the awareness of the chemical community.
PSO5	Qualify national and state-level examinations like GATE, NET, SLET, and SET can lead to career opportunities in academia, research, and related fields.

Int. M.Sc. in Chemistry

Specification of Course	Semester	No. of Courses	Credits
Core	I-IX	63	220
	• Theory = 42 • Practical = 18 • Project/Dissertation = 03		
Elective	X	4	20
	Total	67	240
Additional Courses (Qualifying in nature for Student admitted in Center for Basic Sciences only)	I	01	02
	II	01	02
Skill Enhancement (Value Added Courses) Qualifying in nature, for Student admitted in Center for Basic Sciences only)	V	01	02
	VI	01	02
	VII	01	02
	VIII (For Chemistry students only)	01	02

Course structure for the Integrated M.Sc. Chemistry stream

Effective from July, 2024

(Abbreviation: B: **B**iology, C: **C**hemistry, M: **M**athematics, P: **P**hysics, G: **G**eneral, H: **H**umanities, BL: **B**iology **L**aboratory, CL: **C**hemistry **L**aboratory, PL: **P**hysics **L**aboratory,
GL: **G**eneral **L**aboratory, CE: **C**hemistry **E**lective, SEL: Skill Enhancement Laboratory)

- Minimum total credits for Integrated M.Sc. degree is 240.
- Semesters I to VIII will carry 25 credits each.
- Semesters IX and X will carry 20 credits each.

Int. M.Sc. Chemistry Programme Structure

FIRST YEAR

SEMESTER –I

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Core	B101	Biology – I	T	[2+ 1]	3	60	40	100
Core	C101	Chemistry – I	T	[2+ 1]	3	60	40	100
Core	M101/ MB101	Mathematics –I	T	[2+ 1]	3	60	40	100
Core	P101	Physics– I	T	[2+ 1]	3	60	40	100
Core	G101	Computer Basics	T	[2+ 1]	3	60	40	100
Core	H101	Communication Skills	T	[2]	2	60	40	100
Core	PL101	Physics Laboratory – I	P	[4]	2	60	40	100
Core	CL101	Chemistry Laboratory–I	P	[4]	2	60	40	100
Core	BL101	Biology Laboratory–I	P	[4]	2	60	40	100
Core	GL101	Computer Laboratory	P	[4]	2	60	40	100
				(25 of 240 credits)	**Total= 25**			
Additional Papers								
ES101		Environmental Studies	T	[2]	2	60	40	100

SEMESTER –II

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Core	B201	Biology – II	T	[2+ 1]	3	60	40	100
Core	C201	Chemistry - II	T	[2+ 1]	3	60	40	100
Core	M200/ 201	Mathematics –II	T	[2+ 1]	3	60	40	100
Core	P201	Physics– II	T	[2+ 1]	3	60	40	100
Core	G201	Electronics & Instrumentation	T	[2+ 1]	3	60	40	100
Core	PL201	Physics Laboratory – II	P	[4]	2	60	40	100
Core	CL201	Chemistry Laboratory–II	P	[4]	2	60	40	100
Core	BL201	Biology Laboratory–II	P	[4]	2	60	40	100
Core	GL201	Electronics Laboratory	P	[4]	2	60	40	100
Core	H201	Communication Skills Lab	P	[4]	2	60	40	100
				(50 of 240 credits)	**Total= 25**			
Additional Papers								
ES101		Environmental Studies	T	[2]	2	60	40	100

SECOND YEAR

SEMESTER –III

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Core	CB301	Essential mathematics for Chemistry and Biology	T	[3 + 1]	4	60	40	100
Core	CB302	Biochemistry-I	T	[3 + 1]	4	60	40	100
Core	CB303	Organic Chemistry-I	T	[3 + 1]	4	60	40	100
Core	C301	Inorganic Chemistry-I	T	[3 + 1]	4	60	40	100
Core	H301	Creative Hindi	T	[2 + 0]	2	60	40	100
Core	*H302	History and Philosophy of Science	T	[2 + 0]	2			
Core	CL301	Chemistry Laboratory	P	[6]	3	60	40	100
Core	GL301	Applied Electronics Laboratory	P	[4]	2	60	40	100
				(75 of 240 credits)	**Total= 25**			

***H302 is Indian Knowledge System (IKS) Course.**

SEMESTER –IV

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Core	PCB401	Chemical kinetics	T	[3 + 1]	4	60	40	100
Core	CB401	Introductory Spectroscopy (UV-vis, fluorescence, IR, Raman, NMR)	T	[3 + 1]	4	60	40	100
Core	C401	Properties of Matter	T	[2 + 1]	3	60	40	100
Core	C402	Group theory	T	[2 + 1]	3	60	40	100
Core	G401	Statistical Techniques and Applications	T	[3 + 1]	4	60	40	100
Core	CL401	Chemistry Laboratory	P	[6]	3	60	40	100
Core	GL401	Computational Laboratory and Numerical Methods	P	[4]	2	60	40	100
Core	H401	Communication Skills Lab	P	[4]	2	60	40	100
				(100 of 240 credits)	**Total= 25**			

3rd Year

SEMESTER –V

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Core	CB501	Analytical Chemistry	T	[3 + 1]	4	60	40	100
Core	C501	Quantum Chemistry	T	[3+ 2]	5	60	40	100
Core	C502	Inorganic Chemistry II	T	[3 + 1]	4	60	40	100
Core	C503	Organic Chemistry II	T	[3 + 2]	5	60	40	100
Core	G501	Scientific Writing in Hindi	T	[2]	2	60	40	100
Core	CL501	Chemistry Laboratory	P	[10]	5	60	40	100
				(125 of 240 credits)	**Total= 25**			
Skill Enhancement/Value Added Course								
SE	SEL501	English Language for Competence Skills	P	4	2	60	40	100

SEMESTER –VI

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Core	CB601	Biophysical Chemistry	T	[3 + 1]	4	60	40	100
Core	C601	Atomic and molecular spectroscopy	T	[2+ 1]	3	60	40	100
Core	C602	Inorganic Chemistry III	T	[2 + 1]	3	60	40	100
Core	C603	Organic Chemistry III	T	[3 + 1]	4	60	40	100
Core	C604	Nuclear Chemistry	T	[3 + 1]	4	60	40	100
Core	H601	Ethics in Science and IPR	T	[2 + 0]	2	60	40	100
Core	H602	Scientific writing in English	T	[2]	2	60	40	100
Core	CL601	Chemistry Laboratory	P	[6]	3	60	40	100
				(150 of 240 credits)	**Total= 25**			
Skill Enhancement/Value Added Course								
SE	SEL601	Pratiyogi Prikshaon ke liye Hindi Bhasha	P	4	2	60	40	100

FOURTH YEAR

SEMESTER –VII

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Core	C701	Photochemistry	T	[3 + 1]	4	60	40	100
Core	C702	Chemical biology	T	[3 + 1]	4	60	40	100
Core	C703	Organometallics & Bio-inorganic Chemistry	T	[3 + 1]	4	60	40	100
Core	C704	Physical Organic Chemistry	T	[3 + 1]	4	60	40	100
Core	CPGD701	Chemistry PG Dissertation/Project	P	[8]	4	60	40	100
Core	CL701	Advanced Chemistry Laboratory-I	P	[10]	5	60	40	100
				(175 of 240 credits)	**Total= 25**			
Skill Enhancement/Value Added Course								
SE	SEL701	Linux Operating System	P	4	2	60	40	100

SEMESTER –VIII

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Core	C801	Chemistry of Materials	T	[3 + 1]	4	60	40	100
Core	C802	Macro and Supra-molecular chemistry	T	[3 + 1]	4	60	40	100
Core	C803	Reaction Dynamics	T	[3 + 1]	4	60	40	100
Core	C804	Heterocyclic Chemistry	T	[3 + 1]	4	60	40	100
Core	CL801	Advanced Chemistry Laboratory-II	P	[10]	5	60	40	100
Core	CPGD801	Chemistry PG Dissertation/Project	P	[8]	4	60	40	100
(200 of 240 credits)					**Total= 25**			
Skill Enhancement/Value Added Course								
SE	SECL801	Chemdraw	P	4	2	60	40	100

FIFTH YEAR

SEMESTER –IX

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Core	CPGD901	Chemistry PG Dissertation/Project	P	-	20	-	400	400
(220 of 240 Credits)					**Total = 20**			

SEMESTER –X

Course Nature	Subject Code	Subject	Course Type	Contact Hours /Week (Theory + Tutorials)	Credits	Marks		
						CIA	ESE	Total
Elective	CE1	Environmental Chemistry	T	[4 + 1]	5	60	40	100
Elective	CE2	Inorganic Rings, Cages and Clusters	T	[4 + 1]	5	60	40	100
Elective	CE3	Medicinal Chemistry	T	[4 + 1]	5	60	40	100
Elective	CE4	Nanoscience and Technology	T	[4 + 1]	5	60	40	100
Elective	CE5	Surface and Colloidal Chemistry	T	[4 + 1]	5	60	40	100
Elective	CE6	Computational Chemistry	T	[4 + 1]	5	60	40	100
Elective	CE7	Advanced Polymer Chemistry	T	[4 + 1]	5	60	40	100
(220 of 240 credits)					**Total= 20**			

Note- Four papers will be offered as per the availability of instructors and minimum number of interested students taking a course. The subjects will have codes CE1001, CE1002, CE1003, CE1004, CE1005, CE1006 and CE1007.

IKS courses & Skill Enhancement/ Value Added Courses: (Offered to the students of CBS)

The candidates who have joined the 5-Year Integrated M.Sc. Programme in Center for Basic Sciences shall undergo Skill Enhancement Course /Value Added Course (only qualifying in nature).

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
III	H-302 (IKS)	History and Philosophy of Science	T	2	2	60	40	100
V	SEL501	Learning English for competence skills	P	4	2	60	40	100
VI	SEL601	Pratiyogi Prikshaon ke liye Hindi Bhasha	P	4	2	60	40	100
VII	SEL701	Linux Operating System	P	4	2	60	40	100
VIII	SECL801	Chemdraw	P	4	2	60	40	100

Program Articulation Matrix

Following matrix depicts the correlation between all the courses of the program and Program Outcomes

Course Code	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
B101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
C101	√	√	√	x	x	x	x	x	x	√	√	√	√	x	√	√
M101/ MB101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
P101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
G101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
H101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ES101	√	√	√	x	√	√	√	√	x	√	√	√	√	√	√	√
BL101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CL101	√	√	√	x	x	x	x	x	√	√	√	√	√	√	√	√
PL101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
GL101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
B201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
C201	√	√	√	x	x	x	x	x	√	√	√	√	√	x	√	√
M201/ MB201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
P201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
G201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
H201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ES201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
BL201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CL201	√	√	√	√	x	x	√	√	√	√	√	√	√	√	√	√
PL201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

GL201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CB301	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CB302	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CB303	√	√	√	x	x	x	√	x	x	√	√	√	√	x	√	√
C301	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
H301	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
H302	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CL301	√	√	√	x	x	x	√	x	√	√	√	√	√	x	√	√
GL301	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PCB401	√	√	√	x	x	x	√	x	x	√	√	√	√	x	√	√
CB401	√	√	√	√	x	x	√	x	√	√	√	√	√	√	√	√
C401	√	√	√	x	x	x	√	x	x	√	√	√	√	x	√	√
C402	√	√	√	x	x	x	√	x	x	√	√	√	√	x	√	√
G401	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CL401	√	√	√	√	x	x	√	x	√	√	√	√	√	√	√	√
GL401	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
H401	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CB501	√	√	√	√	x	√	x	x	√	√	√	√	√	√	√	√
C501	√	√	√	x	x	x	x	x	x	√	√	√	√	x	√	√
C502	√	√	√	x	x	x	x	x	x	√	√	√	√	x	√	√
C503	√	√	√	x	x	x	x	x	x	√	√	√	√	x	√	√
H501	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CL501	√	√	√	√	x	x	x	x	x	√	√	√	√	√	√	√
CB601	√	√	√	√	x	x	x	x	√	√	√	√	√	√	√	√
C601	√	√	√	x	x	x	x	x	√	√	√	√	√	x	√	√
C602	√	√	√	x	x	x	x	x	√	√	√	√	√	x	√	√
C603	√	√	√	x	x	x	x	x	x	√	√	√	√	x	√	√
C604	√	√	√	√	x	x	x	x	√	√	√	√	√	√	√	√
H601	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
H602	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CL601	√	√	√	√	x	x	x	x	√	√	√	√	√	√	√	√
C701	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
C702	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
C703	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
C704	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CPr701	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CL701	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
C801	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
C802	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

C803	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
C804	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CL801	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CPr801	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CPr901	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CE1	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CE2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CE3	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CE4	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CE5	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CE6	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CE7	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	71	**71**	**71**	**54**	**49**	**50**	**55**	**48**	**61**	**71**	**71**	**71**	**71**	**57**	**71**	**71**
SEL501	√	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√
SEL601	√	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√
SEL701	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SECL801	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

SEMESTERWISE SYLLABUS

Semester - I

Program	**Subject**	**Year**	**Semester**
Int. M.Sc.	Chemistry	1	I
Course Code	Course Title		Course Type
C101	**CHEMISTRY – I**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	2	1	-

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

- The course aims to equip students with deep understanding of Structure and properties of atoms and molecules and gives a brief introduction of physical organic chemistry.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understand the level of atoms and molecules, and to make connections between the rules governing such microscopic particles to what we observe in	**U**

	the macroscopic world.	
2	Analyze and predict the periodic properties of elements, chemical bonding between atoms, molecules and complexes using various bonding theories, including Valence Bond Theory, Crystal Field Theory, and Molecular Orbital Theory.	**An**
3	Understand and learn the metallic and organometallic bonds, their general properties. Coordinate bond- coordination complexes and Physical properties and molecular structures	**Ap**
4	Understand and learn basics of bonding in organic compounds with Inductive and field effects, delocalization –cross conjugation, resonance, aromaticity and Huckel's rule, Resonance and Hyper conjugation and Reaction mechanism:	**U**
5	Learn the general concepts like Oxidation number and oxidation states, Oxidation – reduction reactions and the use of reduction potential	**E**

CL:Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E** Evaluate;**C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	1	3	2	-	3	2	3	1	2	2	3
CO2	3	3	3	-	1	1	3	2	-	3	2	3	3	-	2	3
CO3	3	3	3	-	1	1	3	2	-	3	2	3	2	-	2	3
CO4	3	3	3	-	1	1	3	2	-	3	2	3	2	1	2	3
CO5	3	3	3	-	1	1	3	2	-	3	2	3	2	2	1	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: Chemistry-I (C101)

Unit No.	Topics	No.of Lect.	CO No.
I	**Structure and Properties of atoms: Revisited** **(i)** Atomic spectra, Bohr's theory of atomic structure, Sommerfield's theory for complex electron spin and magnetic quantum number, Pauli exclusion principle, Hund's rule, electron configuration of elements, Sequence of energy levels and Periodic Table. **(ii)** Size of atoms and ions, ionization energy, electron affinity, electronegativity – values by Pauling, Mulliken and Allred-Rochow, Metallic character, variable valency and oxidation states, horizontal, vertical and diagonal relationships in the periodic table. **(iii)** Atomic Nucleus: Fundamental particles, classification of nuclides, nuclear stability, the neutron to proton ratio N/Z, nuclear potential, binding energy, exchange force. Radioactivity and radioactive elements, radioactive decay and decay kinetics.	10	1
II	**Types of Chemical Bonds** The covalent bond, the Lewis theory, Octet rule and its limitations, Shapes of the molecules, Sidgwick – powel theory, Valence shell electron pair (VSEPR) theory, effect of lone pair and electronegativity, isoelectronic principle, examples to apply VSEPR theory, Valence bond theory, Hybridization, Bond length, bond angle & dihedral angle, d-orbital participation in molecular bonding, sigma and pi bonding, Molecular orbital method – Linear combination of atomic orbitals (LCAO), MO treatment for di- and tri-atomic molecules and involving delocalized pi-bonding, Conjugation & aromaticity.	10	2

III	Metallic and organometallic bonds – general properties. Coordinate bond- coordination complexes. Physical properties and molecular structures – polaizability and dipole moments, melting point, solubility and acid-base properties, Intermolecular forces (dipole-dipole interaction) Hydrogen bonding and vander Waals's forces.	10	3
IV	**Reactivity & Mechanism** **(i)** Inductive and field effects and bond dissociation energy. pπ-dπ bonding. Delocalization –cross conjugation, resonance. Aromaticity and Huckel's rule – systems of 4n and 4n+2 electrons, antiaromaticity, Resonance and Hyper conjugation. **(ii)** Reaction mechanism: Types of mechanisms, Arrhenius theory, collision theory, types of reactions, redox reactions, displacement and addition reactions, thermodynamic and kinetic requirements.	10	4
V	**(iii)**General concepts: Oxidation number and oxidation states, Oxidation – reduction reactions and the use of reduction potential, Bronsted acids and bases, gas phase vs. solution acidity, solvent levelling effects, hardness and softness, surface acidity	05	5

Suggested Textsbooks and References

(1) J.D.Lee, Concise Inorganic Chemistry, 4th Edition, ELBS, 1991.
(2) P.W.Atkins, Physical Chemistry, Oxford University Press, 7th Edition, 2006.
(3) G.M.Barrow, Physical Chemistry, 5th Edition, Tata McGraw-Hill, New Delhi, 1992.
(4)R. T. Morrison and R. N. Boyd, Organic Chemistry, Prentice Hall of India.
(5)G.W. Castellan, Physical Chemistry, 3rd Ed. Addison - Wesley/Narosa Publishing House, 1993.

Semester - I

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	1	I
CourseCode	Course Title		Course Type
CL101	**LABORATORY COURSE –I**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	4

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The learning objective is to perform a series of experiments of physical, organic and inorganic chemistry to enhance the understanding of laboratory skills.

Course Outcomes(CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Gain proficiency in a wide range of experimental techniques and calibration of glasswares.	**E**
2	Learn to determine the effect of various factors Strength, hardness of unknown solution and molar volume.	**E**

3	Able to identify carbonyl based functional groups in given organic samples.	**An**
4	Able to identify the different functional groups like amide, alcohol, carbohydrate etc. in given organic samples	**An**
5	Gain practical experience in using paper chromatography for various separation applications, enhancing their analytical and experimental skills in physical chemistry.	**An**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create)

CO-PO/PSO Mapping for the course:

PO CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	1	3	3	1	3	2	3	3	1	2	3
CO2	3	3	3	1	2	1	3	3	1	3	2	3	3	1	2	3
CO3	3	3	3	1	2	1	3	3	1	3	2	3	3	1	2	3
CO4	3	3	3	1	2	1	3	3	1	3	2	3	3	1	2	3
CO5	3	3	3	1	2	1	3	3	1	3	2	3	3	1	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: CL 101: Chemistry Laboratory

Unit No.	Topics	No.of Lectures	CO No.
I	**GENERAL METHODS OF CALIBRATION OF GLASSWARE WITH SPECIAL REFERENCE TO:** 100 ml beaker, 50 ml volumetric flask, Burette, Pipette, Micripipette & Measuring cylinder.	10	1
II	**VOLUMETRIC ANALYSIS**: Strength of unknown solution of NaOH with N/10 oxalic acid, NaOH with N/10 hydrochloric acid, NaOH with potassium hydrogen phthalate by volumetric, hardness of given water sample, strength of unknown solution of magnesium salt solution.	15	2
III	**TO IDENTIFY FUNCTIONAL GROUP:** Carbonyl group based functional groups like carboxylic acid, aldehyde, ketones etc.	15	3
IV	**TO IDENTIFY FUNCTIONAL GROUP:** Glucose, Starch, Methanol, Ethanol, β- napthol, α- napthol, Benzamide, Urea, Thiourea etc.	10	4
V	**GENERAL METHODS OF SEPARATION:** Ni (II) & Co (II) by paper chromatography.	10	5

Suggested Textbooks and References

(1) J. Mendham, R. C. Denny, J. D. Barnes, M. Thomas, B. Sivasakar, Vogel's textbook of Quantitative Chemical Analysis.

(2) J. N Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments.

(3) J. Singh, R.K. P. Singh, J. Singh, L. D. S. Yadav, I. R. Siddiqui, J. Shrivastava. Advanced Practical Chemistry.

(4) J. B. Yadav, Advanced Physical Chemistry

(5)

Semester - II

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	1	II
Course Code	Course Title		Course Type
C201	**CHEMISTRY – II**		**Core**

Credit	Hours Per Week (L-T-P)		
	L	T	P
3	2	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to equip students with a deep understanding of thermodynamics and their laws, Enthalpy, Entropy, phase equilibrium, Clausius – Clapeyron equation, ideal solution, Colligative properties and Chemical equilibrium.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understand and learn thermochemistry and predict the level of enthalpy, heat entropy changes in a phase transition and first law of thermodynamics.	**An**
2	Understand and learn second and third laws of thermodynamics laws with emphasis on practical applications.	**An**
3	Understand and learn the basics of phase equilibrium along with its thermodynamics.	**An**
4	Understand and learn the basics of Ideal Solutions and colligative properties, along with its thermodynamics.	**An**
5	Understand and learn the basics chemical equilibrium along with its thermodynamics.	**An**

CL: Cognitive Levels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate; **C** Create).

CO-PO/PSO Mapping for the course:

PO/CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	1	3	2	-	3	2	3	2	1	1	3
CO2	3	3	3	1	2	1	3	2	-	3	2	3	2	1	1	3
CO3	3	3	3	1	2	1	3	2	-	3	2	3	2	1	1	3
CO4	3	3	3	1	2	1	3	2	-	3	2	3	2	1	1	3
CO5	3	3	3	2	2	1	3	2	-	3	2	3	2	2	1	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: Chemistry II (C201)

Unit No.	Topics	No.of Lectures	CO No.
I	Thermochemistry: Enthalpy, heat of fusion and heat of vaporization, enthalpy of a chemical reaction (heat of combustion, heat of solution, heat of neutralization), enthalpy of formation, standard reaction enthalpy, Hess's law, Kirchhoff's law, bond energy, dissociation energy. Entropy formulation of Second law, entropy change in a phase transition, Trouton's Rule, calculation of absolute (Third law) entropy, entropy change in a chemical reaction.	12	1

II	Free energy functions, criteria for spontaneity and equilibrium of closed systems, variation of Gibbs free energy with pressure and temperature, Gibbs Helmholtz equation, the concept of chemical potential, partial molar quantity, Gibbs Duhem relation.	08	2
III	Phase equilibrium in simple systems: Solid – liquid, liquid – vapour, vapour – solid, phase diagrams – water, carbon dioxide, sulphur, phase equilibrium condition, Gibbs phase rule, Clapeyron equations, Clausius – Clapeyron equation.	08	3
IV	Ideal Solutions, chemical potential of a solute in a binary ideal solution, Raoult's Law, entropy and Gibbs energy of mixing, Colligative properties – freezing point depression, boiling point elevation, osmotic pressure, van't Hoff equation.	07	4
V	Chemical equilibrium: Gibbs energy change of a reaction, standard reaction Gibbs energy, the condition for chemical equilibrium, equilibrium constant, reactions involving gases and pure substances, the Principle of Le Chatelier and applications. (6) Chemical potential of a charged species, electrochemical cell (galvanic and electrolytic), examples of electrochemical cells, half cell potential (electrode potential), Nernst equation.	10	5

Suggested Textsbooks and References:

(1) P.W.Atkins, Physical Chemistry, Oxford University Press, 7th Edition, 2006.
(2) G.W. Castellan, Physical Chemistry, 3rd Ed.Wesley/Narosa Publishing House, 1993.
(3) G.N.Lewis and Randall, Thermodynamics, (Revised by K.S.Pitzer and L.Brewer), International Students Edition, McGraw Hill, 1961.
(4) K. Denbigh, The principles of Chemical Equilibrium.
(5) B. G. Kyle , Chemical & Process Thermodynamics.

Semester - II

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	1	II
Course Code	Course Title		Course Type
CL201	**LABORATORY COURSE –II**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	4

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The learning objective is to perform a series of physical chemistry experiments by minor instruments like conductivity meter, pH-meter, Ostwald viscometer, stalagmometer etc.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Gain practical exposure of some minor instruments like conductivity meter and pH meter etc.	**E**

2	Gain practical exposure of some minor instruments like Ostwald viscometer, stalagmometer etc	**E**
3	Learn to identify the different radicals like Acidic, basic and interfering radicals.	**E**
4	To study the variation in viscocity using some organic solvents	**E**
5	To study the variation in density using some organic solvents.	**E**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create)

CO-PO/PSO Mapping for the course:

POCO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	1	3	2	1	3	2	3	2	1	2	3
CO2	3	3	3	1	2	1	3	2	1	3	2	3	2	1	2	3
CO3	3	3	3	1	2	1	3	2	1	3	2	3	2	1	2	3
CO4	3	3	3	1	2	1	3	2	1	3	2	3	2	1	2	3
CO5	3	3	3	1	2	1	3	2	1	3	2	3	2	1	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: CL201: Chemistry Laboratory

Unit No.	Topics	No.of Lectures	CO No.
I	**DETERMINATION TECHNIQUIES I**: End point of neutralization by the conductometric titration using strong acid & strong base and weak acid & weak base,	10	1
II	**DETERMINATION TECHNIQUIES II**: p*K*a of monobasic acid, molar volume of isopropyl alcohol and ethanol and % composition of mixture of methanol & water by surface tension method.	15	2
III	**TO IDENTIFICATION:** Acidic, basic and interfering radicals in the given inorganic mixture.	15	3
IV	**TO STUDY THE VARIATION OF VISCOSITY:** ethanol & water and methanol & water.	10	4
V	**TO STUDY THE VARIATION IN DENSITY:** of some organic solvents.	10	5

Suggested textbooks and references:

(1) J. Mendham, R. C. Denny, J. D. Barnes, M. Thomas, B. Sivasakar, Vogel's textbook of Quantitative Chemical Analysis.
(2) J. N Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments.
(3) J. Singh, R.K. P. Singh, J. Singh, L. D. S. Yadav, I. R. Siddiqui, J. Shrivastava. Advanced Practical Chemistry.
(4)ACS Journal of Chemical Education
(5)J. B. Yadav, Advanced Physical Chemistry

Semester - III

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	2	III
Course Code	Course Title		Course Type
CB301	**ORGANIC CHEMISTRY – I**		**Core**

Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to equip students with a deep understanding of structural chemistry of organic compounds with an emphasis on electronic structure, reactivity, conformation and stereochemistry, basic organic transformations, reactions mechanisms etc.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain understanding of structural chemistry of organic compounds with an emphasis on electronic structure, reactivity, conformation and stereochemistry.	**E**
2	Students will learn the chemistry of aliphatic compounds (alkanes, cycloalkanes etc.) synthesis, properties and applications.	**An**
3	Students will learn the chemistry of aliphatic compounds (alkynes, alkyl halides, alcohols etc.) synthesis, properties and applications.	**An**
4	Students will learn the chemistry of aliphatic compounds (ether, epoxide, aldehyde and ketones) synthesis, properties and applications.	**An**
5	Students will learn the chemistry of aliphatic compounds (carboxylic acids and derivatives etc.) synthesis, properties and applications.	**An**

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO/CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	2	1	3	1	1	3	2	3	2	-	2	3
CO2	3	3	3	-	2	1	3	1	1	3	2	3	2	-	2	3
CO3	3	3	3	-	2	1	3	1	1	3	2	3	2	-	2	3
CO4	3	3	3	-	2	1	3	1	1	3	2	3	2	-	2	3
CO5	3	3	3	-	2	1	3	1	1	3	2	3	2	-	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: CB 303: Organic Chemistry-I

Unit No.	Topics	No.ofLectures	CO No.
I	**A. Basic concepts - Recapitulation** Hybridisation, formal charge, inductive and resonance effects and their effect on reactivity and acidity and basicity of organic compounds; polar & non polar covalent bonds; homolytic and heterolytic fission, types of reagents- electrophiles and nucleophiles; curly arrow notation; classification of organic reactions.	10	1

II	**B. Chemistry of Aliphatic compounds** **IUPAC nomenclature** of aliphatic and substituted aliphatic compounds and alicyclic compounds **Preparation, structure, properties and reactions of the following classes of compounds.** **i) Hydrocarbons: a) alkanes,** Methods of formation Kolbe reaction, Wurtz reaction, Corey House reaction, decarboxylation of carboxylic acids; Mechanism of halogenation of alkanes, orientation, selectivity & reactivity, product ratio. b) **Cycloalkanes** : Methods of formation and reactivity ; Baeyer's strain theory and its limitation; theory of strainless rings c**) Alkenes:** Elimination reactions ; Saytzeff & Hoffman elimination; Reactions – halogenation reactions- free radical and polar mechanisms. Markownikoff's rule, the peroxide effect, allylic halogenations using NBS; Ozonides/Ozonolysis. epoxidation; hydroboration-oxidation; oxymercuration-demercuration; Oxidation using KMnO4 & OsO4.; polymerization. d**) Dienes:** Structure of butadiene and allene ; 1,2 vs 1,4 addition ; Diels Alder reaction.	14	2
III	**e) Alkynes**: Methods of formation; acidity of alkynes; electrophilic addition to alkynes; hydroboration oxidation; metal ammonia reductions; hydrogenation using Lindlar's catalyst. **ii) Alkyl halides** Preparation, properties and synthetic applications of alkyl halides; SN1 & SN2 reactions (mechanism), E1 and E2 reactions(mechanism); Grignard reagent and its applications. **iii) Alcohols:** Methods of formation; acidity; H-Bonding; reactions of mono; di & trihydric alcohols; Diols as protecting groups.	12	3
IV	**iv) Ethers and epoxides:** Formation & reactions of ethers and epoxides ; ring opening reactions of epoxides under acidic and basic conditions; reaction of epoxides with Grignard & organolithium reagents **v) Aldehdyes & ketones:** Methods of formation of aldehdyes and ketones; Nucleophilic addition reactions with cyanide, ammonia and derivatives of ammonia; acetal formation; oxidation reduction reactions. Meerwin-Pondroff-Verley reduction, Clemmensen reduction, Wolf-Kishner reduction, Aldol condensation reaction, Cannizzaro reaction, Tischenko reaction, haloform reaction, Baeyer-Villiger oxidation, Wittig reaction; Mannich reaction **Aromatic Aldehyde and Ketones:** Preparation via Gattermann, Gattermann-Koch, Vilsmeyer Haack, Rosenmund and Friedel Crafts acylation reactions, Reactions: Claisen-Schmidt, Knovenagel, Perkin, Benzoin condensation and Cannizaro reactions	12	4
V	**vi) Carboxylic acids:** Methods of formation of mono and di carboxylic acids; acidity and factors affecting acidity; reactions of carboxylic acids. **vii)** Carboxylic acid derivatives: Methods of formation of acid chlorides, amides, anhydrides and esters and their interconversions; relative stabilities of acid derivatives; Rosenmund reaction; Hoffmann rearrangement. Aromatic carboxylic acids: Preparation, acidity, interconversion of acid derivatives. **viii)** Nitrogen compounds. a) Nitro alkanes: methods of formation and reactions of aliphatic and aromatic nitro compounds b) Amines: methods of formation; basicity and factors affecting basicity ; reactions of aliphatic amines.	12	5

Suggested textbooks and References:

(1) I. L. Finar, Organic Chemistry, Vol. 1 & 2, ELBS.
(2) R. T. Morrison and R. N. Boyd, Organic Chemistry, Prentice Hall of India.
(3) J. McMurry, Organic Chemistry, Asian Books Pvt. Ptd.
(4) L. G. Wade, Organic Chemistry, Pearson Education
(5) G. Solomons and C. Fryhle, Organic Chemistry, John Wiley & Sons (Asia) Pte Ltd.
(6) J. March, Advanced Organic Chemistry, 3rd Edn. McGraw Hill,1991.
(7) S.H.Pine, Organic Chemistry, 5th Edn., McGraw Hill, 1987

Semester – III

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	2	III
Course Code	Course Title		Course Type
C301	**INORGANIC CHEMISTRY – I**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to equip students with a deep understanding of chemistry of main group elements and to give a detailed account on the fundamental concepts relevant to structure and bonding and their application in different fields.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain understanding of chemistry of hydrogen, and nobel gases. Their occurrence, extraction, properties, and applications will be covered.	**U**
2	Students will learn s-block elements with their occurrence, extraction, properties, and applications. Compounds of s-block elements will also be taught.	**U**
3	Students will be able to learn p-block elements (Group 13, 14) with their occurrence, extraction, properties, and applications. Compounds of p-block elements will also be covered.	**U**
4	Students will be able to learn p-block elements (Group 15, 16) with their occurrence, extraction, properties, and applications. Compounds of p-block elements will also be covered.	**U**
5	Students will learn group 17 elements and their occurrence, extraction, properties, and applications. Polyhalides, interhalogen compounds will also be taught.	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO/CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	2	1	3	1	-	3	2	3	1	-	2	3
CO2	3	3	3	-	2	1	3	1	-	3	2	3	1	-	2	3
CO3	3	3	3	-	2	1	3	1	-	3	2	3	1	-	2	3
CO4	3	3	3	-	2	1	3	1	-	3	2	3	1	-	2	3
CO5	3	3	3	-	2	1	3	1	-	3	2	3	1	-	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: C 301: Inorganic Chemistry I

Unit No.	Topics	No.of Lectures	CO No.
I	**(i) Hydrogen:** Preparation of hydrogen, Isotopes, ortho and para hydrogen, hydrides. **(ii) Rare gases:** Occurrence and recovery of the elements, physical and chemical properties, Clathrate compounds, chemistry of Xenon and xenon fluoride complexes.	8	1
II	**(iii)** Chemistry of s-block elements: a) alkali and alkaline earth metals: Extraction, general physical properties, flame colours ans spectra, Reaction with water, air and nitrogen, oxides, hydroxides, peroxides and superoxides, sulphides, oxysalts, halides and hydrides, oraganic and organometallic compounds. b) Group IIB elements: Zn, Cd, Hg	12	2
III	**(iv)** Chemistry of p-block elements: a) Group IIIA elements: Boron, aluminium, gallium indium and thalium – physical properties, oxidation states and type of bonds, Reactions with other elements, compounds of boron with oxygen and hydrogen. b) Group IVA elements: carbon, silicon, germanium, tin and lead – physical properties, allotropes of carbon, graphite compounds, carbaides, carbonates, carbon cycle, silicates, organosilicons, hydrides, halides and cyanides, cluster compounds.	15	3
IV	c) Group VA elements: Nitrogen, phosphorous, Arsenic, antimony and bismuth – general properties, hydrides, azides, oxides and oxyacids, sulphides and organometallics, fertilizers. d) Group VIA elements: oxygen, sulphur, selenium, tellurium and polonium – general properties, structure and allotropy of the elements, chemistry of ozone, oxides, oxyacids, oxohalides, hydrides and halides, organo derivatives.	15	4
V	e) Group VIIA elements: Fluorine, chlorine, bromine, iodine and Astatine- general properties, oxidizing power, hydrogen halides, ionic and molecular halides, bridging halides, halogen oxides, oxoacids, interhalogen compounds, polyhalides, pseudohalogens and pseudohalides.	10	5

Suggested textbooks and References:

(1) J. E. Huheey, 'Inorganic Chemistry - Principles of Structure and Reactivity' Harper & Row, 1988.
(2) F. A. Cotton and G. Wilkinson, 'Advanced Inorganic Chemistry', John Wiley, 1995.
(3) D. F. Shriver, P.W. Atkins and C.H. Langford, 'Inorganic Chemistry', OxfordUniversity Press, 1991.
(4) F. A.Cotton and G. Wilkinson, Basic Inorganic Chemistry, Wiley Easter, 1978.
(5) J. D. Lee, Concise Inorganic Chemistry, Van Nostrand Reinhold, 1977.

Semester – III

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	2	III
Course Code	Course Title		Course Type
CL301	**Chemistry Laboratory**		**Core**
Credit	HoursPerWeek(L-T-P)		
	L	T	P

3	-	-	6

MaximumMarks	CIA	ESE
100	60	40

Learning Objective (LO):
The course aims to provide an understanding of synthesis of inorganic salts and coordination compounds. Student will also learn to perform gravimetric and volumetric analysis.

Course Outcomes (CO):

CO No.	Expected Course Outcomes- At the end of the course, the students will be able to:	CL
1	Develop proficiency in preparation skills of specific inorganic salts and enhancing their synthesis skills in inorganic chemistry (double salts like potash alum, Mohar salt, Nickel Ammonium Sulphate)	**C**
2	Synthesis of coordination compounds like tetraamine Cupric Sulphate, Hexamminenickel (II) chloride, Hexamine Cobalt (III) Chloride etc.	**C**
3	Synthesis of inorganic compounds like Epsom salt from Magnesium sulphate, Potassium trioxalato chromate (III), Sodium trioxalato ferrate, Cis-Potassium dioxalato di aqua chromate	**C**
4	Synthesis of Ammonium Ferric Sulphate, Potassium Chlorochromate, Lead chromate, Chrome alum	**C**
5	Gain expertise in gravimetric and volumetric estimation from the mixture of barium chloride and zinc oxide using various methods, expanding their knowledge of estimation.	**C**

CL :Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An** Analyze; **E** Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	2	2	2	2	3	2	2	3	2	3	2	1	3	3
CO2	3	3	2	2	2	2	3	2	2	3	2	3	2	1	3	3
CO3	3	3	2	2	2	2	3	2	2	3	2	3	2	1	3	3
CO4	3	3	2	2	2	2	3	2	2	3	2	3	2	1	3	3
CO5	3	3	2	2	2	2	3	2	2	3	2	3	2	1	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: CL301: Chemistry Laboratory

Unit No.	Topics	No.of Lectures	CO No.
I	Preparation of double salts like potash alum, Mohar salt, Nickel Ammonium Sulphate)	15	1
II	Synthesis of coordination compounds like tetraamine Cupric Sulphate, Hexamminenickel (II) chloride, Hexamine Cobalt (III) Chloride etc.	20	2
III	Synthesis of inorganic compounds like Epsom salt from Magnesium sulphate, Potassium trioxalato chromate (III), Sodium trioxalato ferrate, Cis-Potassium dioxalato di aqua chromate	25	3

IV	Synthesis of Ammonium Ferric Sulphate, Potassium Chlorochromate, Lead chromate, Chrome alum	15	4
V	Gravimetric and volumetric estimation from the mixture of barium chloride and zinc oxide using various methods, expanding their knowledge of estimation.	15	5

Suggested textbooks and References:

(1) J. Singh, R.K. P. Singh, J. Singh, L. D. S. Yadav, I. R. Siddiqui, J. Shrivastava. Advanced Practical Chemistry.

(2) G. Raj, Advanced Practical Inorganic Chemistry

Semester – IV

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	2	IV
Course Code	Course Title		Course Type
PCB401	**CHEMICAL KINETICS**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to equip students with a deep understanding of chemical kinetics and its basic principles. Students will also learn unimolecular reactions, complex reactions, chain reactions and catalysis.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain understanding of Basic concepts of chemical kinetics, theories, and fundamental terms.	**Ap**
2	Student will learn various techniques for kinetic measurements for slow and fast reactions.	**Ap**
3	Student will understand factors affecting reaction rates, effect of ionic strength, solvents etc.	**Ap**
4	Students will be able to learn the complex reactions and their kinetic derivations.	**Ap**
5	Student will understand catalysis, their types and kinetics along with surface reactions.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO/CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	3	3	2	-	3	2	3	3	2	2	3
CO2	3	3	3	1	2	3	3	2	-	3	2	3	3	2	2	3
CO3	3	3	3	1	2	3	3	2	-	3	2	3	3	2	2	3

CO4	3	3	3	1	2	3	3	2	-	3	2	3	3	2	2	3
CO5	3	3	3	1	2	3	3	2	-	3	2	3	3	2	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: PCB 401: Chemical Kinetics

Unit No.	Topics	No. of Lectures	CO No.
I	**Basic Concepts:** Rate, order and molecularity of a reaction, Specific rate and specific rate constant, First, second and third order reactions – effect of concentration on reaction rate, rate expressions and integrated form, pseudo-unimolecular, n^{th} order reaction of a single component.	12	1
II	**Kinetic Measurements:** Experimental determination of reaction rates and order of reactions, Integrated rate method, Vant Haff differential rate method, Graphical method, Half life method, Ostwald dilution law method, initial rate as a function of initial concentrations. Order of complex reaction, Steady State approximation method, Equilibrium method, relaxation methods for fast reaction	12	2
III	**Factors Affecting Reaction Rate:** Effect of temperature on reaction rate – Arrhenius equation and activation energy, temperature coefficient theory, overall rate constant, overall activation energy, overall pre-exponential factor, effect of ionic strength on reactions between ions, kinetic salt effect, effect of solvent on ionic reaction, dielectric constant	12	3
IV	**Complex Reactions:** Kinetics of parallel first order reaction, Wegscheider Test, kinetics of reversible reaction/opposing reaction, kinetics of consecutive reaction, kinetics of photochemical reaction, radioactive decay, complex mechanisms involving equilibria.	12	4
V	**Catalysis:** Homogeneous catalysis, basis of catalytic action, catalysis and the equilibrium constant, Michaelis-Menten kinetics, acid base catalysis, the Bronsted catalysis law, negative catalysis and inhibition, heterogeneous catalysis, surface reactions – effect of temperature and nature of surface.	12	5

Suggested textbooks and References:

(i) K.A.Connors,Chemical Kinetics: A Study of Reaction Ratesin Solution, V.C.H.Publications1990.

(ii) K.J.Laidler, Chemical Kinetics, 3rd ed. HarperandRow, 1987.

(iii)J.W. Moore and R. G. Pearson, Kinetics and Mechanisms, John Wiley and Sons, 1981

(iv) Sanjay K.Upadhay,Chemical kinetics and Reaction Dynamics, Springer,2006

(v) Puri, Sharma, Pathania, Principles of Physical Chemistry, Vishal Publishing Co.

Semester – IV

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	2	IV
Course Code	Course Title		Course Type
CB401	**INTRODUCTORY SPECTROSCOPY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to equip students with a deep understanding of various spectroscopic techniques along with their basic principles, applications and interpretation of organic compounds.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain understanding of basics of spectroscopy, interaction of electromagnetic waves with matter.	**E**
2	Students will learn basic principles, instrumentation and interpretation of organic compounds through of UV-Vis spectroscopy and Fluorescence spectroscopy	**E**
3	Students will learn basic principles, instrumentation and interpretation of organic compounds through infrared spectroscopy and Raman spectroscopy.	**E**
4	Understand and apply Nuclear magnetic resonance spectroscopy, its modifications 13C resonance, COSY, NOSY etc to apply for interpretation of molecules.	**E**
5	Understand and apply Mass spectrometry to interpret the structure of molecules.	**E**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**- Create)

CO-PO/PSO Mapping for the course:

PO/CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	2	3	2	3	2	3	3	3	3	3	2	3
CO2	3	3	3	3	2	3	2	3	2	3	3	3	3	3	2	3
CO3	3	3	3	3	2	3	2	3	2	3	3	3	3	3	2	3
CO4	3	3	3	3	2	3	2	3	2	3	3	3	3	3	2	3
CO5	3	3	3	3	2	3	2	3	2	3	3	3	3	3	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: CB401: Introductory Spectroscopy

Unit No.	Topics	No.ofLectures	CO No.
I	**The electromagnetic spectrum:** Nature of electromagnetic radiation. The electromagnetic spectrum and its regions. Frequency, waveno and wavelength: units and conversions. Absorption of electromagnetic radiation. Molecular energy states and quantisation of internal energy. Boltzmann distribution. **Spectroscopic Processes:** Absorption, emission, and scattering of light, reflection, refraction, diffraction, dispersion	10	1
II	**UV-VIS Absorption Spectroscopy:** Principles and instrumentation of spectrophotometers, UV-vis spectroscopy to determine conjugation, UV-visible spectroscopy and electronic transitions, Electronic ground states and excited states in organic molecules: n to pi-star and pi to pi-star transitions, band position and band intensities. **Fluorescence Spectroscopy:** Principles and instrumentation of fluorimeters, Advantage of fluorimetry compared to absorption spectrophotometry, Luminescence and the fate of excited states: timescale of fluorescence and phosphorescence.	12	2

III	**IR -** Principles and instrumentation of Infrared spectroscopy, infrared spectroscopy and molecular vibrational transitions, Simple dispersive IR spectrometer and ovewrview of modern instrumentation, Transmittance and absorbance, Vibrational modes and selection rules, Factors governing the position and intensity of IR bands: effects of variation in reduced mass and force constant, Group frequency and fingerprint regions: use of IR for identification by presence/absence of absorptions characteristic of specific bonds/bond groupings, Interpretation of IR spectra. **Raman Spectroscopy:** Raman Effect and molecular polarizability, Technique and instrumentation, Pure rotational Raman spectra, vibrational Raman spectra, Structure determination from Raman and IR.	14	3
IV	**Nuclear Magnetic Resonance (NMR):** Introduction to Nuclear Magnetic Resonance (NMR) spectroscopy. ^{1}H and ^{13}C NMR, number of signals, integration, chemical shift, splitting of signals, Principles and instrumentation of NMR spectroscopy, Nuclear spin and nuclear magnetism, Energies of nuclear spin states in a magnetic field, Boltzmann population of nuclear spin states and the origin of NMR signals, Applications: Interpretation of simple ^{1}H NMR spectra, Information from: chemical shifts and delta values, peak areas and integration, splitting patterns and spin-spin coupling constants, (n+1) rule and Pascal's triangle, Interpretation of NMR spectra using examples of organic compounds.	12	4
V	**Mass spectrometry:** Introduction to mass spectrometry (molecular mass, accurate mass and isotopes) Principles, ionisation methods (including EI, MALDI, ESI), Molecular ions and fragmentation processes under EI, Mass spectrometry for determining the molecular weight/formula of organic compounds and identify the presence of isotopes.	12	5

Suggested textbooks and References:

(1) D.A. Skoog, D.M. West, F.J.Holler, S.R.Crouch, Fundamentals of Analytical Chemistry, 8th Edition, Thomson (2004).

(2) A.I.Vogel, A text book of Quantitative Analysis, 5th Edition Revised by G.H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, ELBS (1989).

(3) A.K.De, S.M.Khopkar and R.A.Chalmers, Solvent Extraction of Metals, Van Nostrand, Reinhold (1970).

(4) L.R.Snyderand J.J.Kirkland, Introduction to Modern Liquid Chromatography, 2nd Edition, Wiley (1979).

(5) Jose A.C. Broekaert, Analytical Atomic Spectrometry with flames and Plasmas, Wiley-VCH(2002).

(6) John Roboz, Introduction to Mass Spectrometry: Instrumentation and Techniques, Interscience (1968).

Semester – IV

Program	**Subject**	**Year**	**Semester**
Int. M.Sc.	Chemistry	2	IV
Course Code	Course Title		Course Type
C401	**PROPERTIES OF MATTER**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The objective of this course is to understanding of different states of matter, their properties and applications.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain understanding gaseous state, kinetic theory of gases their mathematical application	**U**
2	Student will learn about liquid state and evaluation of their characteristic properties and their applications.	**U**
3	Student will gain understanding of solid state crystals, their characterization techniques, defects in crystals etc.	**Ap**
4	Student will gain an insight of colloidal states, their preparation method and properties.	**U**
5	Student will learn kinetics properties of colloidal state, Donnan equilibrium etc. emulsions	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate ;**C**- Create).

CO-PO/PSO Mapping for the course:

PO/CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	1	3	1	-	3	2	3	1	1	3	3
CO2	3	3	3	1	2	1	3	1	-	3	2	3	1	1	3	3
CO3	3	3	3	2	2	1	3	1	-	3	2	3	1	2	3	3
CO4	3	3	3	2	2	1	3	1	-	3	2	3	1	2	3	3
CO5	3	3	3	2	2	1	3	1	-	3	2	3	1	2	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: C 401: Properties of Matter

Unit No.	Topics	No.ofLectures	CO No.
I	**Gaseous State** a). Perfect gases and gas laws, law of partial pressures and partial volumes, Graham's law of effusion, critical state and determination of the critical constants, continuity of state (b) The kinetic theory of gases, pressure and temperature of a gas, derivation of the gas laws from the kinetic theory, The Boltzmann constant, Maxwell's law of distribution of molecular velocities, (c) Ideal and real gases, deviations of the real gases from the ideal gas laws, collision diameter, vander Waals equation, reduced equation of state, equation of state	12	1
II	The Liquid State: (a) Vapour pressure, determination of vapour pressure, external and internal pressure, boiling point and vapour pressure. Surface tension, measurement of surface tension. Surface tension and vapour pressure, surface tension and temperature, rheochor, parachor. (b) Viscosity, measurement of relative and absolute viscosity, viscosity and temperature, molecular weight from viscosity.	12	2

III	**(i)** The Solid State: (a) Crystalline and amorphous solids, Crystals – Steno's law, Hauy's law, Laws of symmetry. Crystals systems and lattices, Crystals and X-rays, Bragg's method of crystal analysis, Different kinds of crystal structures, methods of crystal analysis, electron diffraction, magnetic properties – diamagnetic and paramagnetic materials. Ionic, covalent, metallic and coordinate bonds. (b) Radius ratio rules and coordination number, close packing. Classification of ionic structures –AX, AX2 and AX3 groups. Lattice Energy, Stoichiometric defects – Schottky and Frenkel. Non-stoichiometric defects– metal excess and metal deficiency.	12	3
IV	Colloids: The colloidal system, preparation of colloidal systems, classification. Lyophobicsols - optical and electrical properties, effect of addition of electrolytes and applied electric field. Determination of zeta potential by electrophoresis and electroosmotic methods. Origin of charge and the mechanism of flocculation – stability of sols. Properties of Lyophilic sols – viscosity and protective action.	12	4
V	Kinetic properties of sols and Brownian motion, Macromolecules – viscosity and molecular weight of polymers, osmotic pressure, The Donnane equilibrium. Sedimentation and ultracentrifuge, scattering of light, Protein sols, association colloids and emulsions	12	5

Suggested textbooks and References:

(1) P.W. Atkins, Physical Chemistry, Oxford University Press,7th Edition, 2006.
(2) G.M. Barrow, Physical Chemistry,5th Edition, Tata McGraw-Hill, New Delhi,1992.
(3) D.A.McQuarrie and J.D. Simon, Physical Chemistry - a molecular approach, Viva Books Pvt.Ltd.(1998).
(4) D.K.Chakrabarty, Adsorption and catalysis by solids, Wiley Eastern,1990.
(5) F.P. Kaneand G.B.Larrabee (Eds.), Characterisation of solid surfaces, Plenum,1978.
(6) A.W.Adamson,Physical Chemistry of Surfaces, 3rd Edn., WileyInterscience,1976.

Semester – IV

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	2	IV
Course Code	Course Title		Course Type
C402	**GROUP THEORY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to equip students with a deep understanding of symmetry and group theory, selection rules, point groups and representation of group.

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understand and learn the symmetry elements and operations.	**Ap**

2	Understand and learn point groups.	**Ap**
3	Learn Platonic Solids & the "Cubic" Groups, "Infinite Groups" Point Groups & Chirality, Point Groups & Dipole Moment.	**Ap**
4	Learn and understand multiplication Tables, Naming Representations (Mulliken Symbols), Subgroups and Super groups	**Ap**
5	Understand and learn representations of Groups, Irreducible Representations, Character Tables.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO /CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	1	2	2	-	3	2	3	2	2	1	3
CO2	3	3	3	2	1	1	2	2	-	3	2	3	2	2	1	3
CO3	3	3	3	2	1	1	2	2	-	3	2	3	2	2	1	3
CO4	3	3	3	2	1	1	2	2	-	3	2	3	2	2	1	3
CO5	3	3	3	2	1	1	2	2	-	3	2	3	2	2	1	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: C 402: Group Theory

Unit No.	Topics	No.of Lect.	CO No.
I	Symmetry Elements and Operations, Pure Rotations (CnRotations), Improper Rotations, Rotation-Reflection (Sn) & Rotation-Inversion (n-bar) Axes.	12	1
II	Point Groups: Low Symmetry Point Groups (C1 ,Ci , Cs), Simple Axial Point groups (c., S4n, Cnv' Cnh), Dihedral Groups (Dn, , Dnd, Dnh)	12	2
III	Platonic Solids & the "Cubic" Groups (Td, Oh , Ih), Derived High Symmetry Groups (T, Th , O, I), The "Infinite Groups" (C∞v and D∞h), Point Groups & Chirality, Point Groups & Dipole Moment.	12	3
IV	Multiplication Tables (i.e., operation 1 followed by operation 2) for point groups. Similarity Transforms, Classes of Symmetry Elements. Naming Representations (Mulliken Symbols), Subgroups and Super groups, Non Commutative Operations.	12	4
V	Representations of Groups, Irreducible Representations, Character Tables. Their derivations and use of their contents. Matrix Representation of Symmetry Operations. The "Full Form" of the Character Table.	12	5

Suggested textbooks and References:

1. F. A. Cotton, "Chemical Applications of Group Theory", 3rd Edition, John Wiley (1990).
2. F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry, , John Wiley.
3 J.E. Huhey, . Inorganic Chemistry Harpes and Row.
4. N.N. Greenwood and A. Earnshow, Chemistry of the Elements Pergamon.
5. E. Catherine, , Alan G. Sharpe , Inorganc Chemistry, Houshecroft
6. Brian W. Pfenning, Principles of Inorganic Chemistry
7. Gary L. Miessler, Donald A. Tarr, Inorganic Chemistry
8. R. Ameta, S. C. Ameta, Chemical Application of Symmetry and Group Theory.
9. A. Vincent, Molecular Symmetry and Group Theory, Willey 2nd Edition.
10. M. Ladd, Symmetry and Group Theory in Chemisty, Horwood Publishing

Semester – IV

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	2	IV
Course Code	Course Title		Course Type
CL401	**Chemistry Laboratory**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	-	-	6

MaximumMarks	CIA	ESE
100	60	40

Learning Objective (LO):

The course aims to equip students with experimental analysis of rate and rate constants of reactions.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Develop experimental expertise in kinetics, catalysis, and reaction rate analysis, including the exploration of factors such as temperature, concentration, catalysts, and solvent effects, providing a foundation for understanding chemical reactions and reaction mechanisms.	**An**
2	Become proficient in the hydrolysis of ethyl acetate catalysed at room temperature and also study on effect of anionic surfactant SDS (sodium dodecyl sulphate) and cationic surfactant CTAB (trimethyl ammonium bromide).	**An**
3	Develop proficiency in the velocity constant of ethyl acetate (Saponification of ester) and also effect of anionic surfactant SDS (sodium dodecyl sulphate) and cationic surfactant CTAB (trimethyl ammonium bromide).	**An**
4	Student will evaluate the equilibrium constant for reaction between Fe^{3+} and thiocynate.	**E**
5	Become proficient in the relative and absolute viscosity of the given liquid at room temperature and also learn find the surface tension by various method.	**An**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	2	3	2	1	3	2	3	2	2	2	3
CO2	3	3	3	1	2	2	3	2	1	3	2	3	2	2	2	3
CO3	3	3	3	1	2	2	3	2	1	3	2	3	2	2	2	3
CO4	3	3	3	1	2	2	3	2	1	3	2	3	2	2	2	3
CO5	3	3	3	1	2	2	3	2	1	3	2	3	2	2	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: CL401: Chemistry Laboratory

Unit No.	Topics	No. of Lectures	CO No.
I	Study on hydrolysis of ethyl acetate catalysed by 1M of HCl at room temperature and also study on effect of anionic surfactant SDS (sodium dodecyl sulphate) and cationic surfactant CTAB (trimethyl ammonium bromide).	20	1
II	Study on the velocity constant of ethyl-acetate by NaOH (saponification of ester) and also study on effect of anionic surfactant SDS (sodium dodecyl sulphate) and cationic surfactant CTAB (trimethyl ammonium bromide).	20	2
III	Study on the saponification of ethyl acetate by NaOH as equal concentration of ester and alkali by conductivity meter.	20	3
IV	KINETIC STUDY: Study on the rate of reaction of ethyl acetate at two different concentrations of acid and the decomposition of H_2O_2 by Fe^{3+} and Cu^{2+} at 35°C.	20	4
V	Study on the relative and absolute viscosity of the given liquid and also surface tension of the given liquid by drop number method at room temperature.	10	5

Suggested textbooks and References:

1. Advanced Physical Chemistry Experiments, Dr. J.N. Gurtu, Amit Gurtu, 7th edition.
2. Advanced Practical Physical Chemistry, J. B. Yadav
3. J. Singh, R.K. P. Singh, J. Singh, L. D. S. Yadav, I. R. Siddiqui, J. Shrivastava. Advanced Practical Chemistry.

Semester – V

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	V
Course Code	Course Title		Course Type
CB501	**ANALYTICAL CHEMISTRY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to equip students with a deep understanding of analytical chemistry, separation techniques, electrochemistry and mass spectrophotometry facilitating molecular structure determination and spectral analysis.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understand and analyze error analysis, classification, propagation, Normal distribution, Tests of Significance and Confidence Limits.	**Ap**

2	Student will gain understanding of solvent extraction and various separation techniques like HPLC, GC, GC MS.	**An**
3	Understand the mass spectrophotometry and its instrumentation including mass analyzer, ion sources. Introduction to various hyphenated techniques of it.	**Ap**
4	Understanding the Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Evolved Gas Analysis (EGA).	**U**
5	Acquire an in-depth understanding of Electrolytic conduction- Various theories, law and applications of conductance measurements, conductometric titrations, activities of electrolytic solutions, ionic strength etc.	**Ap**

CL: Cognitive Levels (**R**-Remember;**U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**- Create).

CO-PO/PSO Mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	3	3	3	1	3	2	3	3	3	2	3
CO2	3	3	3	3	2	3	3	3	1	3	2	3	3	3	2	3
CO3	3	3	3	3	2	3	3	3	1	3	2	3	3	3	2	3
CO4	3	3	3	3	2	3	3	3	1	3	2	3	3	3	2	3
CO5	3	3	3	3	2	3	3	3	1	3	2	3	3	3	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: CB501: Analytical Chemistry

Unit No.	Topics	No.of Lect.	CO No.
I	**(i) Error analysis:** Methods of sampling and associated errors, Classification of errors, Propagation of errors, treatment of errors, Normal distribution, Tests of Significance and Confidence Limits.	10	1
II	**(ii) Separation techniques:** Solvent Extraction Technique: Conventional, Liquid Membranes – Bulk, Supported and Emulsified, Solid Phase Extraction (SPE). Ion Exchange: Conventional, Membranes. Chromatography: Gas chromatography (GC), High Performance Liquid Chromatography (HPLC), Ion chromatography (IC).	10	2
III	**(iii) Mass Spectrometry:** Mass Analysers – Magnetic, Quadrupole, Time of Flight (TOF), Resolution, Ion Sources –Thermal Ionisation (TI), Electron Ionization (EI), Chemical Ionization (CI), FAB, Secondary Ionisation (SI), Matrix Assisted Laser Desorption and Ionisation (MALDI), Hyphenated Technique – IC-MS, HPLC-MS, GC-MS.	10	3
IV	**(iv) Thermal Methods:** Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Evolved Gas Analysis (EGA). **(v)Electrochemical Methods:** Introduction, Potentiometry, Ion Selective Electrodes (ISE), Voltammetry & Polarography , Cyclic, Pulse and Stripping Voltammetry, Coulometry and Amperometry, Scanning Electrochemical Microscopy. **(vi) Detectors**- Photomultiplier Tube (PMT), Charge Coupled Device (CCD), Charge Injection Device (CID), Spectrometers – Czerny Turner, Echelle, Sample Introduction Devices – Flame, Laser Ablation, Direct Sample Insertion Devices, Interferences, detection limits, sensitivity.	15	4
V	**(vii) Conductance of solutions and electrochemistry:** Electrolytic conduction-Arrhenius theory of electrolytic dissociation, strong and weak electrolytes, Migration of ions – transference numbers, Conductance of solutions – electrolytic	15	5

	conductance, determination of conductance, equivalent conductance and concentration, Kohlrausch's law of independent migration of ions, ionic mobilities, temperature dependence, Applications of conductance measurements, degree of dissociation of weak electrolytes, dissociation constants of weak acids, degree of dissociation of water, basicity of organic acids, determination of solubilities of sparingly soluble salts, conductometric titrations, activities of electrolytic solutions, ionic strength, The Debye-Huckel theory of dilute ionic solutions.		

Suggested textbooks and References:

(1) D.A. Skoog, D. M. West, F. J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8th Edition, Thomson (2004).

(2) A.I. Vogel, A text book of Quantitative Analysis, 5th Edition Revised by G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, ELBS (1989).

(3) A. K. De, S. M. Khopkar and R. A. Chalmers, Solvent Extraction of Metals, Van Nostrand, Reinhold (1970).

(4) L. R. Snyder and J. J. Kirkland, Introduction to Modern Liquid Chromatography, 2nd Edition, Wiley (1979).

(5) Jose A. C. Broekaert, Analytical Atomic Spectrometry with flames and Plasmas, Wiley-VCH (2002).

(6) John Roboz, Introduction to Mass Spectrometry: Instrumentation and Techniques, Interscience (1968).

Semester – V

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	V
Course Code	Course Title		Course Type
C501	**QUANTUM CHEMISTRY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

This course aims to apply matrices in quantum chemistry, understand angular momentum concepts, approximate methods like perturbation theory and the variation method for practical quantum chemistry problems, providing students with the tools to address complex chemical systems.

Course Outcomes(CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understand the rules governing the behavior of molecules and atoms the theory of quantum mechanics – and thereby get a feeling for how to explain and predict chemical properties.	**U**
2	The course starts by discussing the fundamental principles of quantum mechanics with an emphasis on the physical implications of this elegant, yet non-intuitive theory. It then applies quantum mechanics to simple model systems and eventually to atoms and molecules.	**Ap**
3	It explores one of the most pervasive concepts in chemistry: the chemical bond. The ideas discussed in this course will be useful to those who wish to pursue further study in the areas of theoretical and computational chemistry,	**U**

	spectroscopy, molecular biology and materials science.	
4	Understand the concept of LCAO, Huckel MOT and angular momentum of may particle systems. MO and VB theory explained to understand the H_2 molecule.	**Ap**
5	Student will learn spin orbital interactions with LS and JJ coupling, spectroscopic term symbols.	**E**

CL:Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	2	1	3	1	-	3	2	3	2	-	1	3
CO2	3	3	3	1	2	1	3	1	-	3	2	3	2	1	1	3
CO3	3	3	3	1	2	1	3	1	-	3	2	3	2	3	1	3
CO4	3	3	3	1	2	1	3	1	-	3	2	3	2	3	1	3
CO5	3	3	3	1	2	1	2	1	-	3	2	3	2	1	1	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus of C-501 (QUANTUM CHEMISTRY)

Unit No.	Topics	No.of Lect.	CO No.
I	Foundations of quantum mechanics, Operator concept in quantum chemistry, Wavepackets and the uncertainty principle, shapes of atomic orbitals.	10	1
II	Wavefunction for a free particle, the Schrodinger equation, physical interpretation of the Schrodinger equation wavefunction, Solution of Schrodinger's equation in some simple systems: one and three dimensional boxes, electron in a ring, rigid rotator, concept of tunnelling, one dimensional harmonic oscillator, hydrogen-like atoms	15	2
III	Approximate methods of quantum chemistry: perturbation and variation method, Time-independent perturbation theory: Many electron sysytems: Orbital approximation, Slater determinant, Hartree-Fock self-consistent field theory; Slater type orbitals.	15	3
IV	Concept of LCAO, Huckel Theory, Huckel MOT, Angular momentum of many-particle systems, Born-Oppenheimer approximation, MO and VB theories illustrated with H2-molecule.	10	4
V	Spin orbital interaction, LS and JJ coupling, Spectroscopic term symbols for atoms, Molecules and Chemical bonding, Directed valence & hybridization in simple polyatomic molecules.	10	5

Suggested texts and References:

(1) Ira N. Levine, Quantum ChemistryPrentice Hall India.
(2) John L. Powell and Bernd Crasemann, Quantum Mechanics, Oxford & IBH Publishing.
(3) A. K. Chandra, Introductory Quantum Chemistry, Tata McGraw-Hill Publishing Comp. Ltd.
(4) David B. Beard, Quantum Mechanics, Allyn & Bacon, Inc, Boston.

Semester – V

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	V
Course Code	Course Title		Course Type
C502	**INORGANIC CHEMISTRY**		**Core**
Credit	Hours Per Week (L-T-P)		

	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):
The objective of this course is to provide a detailed account to the chemistry of different transition series metals and emphasize their relationship to other multidisciplinary topics such as organometallic chemistry.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Chemistry of transition metals group-wise and series-wise. The central theme of this course is to focus on the fundamental concepts.	**U**
2	Course explains about occurrence, separation and extraction of first transition series elements and their application to biology.	**U**
3	Chemistry of second and third transition series and its various applications to different fields.	**U**
4	Transition metal chemistry relevant to their structure, bonding, properties such as spectral characteristics, reactivity, stereochemistry etc.	**U**
5	Chemistry of f-block elements (lanthanide and actinide elements)	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**- Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	-	3	1	-	3	3	3	2	1	2	3
CO2	3	3	3	-	1	1	3	1	-	3	2	3	2	2	2	3
CO3	3	3	3	-	1	1	3	1	-	3	2	3	2	2	2	3
CO4	3	3	3	-	1	1	3	1	-	3	3	3	2	2	2	3
CO5	3	3	3	-	1	1	3	1	-	3	3	3	2	2	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed syllabus: C 502: Inorganic Chemistry II:

Unit No.	Topics	No.of Lect.	CO No.
I	**(i) General introduction to transition elements:** Electronic structure, Metallic character, variable oxidation state, complexes, magnetic and catalytic properties.	12	1
II	**(ii) Elements of the first transition series:** Occurrence, separation, extraction and chemistry of the scandium group (IIIB), titanium Group (IVB), vanadium group (VB), chromium group (VIB), Manganese group (VIIB). Iron group (VIIIB(8)), Nickel group (VIII(9)) and Copper group (VIIIB(10).	12	2
III	**(iii) Chemistry of the elements of the second and third transition series :** Zirconium and Halfnium (Group IVB), Niobium and Tantalum (Group VB), Molybdenum and tungsten (Group VIB), Technetium and Rhenium (GroupVIIB)	12	3
IV	**Chemistry of the elements of the second and third transition series :** Ruthenium and Osmium (Group VIII(8)), Rhodium and Irridium (GroupVIII(9)), Palladium and Platinum(GroupVIII(10),Silver and gold Group(1B(11)).	12	4

V	**Chemistry of f-block elements** – The lanthanide and actinide elements: oxidation state, occurrence, extraction and general properties.	12	5

Suggested textbooks and References:

(1) F.A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley Eastern, John Wiley, 6th Ed., 1999.
(2) J.E. Huheey, E. Keiter and R. Keiter, Inorganic Chemistry, 4th Ed., Harper Collins College Publisher, 1993.
(3) D.Banerjea, Inorganic Chemistry Principles, Books Syndicate Pvt. Ltd., 2000.
(4) N.N. Greenwood and E.A. Earnshaw, Chemistry of Elements, Pergamon Press, 1989.
(5) J.J. Kratz, G.T. Seaborg and L.R. Morss; *The Chemistry of Actinide Elements,* 2nd Edition, Vol. 1&2, Chapman & Hall, New York (1986).
(6) J.C. Bailar, H.J. Emelius, R. Nyholm and A.F. Trotman-Dickenson; *Comprehensive*

Semester – V

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	V
Course Code	Course Title		Course Type
C503	**ORGANIC CHEMISTRY-II**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The objective of this course is to provide a detailed account to the chemistry of different transition series metals and emphasize their relationship to other multidisciplinary topics such as organometallic chemistry.

Course Outcomes(CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	The module is the extension of Organic Chemistry–I and student will gain understanding of Stereochemistry of organic compounds, molecular chirality and elements of symmetry.	**U**
2	Understand the stereoisomerism in olefins, cycloalkanes and oximes. Assigning the stereochemical description R/S to Fisher projection. E/Z nomenclature to olefins.	U
3	Understand the molecular chirality and symmetry of elements. Nomenclature of various organic compounds. Concept of conformation acyclic and acyclic compounds. Stereoselectivity and stereospecific of various organic reactions.	**U**
4	Understand the Mechanism and stereochemical outcome of various reactions include SN1, SN2 and SNi reactions, catalytic hydrogenation of alkenes, ionic trans addition of bromine to alkenes, epoxidation of alkenes, acid catalysed ring opening of epoxides and E2 reactions.	**U**
5	Understand the chemistry of acyclic compounds and their conformations.	**U**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-

Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	2	1	3	2	-	3	2	3	2	2	2	3
CO2	3	3	3	2	2	1	3	2	-	3	2	3	2	2	2	3
CO3	3	3	3	2	2	1	3	2	-	3	2	3	2	2	2	3
CO4	3	3	3	2	2	1	3	2	-	3	2	3	2	2	2	3
CO5	3	3	3	2	2	1	3	2	-	3	2	3	2	2	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed syllabus: C 503: organic Chemistry II

Unit No.	Topics	No.of Lect.	CO No.
I	**(A) Stereochemistry of Organic Compounds (i)** Isomerism – Concept and types **(ii)** Chirality: Configuration, stereogenic/chiral center, chirality and enantiomerism. Representation of configuration by flying wedge formulae and Fischer, Newman and Sawhorse projection formulae. **(iii)** Stereochemistry of carbon compounds with upto three similar and dissimilar asymmetric carbon atoms, enantiomers, diastereomers, and racemic mixtures and their properties, resolution (chemical and chromatographic).	12	1
II	**(iv)** Diastereomerism: Threo, erythro, meso diastereomers, Geometrical isomerism in olefins, cycloalkanes and oximes, Absolute configuration: Assigning of stereochemical descriptors - R/S to Fischer projection and flying wedge formulae of chiral molecules and E/Z to olefins.	12	2
III	**(v)** Molecular chirality and elements of symmetry: Stereochemistry and stereochemical nomenclature of biphenyls, spirans, cummulenes, and alkylidene cycloalkanes. **(vi)** Conformational concepts, conformations of acyclic molecules (ethane and butane), cyclohexane and mono, di-substituted cyclohexanes. Conformationally rigid and mobile diastereomers. **(vii)** Stereoselectivity and stereospecificity of organic reactions: Enantiomeric and diastereomeric selectivities.	12	3
IV	The mechanism and stereochemical outcome of the following reactions: (a) SN^1, SN^2 and SN^i reactions (b) Catalytic hydrogenation of alkenes (c) Ionic trans addition of bromine to alkenes (d) Epoxidation of alkenes, acid catalysed ring opening of epoxides. (e) Reactions of OsO4 and KMnO4 with olefins (f) E2 reactions. (g) Topocity and prostereoisomerism - Enantiotopic and diastereotopic atoms, groups and faces.	12	4
V	**Chemistry of Alicyclic compounds:** Cycloalkanes and cycloalkenes, Factors affecting stability of conformations, conformation of cycloalkanes. Reaction mechanism in alicyclic compound **Conformation of Cyclic System**: Monocyclic compounds and Fused ring and Bridged ring Compound, Neighboring group participation; non-classical carbocataion; Rearrangements of Carbocataion, Free-radical: Allylic, Pinacol/ Pinacolone, 1,2 rearrangements etc and rearrangement to heteroatoms, Chemistry of Carbon radical (Single electron transfer mechanism).	12	5

Suggested textbooks and References:

(1) I. L. Finar, Organic Chemistry, Vol. 1 & 2, ELBS.
(2) R. K. Bansal, Heterocyclic Chemistry, Synthesis, Reactions and Mechanisms, Wiley Eastern Ltd., 1990.
(3) J.A.J. Joule and G.F. Smith, Heterocyclic Chemistry, ELBS, 2nd Ed., 1982.F.G. Riddell, The Conformational Analyis of Heterocyclic Compounds, Academic Press, 1980.
(4) L.A. Paquette, Principles of Modern Heterocyclic Chemistry, W.B. Benjamin, Inc., 1978.

(5) B.M. Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, Interscience, 2nd Ed., 1975.

Semester-V

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	V
Course Code	Course Title		Course Type
CL501	**Chemistry Laboratory**		**Core**
Credit	HoursPerWeek(L-T-P)		
	L	T	P
5	-	-	10

MaximumMarks	CIA	ESE
100	60	40

Learning Objective (LO):

The objectives of this course are to enable students to perform quantitative analysis of metal ions estimation and the extraction of organic compounds from natural sources, while also introducing them to advanced-level instrument-based experiments utilizing techniques such as flame photometer, spectroscopy, tensiometry and more to enhance their practical organic and inorganic chemistry skills.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Develop proficiency in multi-step organic synthesis, including rearrangements and enzymatic reduction, enabling them to synthesize a variety of organic compounds with precision.	**An**
2	Gain expertise in quantitative analysis, with a focus on estimation methods for concentration of K^+ ion and Na^+ ion in given water sample and concentration of Fe in a sample of water using ammonium thiocyanate, enhancing their analytical skills in inorganic chemistry.	**An**
3	Learn to estimate the Saponification of ethyl acetate by sodium hydroxide and potassium hydroxide at equal concentration of ester and alkali at room temperature. using various methods, expanding their knowledge of analysis.	**An**
4	Become proficient in the extraction of organic compounds from natural sources, such as leaves, milk, tobacco, and various foods, allowing them to isolate and identify specific compounds found in these sources.	**An**
5	Introduced to advanced-level experiments utilizing sophisticated instruments like flame photometer, tensiometers, and more, enhancing their practical and analytical skills in the field of organic chemistry.	**An**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO	POs	PSO

CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	3	3	3	2	2	3	3	3	3	2	2	3
CO2	3	3	3	2	3	3	3	2	2	3	3	3	3	2	2	3
CO3	3	3	3	1	3	3	3	2	2	3	3	3	3	1	2	3
CO4	3	3	3	1	3	3	3	2	2	3	3	3	3	1	2	3
CO5	3	3	3	1	3	3	3	2	2	3	3	3	3	1	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: CL501: Chemistry Laboratory

Unit No.	Topics	No.of Lectures	CO No.
I	**QUANTITATIVE ANALYSIS**: concentration of K^+ ion and concentration of Na^+ ion in given water sample by using flame photometer, concentration of Fe in a sample of water using ammonium thiocyanate and concentration of Fe in a sample of water using 1,10 phenanthroline by spectrophotometer.	30	1
II	**Conductometric study** of Saponification of ethyl acetate by sodium hydroxide and ethyl acetate by potassium hydroxide at equal concentration of ester and alkali at room temperature.	30	2
III	**EXTRACTION OF ORGANIC COMPOUNDS FROM NATURAL SOURCES-I:** Isolation of caffeine from leaves. Isolation of Casein from milk. Isolation of lactose from milk.	30	3
IV	**EXTRACTION OF ORGANIC COMPOUNDS FROM NATURAL SOURCES-II:** Isolation of Piperine from black pepper. Isolation Lycopene from tomatoes. Isolation of β–Carotene from carrots.	30	4
V	**Determination** of strength of given HCl solution by titrating it potentiometrically against a solution of sodium hydroxide.	30	5

Suggested textbooks and References:

1. Practical Organic chemistry by A. I. Vogel.
2. Practical Organic chemistry by Mann and Saunders.
3. Practical Organic chemistry by Garg and Salija.
4. The Systematic Identification of Organic compounds, R. L. Shriner and D. Y. Curtin.
5. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J. B. Entrikin and E. M. Hodnett.
6. Practical Physical chemistry by Alexander Findlay.
7. Experimental Physical chemistry, D. P. Shoemaker, G. W. Garland and J. W. Niber, Mc Graw Hill Interscience.
8. Findlay's Practical Physical chemistry, revised B

Semester-VI

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	VI
Course Code	Course Title		Course Type
CB601	**BIOPHYSICAL CHEMISTRY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The objective of this course is to provide a detailed account to the formation of structures in biological systems, explains their basic concepts within statistical thermodynamics and Physical basis of conformation diseases, Therapeutic approaches to protein misfolding diseases**.**

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Gain understanding of different interactions those are important for the formation of structures in biological systems and how thermodynamic parameters can be measured and explains the basic concepts within statistical thermodynamics.	**U**
2	Understand the various hydrodynamic properties, molecular weight determination by sedimentation and diffusion, introduction to ultracentrifugation and dynamic light scattering. Various spectroscopic properties of proteins through UV-Vis, fluorescence and circular dichroism.	**AP**
3	Understand and analyze protein denaturation and stability, Introduction of DSC and ITC. It also includes spectroscopic methods to study of structures, functions and interactions of biomolecules.	**U**
4	Understand the kinetics of protein folding, misfolding and its aggregation, disease causes by protein misfoldings.	**U**
5	Understand and apply introduction to basic principles of protein X-ray crystallography, NMR, Small Angle X-ray scattering (SAXS), and Electron microscopy (EM), ITC (Isothermal titration calorimetry).	**U**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	2	3	3	1	1	3	3	3	3	-	3	3
CO2	3	3	3	3	2	3	3	2	1	3	3	3	3	3	3	3
CO3	3	3	3	2	2	3	3	2	1	3	3	3	3	2	3	3
CO4	3	3	3	2	2	3	3	2	1	3	3	3	3	2	3	3
CO5	3	3	3	3	2	3	2	3	1	3	3	3	3	3	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: CB-601 (Biophysical Chemistry)

Unit No.	Topics	No.of Lect.	CO No.
I	**(i) The Chemistry of Life: An introduction:** Physical properties of water: Structure, water as solvent, The hydrophobic effect, osmosis and diffusion. Introduction to Biomolecules: Nucleic Acid, Protein - Polymer Description of Macromolecular Structure, Intermolecular and Intramolecular forces, Non Covalent Interaction.	12	1
II	**(ii) General principles of Biophysical chemistry I:** Hydrodynamic properties: Diffusion and sedimentation, determination of molecular weight from sedimentation and diffusion; Introduction of Ultra Centrifugation, Dynamic Light Scattering and Electrophoresis. Spectroscopic properties of proteins and nucleic acid: UV/Vis, Intrinsic fluorescence, Circular dichroism.	12	2

III	**(iii) General principles of Biophysical chemistry II**: The concept and application of Chemical and Physical equilibria in Biological system, The equilibrium constant and Standard Gibbs Free energies of reactants and products, Temperature dependence of the equilibrium constant, Double Strand formation in nucleic acid, Ligand-protein binding, Protein denaturation and stability.	12	3
IV	**(iv) Molecular self-assembly and Molecular medicine:** Protein folding kinetics and Biophysical methods, Misfolding and aggregation, Physical basis of conformation diseases, Therapeutic approaches to protein misfolding diseases.	12	4
V	**(v) Introduction to structure biology:** Introduction to basic principles of protein X-ray crystallography, NMR, Small Angle X-ray scattering (SAXS), and Electron microscopy (EM), ITC (Isothermal titration calorimetry).	12	5

Suggested textbooks and References:

(1) Tinoco, Sauer, Wang, and Puglisi. (2003) Physical Chemistry: Principles and Applications in the Biological Sciences. Prentice Hall, Inc.

(2) Physical Chemistry for the Life Sciences: Peter Atkins and Julio de Paula

(3) General review papers Dobson CM. Principles of protein folding, misfolding and aggregation. Semin Cell Dev Biol. 2004 Feb;15(1):3-16.

Semester-VI

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	VI
Course Code	Course Title		Course Type
C601	**ATOMIC AND MOLECULAR SPECTROSCOPY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The course aims to equip students with a deep understanding and analyze electromagnetic radiation-matter interactions, covering absorption, emission, transmission, and scattering, and apply these principles to understand rotational, vibrational, and electronic energy levels across the electromagnetic spectrum, particularly in microwave, infrared, and Raman spectroscopy, facilitating molecular structure determination and spectral analysis.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain understanding of structure, property and interaction of molecules.	**Ap**
2	Understand the rotation of molecule, Rotational spectra of polyatomic molecules, techniques and instrumentation of microwave spectroscopy.	U
3	Understand and apply infrared spectroscopy concepts, covering oscillators, diatomic-vibrating rotators, polyatomic vibrations, Fourier Transform instrumentation, and interpretation of diverse compound spectra.	**Ap**
4	Understanding the classical and quantum theories of Raman effect, molecular polarizability, Techniques and instrumentation of Raman Spectroscopy, detemination of structure from this, about near IR FT Raman Spectroscopy, electronic transitions and applications.	**U**

5	Student will gain understanding of basic principles, instrumentation and applications of EPR and Mossbauer for metal ions.	**Ap**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	2	1	3	1	-	3	2	3	3	-	2	3
CO2	3	3	3	3	2	3	3	2	1	3	3	3	3	3	2	3
CO3	3	3	3	3	2	3	3	2	1	3	3	3	3	3	2	3
CO4	3	3	3	3	2	3	3	2	1	3	3	3	3	3	2	3
CO5	3	3	3	3	2	3	2	2	1	3	3	3	3	3	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed syllabus: C 601: Atomic and molecular Spectroscopy

Unit No.	Topics	No.of Lect.	CO No.
I	**(i)** Born-Oppenheimer approximation - rotational, vibrational and electronic energy levels of homonuclear and heteronuclear diatomic and polyatomic molecules.	10	1
II	**(ii)** Microwave Spectroscopy: Rotational of molecules and rotational spectroscopy of rigid diatomic molecules, Effect of isotopic substitution, non-rigid rotator and rotational spectra, Rotational spectra of polyatomic molecules – linear, symmetric and asymmetric top molecules, Techniques and instrumentation.	10	2
III	**(iii)** Infrared spectroscopy: energy levels of vibrating diatomic molecule, simple harmonic oscillator and anharmonic oscillator, diatomic vibrating rotator, vibration-rotation spectra of CO. Breakdown of B-O approximation – interaction of rotations and vibrations. Vibrations of polyatomic molecules – Fundamental vibrations and their symmetry, overtone and combination frequencies, influence of rotation on the spectra of polyatomic molecules – linear and symmetric top molecules. Influence of nuclear spin. Group frequencies and analysis of spectra, Techniques and instrumentation, FTIR spectroscopy.	15	3
IV	**(iv)** Raman Spectroscopy: Classical and quantum theories of Raman effect and molecular polarizability. Pure rotational Raman spectra, Vibrational Raman spectra, Polarization of light and the Raman effect, Structure determination from Raman and infrared spectroscopy, Techniques and Instrumentation, Near IR FT Raman spectroscopy. Resonance Raman and electronic Raman transition and applications.	10	4
V	**(v)** Electronic spectroscopy – Electronic structure and spectra of diatomic and polyatomic molecules, Techniques and instrumentation, Molecular photoelectron spectroscopy. **(vi)** Electron spin resonance spectroscopy - spin and spectra, relaxation processes, origin of g-shifts and hyperfine coupling, Kramer's degeneracy, ESR of transition metal complexes, Application of ESR Spectra	15	5

Suggested textbooks and References:

(1) G. M. Barrow, Molecular spectroscopy
(2) C.N. Banwell and E. M. McCash, Fundamentals of Molecular spectroscopy, Tata McGraw HillPub. Co.New delhi
(3) J. D. Graybeal, Molecular Spectroscopy, McGraw Hill International Book Co. N.Y.
(4) Puri, Sharma, Pathania, Principles of Physical Chemistry, Vishal Publishing Co.

Semester-VI

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	VI
Course Code	Course Title		Course Type
C602	**INORGANIC CHEMISTRY III**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The course aims to equip students with a deep understanding of, metal-ligand bonding theories, and the chemistry of f- block elements, including metal clusters and unique ring structures.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain detailed understanding of chemistry of transition metals group-wise and series-wise. The central theme of this course is to focus on the application part of coordination chemistry.	**U**
2	Analyze and predict the properties of transition metal complexes using various bonding theories, including Valence Bond Theory, Crystal Field Theory, and Molecular Orbital Theory, Jahn-Teller distortion and metal complexes.	**An**
3	Understanding of d-orbital splitting in various fields, Tanabe-Sugano diagram, Orgel diagram, ligand field parameter and spin orbit coupling.	**U**
4	Transition metal chemistry relevant to their structure, bonding, properties such as spectral characteristics, reactivity, stereochemistry etc. Chemistry of f-block elements (lanthanide and actinide elements)	**U**
5	At the end of this course, students will also learn about the role of transition metals in several other fields like materials science, biology and catalysis.	**U**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C-** Create).

CO-PO/PSO Mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	2	1	3	2	-	3	2	3	3	-	2	3
CO2	3	3	3	-	2	2	3	2	-	3	2	3	3	1	2	3
CO3	3	3	3	1	2	2	3	2	-	3	2	3	3	1	2	3
CO4	3	3	3	1	2	2	3	2	-	3	2	3	3	1	2	3
CO5	3	3	3	1	2	3	3	2	-	3	2	3	3	1	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed syllabus: C 602: Inorganic Chemistry III

Unit No.	Topics	No.of Lect.	CO No.
I	**(i)** Coordination compounds, Werners's theory, effective atomic number, coordination number, shapes of d-orbitals and bondingin transitionmetalcomplexes,stabilityofcomplexes,thechelatesandmacrocycliceffects,typesofclassificationofligands,secondsphere of coordination, π-complexes,π-acid ligands, multiple bonds from ligands to metals.	10	1
II	**(i)** Crystal Field theory – crystal filed splitting and elementary treatment of the electronicspectra, Jahn-Teller distortion of octahedral complexes, square planar complexes, tetrahedral complexes, magnetic properties of 3*d* compounds.	10	2
III	**(ii)**MO theory, Nomenclature of coordination compounds, d-orbital splitting in various fields -Spectroscopic states, Tanabe-Sugano and Orgel diagrams , Derivation of Ligand field parameters(Dq. B) from electronic spectra, Magnetic moments ,Orbital contribution, spin-orbit coupling and covalency.	15	3
IV	Stability of Co-ordination Complexes **–** Thermodynamic and kinetic stability, Chelate effect, nature of metal ions**,** Isomerism in coordination compounds – structural and stereoisomers, optical isomerism.	15	4
V	**(iii)**Reaction mechanisms: Substitution reactions - Dissociative and associative interchange -trans-effect - Linear free energy relations. Rearrangements - Berry pseudo rotation, Electron transfer reactions. Photo-dissociation, substitution and redox reactions, Fluxional molecules	10	5

Suggested textbooks and References:

(1) F.A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley Eastern, JohnWiley, 6th Ed., 1999.

(2) J.E. Huheey, E. Keiter and R. Keiter, Inorganic Chemistry, 4th Ed., Harper Collins CollegePublisher,1993.

(3) D. Banerjea, Inorganic Chemistry Principles, Books Syndicate Pvt.Ltd.,2000.

(4) N.N.Greenwoodand, E.A.Earnshaw, Chemistry of Elements,PergamonPress,1989.

(5) J.J. Kratz, G.T. Seaborg and L.R. Morss; *The Chemistry of Actinide Elements,* 2nd Edition, Vol.1&2, Chapman & Hall, New York(1986).

(6) J.C.Bailar,H.J.Emelius,R.Nyholm andA.F.Trotman-Dickenson;*Comprehensive*

Semester-VI

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	VI
Course Code	Course Title		Course Type
C603	**ORGANIC CHEMISTRY III**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):
The objective of this course is to provide students an understanding of natural product chemistry such as terpenoids, carotenoids, alkaloids, steroids, and plant pigments, including their classification, structure determination, isolation, synthesis, and the role they play in plants.

Course Outcomes(CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain understanding of basics, classification and role of several natural products along with their stereochemical aspects and their characteristics reactions.	**U**
2	Gain a deep understanding of the chemistry and properties of steroid and bile salts, estrogens, androgen, gestigens and adrenocortical hormones along with their isolation, synthesis, and physiological roles.	**U**
3	Characteristic reactions of alkaloids, method of their degradation and understanding its chemistry.	**U**
4	Student will explore plant pigments, understanding occurrence, nomenclature, and structure determination, while isolating and synthesizing various compounds.	**U**
5	Apply and understand the Carbohydrates: Stereochemistry, reaction and conformation and Chemistry of Chemistry of vitamins A, B, C and E.	**AP**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C** Create).

CO-PO/PSO Mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	2	3	1	-	3	2	3	3	2	3	3
CO2	3	3	3	-	1	2	3	1	-	3	2	3	3	2	3	3
CO3	3	3	3	-	1	2	3	1	-	3	2	3	3	2	3	3
CO4	3	3	3	-	1	2	3	1	-	3	2	3	3	2	3	3
CO5	3	3	3	-	1	2	2	1	-	3	2	3	3	2	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed syllabus: C 602: Organic Chemistry III

Unit No.	Topics	No.of Lect.	CO No.
I	Chemistry of Natural Products: **Terpenoids:** Classification, structure, chemistry and biogenesis of some important mono; sesqui,di, and triter penes.	12	1
II	**Steroids:** Sterols and bile acids, estrogens, androgens, gestogens and adrenocortical hormones. Hormone production. Cardiac glycosides. Steroidal triterpenes; biogenesis of steroids and correlation with terpenoids.	12	2
III	**Alkaloids:** Characteristic reactions, general methods of degradation, structure and chemistry of some well-known alkaloids.	12	3
IV	**Natural Pigments:** anthocyanines, Flavones, flavanones, isoflavones, xanthones, quinones, pterins, chlorophyll and haemin.	12	4
V	**Carbohydrates:** Stereochemistry, reaction and conformation of monosaccharides, deoxy and aminosugars, hexonic acid and vitamin C, disaccharides, polysaccharides, inositol; gan- gliosides and other glycosides. Chemistry of vitamins A, B, C and E.	12	5

Suggested textbooks and References:

(1) I. L. Finar, Organic Chemistry, Vol. 1 & 2, ELBS.
(2) J.Singh, S. M. Ali, J.Singh, Natural Products Chemistry.
(3) J. Mann, R. S. Davidson, J. B. Hobbs , Natural Products: Chemistry and Biological Significance.
(4) B. A. Bhom , Introduction to Flavonoids, , Harwood Academic Publishers.
(5) Att-ur-Rahman and M. I. Choudhary , New Trends in Natural Product Chemistry, Harwood, Academic Publishers.
(6) Insecticides of Natural Origin, Sukh Dev, Harwood Academic Publishers.

Semester-VI

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	3	VI
Course Code	Course Title		Course Type
C604	**NUCLEAR CHEMISTRY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):
The aim of this course is to empower students with in-depth understanding of, nuclear theory, nuclear fission, nuclear energy, and applied radiochemistry, enabling them to comprehend the principles, applications, and advanced concepts in these diverse fields of chemistry.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain understanding of fundamental nuclear particles, nuclear structure, stable and unstable atomic nuclei, nuclear reactions. Different type's nuclear models and their features with nuclear reactions and their energies.	**U**
2	Nuclear structure, stable and unstable atomic nuclei, different modes of radioactive decay and also methods for measurements of radioactivity.	**U**
3	Understanding of nuclear theory, fission, and energy, covering nuclear structure, reactions, reactor applications and radiochemistry.	**Ap**
4	Understand the interaction of radiation with matter and various radiolytic events.	**U**
5	Understanding and application of various nuclear methods like activation and ion beam analysis.	**U**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create)

CO-PO/PSO Mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	2	2	3	1	-	3	3	3	3	-	2	3
CO2	3	3	3	1	2	3	3	2	-	3	3	3	3	1	2	3

CO3	3	3	3	1	2	3	3	2	-	3	3	3	3	1	2	3
CO4	3	3	3	3	2	3	3	2	2	3	3	3	3	3	2	3
CO5	3	3	3	3	2	3	3	3	2	3	3	3	3	3	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed syllabus: C 604: Nuclear Chemistry

Unit No.	Topics	No.of Lect.	CO No.
I	**Nuclear Stability:** Concept of nucleus and properties, nuclear mass and binding energy, elemental abundance, radioactive decay laws and equilibria. Nuclear Models: Liquid drop model, Shell model, Fermi gas model, concept of spin, parity and magnetic moments.	12	1
II	**Modes of Decay:** α decay, β decay, electron captures, γ de-excitation, internal conversion, artificial radioactivity. **Nuclear reactions:** Energetics, cross-section, centre of mass system, angular momentum, compound nucleus, statistical model, nuclear fission and fusion, nuclear reactors, Heavy ion induced reactions, Accelerators.	12	2
III	**Applications of radioactivity:** Probing by isotopes, preparation of radioisotopes, Szilard-Chamers' reaction, Concept of tracers, chemical yield, radiochemical purity, Application of radiotracers in Chemical Sciences, uses of nuclear radiations, radioisotopes as a source of electricity.	12	3
IV	**Elements of Radiation Chemistry:** Interaction of radiation with matter, radiation dosimetry, radiolysis of water and some aqueous solutions, other radiolytic events. **(vi) Nuclear Methods:** Activation Analysis – Neutron Activation Analysis (NAA), Charged Particle Activation Analysis (CPAA), X-ray fluorescence (XRF) spectrometry.	12	4
V	**Ion Beam Analysis** – Backscattering Spectrometry (BS), Particle Induced γ-ray Emission (PIGE), Nuclear Reaction Analysis (NRA), Elastic Recoil Detection Analysis (ERDA), Particle Induced X-ray Emission (PIXE).	12	5

Suggested textbooks and References:

(1) G. Friedlander, J. Kennedy, Nuclear and Radiochemistry (1981) –J. M. Miller and J. W. Macias
(2) R. D. Evans, Atomic Nucleus (1955)
(3) S. Glasstone, Source book of Atomic Energy (1969)
(4) G. T. Seaborg, Man made elements (1963).
(5) H. J. Arnikar, Essentials of Nuclear Chemistry (1982).
(6) C. Keller, The Chemistry of Transuranium Elements (1971).
(7) J.C. Bailar, H.J. Emelius, R. Nyholm and A.F. Trotman-Dickenson; Comprehensive Inorganic Chemistry, Vol. 5, Pergamon Press, Oxford (1973).
(8) K. H. Lieser, Nuclear and Radiochemistry Fundamentals and applications, VCH Wiley Company (1997)

Semester-VI

Program	Subject	Year	Semester
Int.M.Sc.	Chemistry	3	VI
Course Code	Course Title		Course Type
CL601	**Laboratory Course - VII**		Core
Credits	Hours Per Week (L-T-P)		
	L	T	P

3	-	-	6

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The objectives of this course are to provide students with the essential skills and enable students to perform multi-step inorganic synthesis of various compounds, construction of phase diagram, determination of CMC and metal of given water sample, while also introducing them to advanced-level instrument-based experiments utilizing techniques such as analytical techniques. tensiometry, and more to enhance their practical organic chemistry skills.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Students will expertise in the determination of total alkalinity in various water samples.	**An**
2	Learn to estimate the CMC (Critical Micelle Concentration) of surfactant by surface tension and conductivity technique.	**An**
3	Spectroscopic determination of metals in given water samples using diathiozone.	**An**
4	Become proficient in the determination of acid dissociation constant of methyl red using spectroscopy and expanding their knowledge of physical chemistry skills.	**Ap**
5	Introduced to advanced-level experiments utilizing sophisticated instruments like spectroscopy, tensiometers, and more, enhancing their practical and analytical skills in the field of organic chemistry.	**Ap**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E** Evaluate;**C** Create).

CO-PO/PSO Mapping for the course:

PO CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	3	3	3	2	1	3	2	3	3	1	2	3
CO2	3	3	3	2	3	3	3	2	1	3	2	3	3	2	2	3
CO3	3	3	3	2	3	3	3	2	1	3	2	3	3	2	2	3
CO4	3	3	3	2	3	3	3	2	1	3	2	3	3	2	2	3
CO5	3	3	3	2	3	3	3	2	1	3	2	3	3	2	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: **CL601: Chemistry Laboratory**

Unit No.	Topics	No.of Lectures	CO No.
I	**Determination**: Total alkalinity in a given water sample, acidity, turbidity and other parameters of water.	18	1
II	**Determination** of some metals like Lead (Pb), Molybdenum (Mo) and others in given water sample using solvent extraction method.	18	2

III	**Determination**: CMC (Critical Micelle Concentration) of surfactants by surface tension and conductivity method.	18	3
IV	**Determination**: Acid dissociation constant of methyl red by spectroscopic method.	18	4
V	**Analysis:** Quantitative analysis of transition metals by UV-vis spectroscopy.	18	5

Suggested textbooks:

(1) J. Mendham, R. C. Denny, J. D. Barnes, M. Thomas, B. Sivasakar, Vogel's textbook of Quantitative Chemical Analysis.
(2) J. N Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments.
(3) J. Singh, R.K. P. Singh, J. Singh, L. D. S. Yadav, I. R. Siddiqui, J. Shrivastava. Advanced Practical Chemistry.

Semester-VII

Program	**Subject**	**Year**	**Semester**
Int. M.Sc.	Chemistry	4	VII
Course Code	Course Title		Course Type
C701	**Photochemistry**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The aim of this course is to understand and to gain knowledge of photophysical and photochemical processes, reaction mechanisms, principles in the context of various chemical systems.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	How light can take a major role in many natural and chemical processes. Here the students will also get through knowledge about excited state processes (e.g. fluorescence, phosphorescence etc.) and the importance of the above mentioned processes in all fields of science.	**U**
2	Understanding of photochemistry of organic and inorganic compounds.	**U**
3	Understanding of process of photosynthesis, photochemistry of vision, atmospheric photochemistry, about solar energy conversion.	**U**
4	The course also covers organic photochemistry and describes photochemistry of, pericyclic reactions and sigmatropic reactions.	**U**
5	Understanding the photochemistry of inorganic compounds, photoelectrochemistry of excited state redox reactions and ligand field photochemistry of dn complexes.	**U**

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	2	3	3	1	2	3	3	3	3	2	3	3
CO2	3	3	3	1	2	3	3	3	2	3	3	3	3	1	3	3
CO3	3	3	3	-	2	3	3	1	1	3	2	3	3	-	3	3
CO4	3	3	3	-	2	3	3	2	1	3	2	3	3	-	3	3
CO5	3	3	3	-	2	2	3	2	1	3	2	3	3	-	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: C701 PHOTOCHEMISTRY

Unit No.	Topics	No.of Lect.	CO No.
I	**Basic Principles of photochemistry:** **Photophysical processes:** Deexcitation processes for the excited molecules (fluorescence, phosphorescence, delayed emission, nonradiative relaxation, excimer and exciplex formation, heavy atom effect, etc.). Kinetics of excited state processes and quantum yields of different processes.	12	1
II	**Photoinduced processes:** Photo-dissociation, photo-ionization, intramolecular charge and proton transfer processes, intermolecular electron and proton transfer reactions, intra and intermolecular energy transfer processes **Applications of photochemistry:** Photosynthesis, vision, solar energy conversion, atmospheric photochemistry, etc.	12	2
III	**Organic Photochemistry** Distinctive features of photochemical reactions, Photochemistry of alkenes, geometrical isomerism, electrocyclic processes, sigmatropic shifts, di-π methane reactions, cycloaddition and oxidative reactions.	12	3
IV	**Photochemistry of aromatic compounds**: bond cleavage and hydrogen abstraction reactions, cycloaddition reactions, rearrangements of cyclo-hexenones and cyclo-hexadienones, thiocarbonyl compounds, Photochemistry of other organic compounds – imines, imminium salts, nitriles and nitrocompounds, azo and diazocompounds, diazoniumsalts, sulphur and halogenated compounds, photohalogenation and photonitrosation reactions. Photooxidation of alkanes, photochemistry of carbonyl compounds.	12	4
V	**Inorganic Photochemistry** Introduction to inorganic photochemistry. Photophysical processes, The electronic absorption spectra of inorganic compounds, Characteristics of the electronically excited states of inorganic compounds, Photoelectochemistry of excicted state redox reactions, Photosensitization, Photochemical reactions; substitution, decomposition and fragmentation, rearrangement and redox reactions, Ligand field photochemistry of d^n complexes.	12	5

Suggested texts and References:

(1) K.K.Rohatagi Mukherjee, Fundamentals of Photochemistry,WileyEastern,1978.

(2) M.S.Wrighton, InorganicandOrganometallic photochemistry,ACSPub.,1978.

(3) V. Balzani and V. Carasiti, Photochemistry of Co-ordination compounds, Academic Press,1970.

(4) J.D.Coyle, Introduction to Organic Photochemistry, ISBN

(5) A. Cox and T. Camp, Introductory Photochemistry McGraw-Hill

(6) R.P. Kundall and A. Gilbert, Photochemistry, Thomson Nelson.

(7) J. Coxon and B. Halton, Organic Photochemistry, Cambridge University Press.

Semester-VII

Program	Subject	Year	Semester

Int. M.Sc.	Chemistry	4	VII
Course Code	Course Title		Course Type
C703	**Organometalics and Bioinorganic Chemistry**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The objective of this course is to understand the Concept of organometallic compounds involved in various biological processes and role of metal as catalysts in various biological reactions.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	This course will help to explore the inorganic chemistry behind the requirement of biological cells for metals such as zinc, iron, copper, manganese, and molybdenum.	An
2	Understanding of structure and bonding in organometallic compounds.	U
3	The reactivity of coordination complexes of metal ions will be discussed in the context of the reaction mechanisms of specific metalloenzymes.	U
4	Understand the concept of catalysts, transition metal carbine complexes its structure, preparation.	U
5	Understanding the biochemistry of iron and other metals and its role in biology.	Ap

CL: Cognitive Levels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	3	3	2	2	3	3	3	3	3	3	3
CO2	3	3	3	1	2	2	3	2	1	3	2	3	3	1	3	3
CO3	3	3	3	-	2	3	3	2	1	3	2	3	3	-	3	3
CO4	3	3	3	2	2	2	3	2	2	3	3	3	3	2	3	3
CO5	3	3	3	2	2	3	3	2	2	3	3	3	3	2	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: C703 ORGANOMETALICS AND BIOINORGANIC CHEMISTRY

Unit No.	Topics	No.of Lect.	CO No.
I	**Organometallics:** Overview, 18-electron rule, square planar complex, Carbonyl ligand – bonding, binary carbonyl complexes, oxygen-bonded carbonyls, other ligands similar to CO, IR spectrum, main group parallels with binary carbonyl, Pi-ligands – linear and cyclic pi systems, NMR spectra of organometallic complexes.	12	1

II	Structure and bonding of metal alkyls and aryls, complexes with π acids, CO and related ligands, complexes with olefins, acetylenes and related unsaturated molecules, catalytic properties of mononuclear compounds, boranes, carboranes and metallocarboranes, bimetallic and cluster complexes.	12	2
III	Complexes containing M – C, M= C, M ≡ C bonds, hydride and dihydrogen complexes, phosphines and related ligands. Organometallic reactions occurring in metal – ligand substitution, oxidative addition, reductive elimination, Organometallic reactions involving modification of ligands –insertion and deinsertion, nucleophilic addition to ligands, nucleophilic abstraction, electrophilic reactions.	12	3
IV	Homogeneous catalysis and heterogeneous catalysis, use of transition metal complexes, hydroformylation reaction, Walker-Smidt synthesis of acetaldehyde, hydrogenation, Monsanto acetic acid process, Transition metal carbine complexes – structure, preparation and chemistry, metathesis and polymerization reactions.	12	4
V	Bio-inorganic chemistry - biochemistry of iron - its storage, transport and function, copper and zinc proteins, biological activation of oxygen, bioinorganic chemistry of alkali and alkaline earth metal cations, photosynthesis, nitrogen fixation, toxicity of metals. Chemistry aspects of metal complexes, Spectral, biochemical and biological methods used in bioinorganic chemistry, Role of metal ions in biology : Proteins and enzymes of V, Mn, Fe, Co, Ni, Cu, Zn and Mo. Structural and functional models. Bioinorganic chemistry of Na^+, K^+, Ca^{++}, Mg^{++}, Carcinogenicity of chromium and selenium in biology.	12	5

Suggested textbooks and References:

(1) G.O.Spessard, G.L.Miessler, Organometallic Chemistry, Prentice Hall, 1997.
(2) C.Elsehenbroich and A. Salzer, Organometallic Chemistry, 2nd Ed., Wiley VCH, 1992.
(3) F.A.Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, 6th Edn. Wiley, 1999.
(4) N.N.Greenwood and A. Earnshaw, Chemistry of the Elements, lst Edn., Pergamon, 1985.
(5) S.J.Lippard & J.M.Berg, Principles of bioinorganic chemistry, University Science Books, Mill Valley, 1994.
(6) I. Bertini, H.B.Gray, S.J.Lippard and J.S.Valentime, Bioinorganic Chemistry, Univ. Sci. Books, Mill Valley, 1994.
(7) James A.Cowan, Inorganic Biochemistry, VCH Publishers, 1993.

Semester-VII

Program	**Subject**	**Year**	**Semester**
Int. M.Sc.	Chemistry	4	VII
Course Code	Course Title		Course Type
C704	**Physical Organic Chemistry**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The main objective of this course is to understand the fundamental concepts of structure and

function in organic reactions, also about their kinetics and thermodynamics.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understanding the concept of LCAO, concept of basic bonding in reactive intermediate, Huckel Theory, Huckel MOT in cyclic, acyclic pi-systems, aromatic and antiaromatic pi systems.	U
1	Understand the thermochemistry of stable molecules and reactive intermediate, concept of acid base chemistry.	U
2	Fundamental concepts of structure and function in organic reactions.	U
3	Learn the use of kinetics and thermodynamics to elucidate mechanisms of reactions will be dealt with.	E
4	At the end of this course, students will be in a position to predict reactivity patterns and propose reasonable mechanisms.	Ap

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	2	1	3	2	2	3	2	3	3	2	2	3
CO2	3	3	3	-	2	1	3	2	1	3	2	3	3	-	2	3
CO3	3	3	3	-	2	1	3	2	2	3	2	3	3	-	2	3
CO4	3	3	3	2	2	1	3	2	2	3	2	3	3	2	2	3
CO5	3	3	3	-	2	1	3	2	2	3	2	3	3	-	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: C704 PHYSICAL ORGANIC CHEMISTRY

Unit No.	Topics	No.of Lect.	CO No.
I	**Structure and Models of Bonding:** Basic Bonding Concepts, Bonding and Structure of Reactive Intermediates, Molecular Orbital Theory, electron in a box problem, energies and coefficients of linear pi-systems, Secular Determinant, Huckel MOT, HMOT in cyclic and acyclic pi-systems, Aromatic and antiaromatic systems.	10	1
II	**Strain and Stability:** Thermochemistry of Stable Molecules, Relation Between Structure and Energetics-Basic Conformational Analysis, Conformations of Acyclic and Cyclic Systems, Electronic Effects. **Acid-Base Chemistry:** Bronsted Acid-Base Chemistry, Aqueous and Non-Aqueous Systems, Predicting Acid Strength in Solution, Lewis Acids/Bases and Electrophiles/Nucleophiles.	15	2
III	**Thermal Pericyclic Reactions:** Cycloadditions, Orbital correlation diagram, Frontier Molecular Orbital, Comments on forbidden and allowed reactions, Photochemical pericyclic reactions, D-A cycloadditions, regio- and stereoselectivity, endo-effect, [2+2] cycloaddition, ketene cycloaddition, 1,3-dipolar cycloaddition, ene-reaction, retrocycloaddition, electrocyclic reactions, sigmatropic rearrangements, Claisen and Cope rearrangements, Cheletropic reactions.	15	3
IV	**Reactivity, Kinetics and Mechanisms:** Energy Surfaces and Related Concepts, Postulates and Principles Related to Kinetic Analysis, Kinetic Experiments and Deciphering Mechanisms **Experiments Related to Thermodynamics and Kinetics:** Isoptope Effects,	10	4

	Substituent Effects, Hammett Plots and Linear Free Energy Relationships, Other Linear Free Energy Relationship, Acid-Base Related Effects.		
V	**Application of physical methods:** Deciphering mechanisms of electrophilic and nucleophilic substitution/additions, eliminations, cyclizations, radical reactions and reactions involving reactive intermediates.	10	5

Suggested textbooks and References:

(1) E. V. Anslyn and D. A. Dougherty, Modern Organic Chemistry, University Science, 2005.
(2) I. Fleming, Molecular Orbitals and Organic Chemical Reactions, John Wiley, 2009.
(3) J. Clayden, S. Warren, N. Greeves, P. Wothers, Organic Chemistry, 1st Edition, Oxford University Press, 2000
(4) F. J. Carey and R. J. Sundburg, Advanced Organic Chemistry, Part A and Part B, 5th Ed., Springer, 2007
(5) J. March, Advanced Organic Chemistry, 3rd edition, McGraw Hill, 1991.
(6) S. H. Pine, Organic Chemistry, 5th edition, McGraw Hill, 1987.

Semester-VII

Program	**Subject**	**Year**	**Semester**
Int. M.Sc.	Chemistry	4	VII
Course Code	Course Title		Course Type
CL701	**Chemistry Laboratory**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	-	-	10

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The objective of this course is to acquire a thorough understanding of green synthesis of nanoparticles and quantum dots. Student can also learn about detection of various ions via different techniques.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Detection of various types of ions using Nephloturbiditimetry, Conductivity and Cyclic Voltametry.	An
2	Understand the methods of green synthesis of nanoparticles and their characterization through various spectroscopic techniques.	An
3	Determination the salinity of various samples with use of conductivity meter.	An
4	Understand the determination of solubility and solubility product in sparingly soluble compound	An
5	Investigate the Langmuir and Freundlich Adsorption Isotherm.	An

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	2	3	3	3	3	2	3	3
CO4	3	3	3	2	3	3	3	3	2	3	3	3	3	2	3	3
CO5	3	3	3	2	3	3	3	3	2	3	3	3	3	2	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: CL701 CHEMISTRY LABORATORY

Unit No.	Topics	No.of Lect.	CO No.
I	**Green synthesis and characterization nanoparticle** Synthesis of silver nanoparticles (AgNPs) using leaf extract of basil (*Ocimum sanctum*). synthesis of silver nanoparticle (AgNPs) using mango (*Magniferaindica*) leaf extract. Synthesize the Gold Nanoparticles using Tea Powder extracts.	30	1
II	**Synthesis and characterization Quantum Dots** Synthesize and characterize the carbon and graphene quantumdots using UV-VIS and Fluorescence. Also calculate the diameter (size), Band gap and FWHM (Full Wave Half Maxima) of quantum dot.	30	2
III	Determination of salinity and $SO4^{-2}$(sulphate) ion concentration of given water sample using conductivity meter and nephloturbiditymeter respectively.	30	3
IV	Determination of solubility and solubility product of sparingly soluble salt ($BaSO_4$) conductometrically.	30	4
V	To determine the distribution coefficient of iodine between CCl_4 and H_2O at room temperature and investigate the adsorption of acetic acid from aqueous solution by activated charcoal, verifying Freundlich and Langmuir adsorption isotherm.	30	5

Suggested Books and References:

(1) J. Mendham, R. C. Denny, J. D. Barnes, M. Thomas, B. Sivasakar, Vogel's textbook of Quantitative Chemical Analysis.
(2) J. N Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments.
(3) J. Singh, R.K. P. Singh, J. Singh, L. D. S. Yadav, I. R. Siddiqui, J. Shrivastava. Advanced Practical Chemistry.
(4) ACS Journal of Chemical Education
(5) J. B. Yadav, Advanced Physical Chemistry

Semester-VIII

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	4	VIII
Course Code	Course Title		Course Type
C801	**Chemistry of Materials**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P

4	3	1	0
Maximum Marks	CIA	ESE	
100	60	40	

Learning Objective (LO):

The objective of the course is to provide students a comprehensive understanding of principles solid-state chemistry, synthesis of materials, phase diagrams, liquid crystals and multiphase materials including their structures, properties, and various associated concepts and applications in the field of chemistry.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Basic aspects of the solid state, their structures, defects and types of defects.	U
2	Thermal properties of solids and conductors. It describes High Tc Materials, Defect pervskites and their Magnetic and Optical Properties.	An
3	Understand the high Tc superconductivity in cuprates and their different properties	U
4	Synthesis of multiphase materials, thin films and properties.	An
5	Understand about Liquids crystals and its mesmorphic behavior.	U

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	2	3	2	1	3	2	3	3	1	2	3
CO2	3	3	3	2	3	3	3	2	1	3	3	3	3	2	2	3
CO3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: C801 CHEMISTRY OF MATERIALS

Unit No.	Topics	No.of Lect.	CO No.
I	**Basic Aspects of the Solid State** Solid State Structure: Primitive lattice vectors - reciprocal lattice - crystal systems and desymmetrization schemes. Bravais lattices; closed packed structures, octahedral and tetrahedral holes, crystallographic point groups and space groups - organic and in organic crystal structure motifs - polytypes and polymorphs. pervskites and related structures, normal and inverse spinels. Defects and Non-stoichiometry: Intrinsic and extrinsic defects - point, line and plane defects; vacancies, Schottky defects, Frenkal defects - Charge compensation in defective solids - non-stoichiometry, thermodynamic aspects and structural aspects.	12	1
II	Thermal Properties: Free electron theory, electrical conductivity, Hall effect - band theory, band gap, metals and semiconductors - intrinsic and extrinsic semiconductors, hopping semiconductors - semi-conductor/metal transition - p-n junctions - superconduction, Meissner effects, type I and II superconductors, isotope effect, basic concepts of BCS theory, manifestations of the energy gap, Josephson devices. Ionic Conductors: Types of ionic conductors, Mechanism of ionic conductors, examples and applications of ionic conductors.	12	2

III	**(v)** High T_c (Critical temperature) Materials: Defect pervskites, high T_c superconductivity in cuprates, anisotropy, temperature dependence of electrical resistance, optical phonon modes, superconducting state, heat capacity, coherence length, elastic constants, positron lifetimes, microwave absorption, pairing and multigap structure in high T_c materials, Magnetic and Optical properties of high T_c materials, applications of high T_c materials.	12	3
IV	Synthesis of Materials: Phase diagrams, preparation of pure materials, mass transport, nucleation and crystal growth, preparative techniques - zone refining, chemical transport, etc. Multiphase materials: Ferrous alloys, Fe-C phase transformations in ferrous alloys, stainless steels, non-ferrous alloys, properties of ferrous and non-ferrous alloys and their applications.	12	4
V	Liquids Crystals: Mesomorphic behavior, thermotropic and lyotropic phases, description of ordering in liquid crystals, the director field and order parameters, nematic and smectic mesophases, smectic -nematic transition and clearing temperature, homeotropic, planar and twisted nematics, chiral nematics, smectic A and smectic C phases, cholesteric-nematic transition, optical properties of liquid crystals, effect of external field.	12	5

Suggested textbooks and References:

(1) H.V. Keer, Principles of the Solid State, Wiley Eastern (1993).
(2) N.W. Ashcroft, N.W. Mermin, Solid State Physics, Saunders College, Philadelphia (1976).
(3) W.D. Callister, Material Science and Engineering. An Introduction, Wiley, New York (1985).
(4) Charles Kittle, Introduction to solid state physics, John Wiley & Sons, New York (1968). Anthony R.West, Solid State Chemistry and its Applications, John Wiley & Sons, New York (2005).
(5) Lesley E. Smart, Elaine A. Moore, Solid State Chemistry (3rd Ed), Taylor & Francis (2005).
(6) N.N. Greenwood, Ionic crystals, lattice defects and non-stoichiometry.

Semester-VIII

Program	**Subject**	**Year**	**Semester**
Int. M.Sc.	Chemistry	4	VIII
Course Code	Course Title		Course Type
C802	**Macro and Supramolecular Chemistry**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The aim of this course is to empower students with in-depth understanding of polymers, its physical characterization by different methods, fundamentals of supramolecular chemistry, enabling them to comprehend the principles, applications, and advanced concepts in these diverse fields of chemistry.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Fundamental aspects of self-assembly in chemistry and its application for supramolecular architectures.	U
2	Characterization of polymers using various techniques, their reaction and degredation, about biodegradable polymer.	An
3	This course is beneficial for students who are interested in molecular materials, nanomaterials, biology-chemistry interface and self-assembly in chemical and biological systems.	An
4	Understanding the various macrocyclic ligands, inclusion complexs, their preparation and stabilization.	U
5	The course also consists of student's seminars on selected topics, problem solving, and idea generation and laboratory experiments on making and testing of self-assembled objects.	E

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create)

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	2	3	2	1	3	3	3	3	1	3	3
CO2	3	3	3	3	2	2	3	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	2	2	3	2	-	3	3	3	3	3	3	3
CO4	3	3	3	2	2	2	3	2	2	3	3	3	3	2	3	3
CO5	3	3	3	3	2	2	3	2	2	3	3	3	3	3	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: C802 (Macro and Supramolecular Chemistry)

Unit No.	Topics	No.of Lect.	CO No.
I	**Polymer Chemistry** Polymerization reactions, mechanism and kinetics – cationic, anionic and radical polymerization, emulsion and electrochemical polymerization, Condensation, ring opening, step growth and radiation polymerization reactions. Coordination complex polymerization, Naturally occurring polymers, Biological polymers, inorganic polymers.Thermodynamics and kinetics. Polymerization and depolymerization equilibria - Kinetics of condensation (Step-Growth), Free radical and ionic polymerizations.	12	1
II	Physical Characterization: Fabrication and Testing, Relationship between structure and properties, Thermal, flame and chemical resistance, Additives - Electroactive polymers, Biomedical applications, Molecular wieght (Mn, Mw) determination, Morphology, Glass transitions and crystallinity, NMR and neutron scattering studies. Reactions and degradation of polymers, biodegradable polymers. Thermal and oxidative degradation, catalysis by macromolecules.	12	2
III	Fundamental of supramolecular chemistry: Definitions, brief overview & examples, types of non-covalentinteractions [H-bonding,electrostatic(ion-ion,ion-dipole,dipole-dipole) hydrophobic and steric, π-π, vander waals], concepts of host guest complexation with examples, macrocyclic effect, complexation of neutral molecules, self-assembly, molecular boxes and capsules, self-complementary species and self-replication.	12	3
IV	The most interesting macrocyclic ligands which are hosts for inclusion complexes, crown ethers and coronands, cryptates and cryptands, calixarenes, hemispherands and spherands, carcerands, hemicarcerands and novel `molecular flasks' enabling	12	4

	preparation and stabilization of short-lived species, cyclodextrins and their complexes, endohedral fullerene complexes, nanotubes and other fullerene-based supramolecular systems, dendrimers, cyclophanes and steroids forming inclusion complexes, anion binding receptors and receptors with multiple binding sites.		
V	Other Exciting Supramolecular Systems, Making use if the preorganization phenomenon, topological molecules, multiple hydrogen bonded systems, organic zeolite, metal directed self assemble of complex, supramolecular architecture, chains, racks, ladders, grids, macrocycles, cages, nanotubes, and self- Interwinning starns (helicates). The prospects of future development of Supramolecular chemistry	12	5

Suggested texts and References:

1. H.R. Allcock, F.W. Lampe and James Mark, Contemporary Polymer Chemistry, Prentice Hall, Inc. (1990).
2. M.P. Stevens, Polymer Chemistry: An Introduction (2nd Edition) Oxford University Press 91990).
3. F.W. Billmeyer, Jr., Textbook of Polymer Science (3rd Edition) Wiley-Inter Science (1984) paperback.
4. A. Ravve, Principles of Polymer Chemistry.
5. Recommended Review Articles in the field of supramolecular chemistry.
6. "Supramolecular Chemistry" by F. Vogtle, John Wiley, 1991.
7. "Crystal Engineering. The Design of Organic Solids" by G.R. Desiraju, Elsevier, 1989.
8. Introduction to Supramolecular Chemistry, Dodzuick Helena.

Semester-VIII

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	4	VIII
Course Code	Course Title		Course Type
C803	**Reaction Dynamics**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

This course aims to grasp statistical thermodynamics principles, and explore chemical dynamics in fast reactions, kinetics and mechanism, unimolecular reactions, providing students with the tools to address complex chemical systems.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understanding the chain reactions and its general treatment, bond dissociation energy, inhibition and branching chain reaction	U
2	About collision theory, rate and rate constants, factors affecting effectiveness of collision, relation of cross section and rate coefficient.	An
3	Understanding the kinetics of fast reactions, various methods viz. flash	U

	photolysis, pulse radiolysis, theoretical calculation of rate constant.	
4	Understanding the potential energy surfaces, and details of the reaction path and molecular dynamics of few reactions as H_2 + H reaction	U
5	Course also covers dynamics of transition state theory.	U

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create)

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	2	2	3	2	1	3	3	3	2	-	2	3
CO2	3	3	3	1	2	2	3	2	1	3	3	3	2	1	2	3
CO3	3	3	3	2	2	2	3	2	1	3	3	3	2	2	2	3
CO4	3	3	3	3	2	2	3	2	1	3	3	3	2	2	2	3
CO5	3	3	3	2	2	2	3	2	1	3	3	3	2	2	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: C803 REACTION DYNAMICS

Unit No.	Topics	No.of Lect.	CO No.
I	Chain reactions: general treatment, activation energy, chain length, chain transfer reactions, inhibition, bond dissociation energies, branching chain reactions.	12	1
II	The collision theory: Dynamics of bimolecular collisions and rate and rate constant of bimolecular reaction, factors determining effectiveness of collisions, Termolecular reactions, unimolecular reactions, relation between cross section and rate coefficients.	12	2
III	Kinetics of fast reactions, flow methods for fast reaction, pulse methods, flash photolysis, pulse radiolysis, molecular reaction dynamics, potential energy surfaces, theoretical calculation of the rate constant, Kinetics and mechanism of photochemical reactions.	12	3
IV	Potential Energy Surfaces: Long range, empirical intermolecular and molecular binding potentials, Internal coordinates and normal modes of vibration, Potential energy surfaces, ab-initio calculation of potential energy surface, experimental determination of potential energy surfaces.	12	4
V	Transition State Theory (TST): Motion on the potential energy surface, Basic postulates and derivation of TST, dynamical derivation of TST, Thermodynamic formulation of TST, Application of TST.	12	5

Suggested textbooks and References:

(1) J.I. Steinfeld, J.S. Francisco and W.L. Hase, Chemical Kinetics and Dynamics, Prentice Hall 1989.
(2) Paul L. Houston, Chemical Kinetics and reaction dynamics.
(3) R.D.Levine and R.B.Bernstein, Molecular Reaction Dynamics and Chemical Reactivity, Oxford University Press, 1987.
(4) Sanjay K. Upadhay, Chemical kinetics and Reaction Dynamics, Springer, 2006

Semester-VIII

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	4	VIII

Course Code	Course Title		Course Type
C804	**Heterocyclic Chemistry**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

Student will gain understanding of heterocyclic aromatic organic compounds, classifications and explains their reactivity based on their properties.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understanding the spectral characteristics, nomenclature, reactivity and aromaticity of fused and bridged heterocycles.	U
2	A mechanistic level, reactions and synthesis of important electron rich heterocycles; furans, pyrroles and thiophenes and 1,3 azoles, and benzo-condenced analogs.	An
3	Heterocyclic aromatic organic compounds, classifications and explains their reactivity based on their properties.	An
4	Understand the chemistry of heterocyclic compounds (furan, thiophene, pyrrole, pyridine) and more than one heteroatom (pyrazole, imidazole, oxazole, thiazole, pyrimidine and pyrazines)	U
5	Reactions and synthesis of important electron deficient nitrogen containing heterocycles; pyridines, diazines and their benzo- condensed analogs.	An

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create)

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	2	1	3	3	3	3	2	3	3
CO2	3	3	3	2	1	2	3	2	1	3	3	3	3	2	3	3
CO3	3	3	3	2	1	2	3	2	1	3	3	3	3	2	3	3
CO4	3	3	3	2	1	2	3	2	1	3	3	3	3	2	3	3
CO5	3	3	3	2	1	2	3	2	1	3	3	3	3	2	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: C804 HETEROCYCLIC CHEMISTRY

Unit No.	Topics	No.of Lect.	CO No.
I	**Introduction to Heterocycles**: Nomenclature (Hantzsch Widman System), spectral characteristics, reactivity and aromaticity of monocyclic, fused and bridged heterocycles.	12	1

II	**Nonaromatic heterocycles:** Different types of strains, interactions and conformational aspects on nonaromatic heterocycles, Synthesis, reactivity, and importance of the following ring systems: Azirines, Oxaranes, Thiiranes, Diazirenes.	12	2
III	**Five and six-membered heterocycles with two hetero atoms**: Synthesis, reactivity, aromatic character and importance of the following heterocycles: Pyrazole, Imidazole, Oxazole, Thiazole, Pyrimidine, Pyrazine, Oxazine, and Thiazine.	12	3
IV	**Larger ring and other heterocycles:** Synthesis and reactivity of Azepines, Oxepines and Thiepines, Synthesis and rearrangement of Diazepines. Synthesis of Benzothiepines, Azocines.	12	4
V	**Banzanellated azoles and dipolar structures**: Banzanellated azoles: Synthesis and reactivity of Benzimidazoles, Benzoxazoles and Benzothiazoles. Heterocyles with Ring-Junction nitrogen: Synthesis and reactivity of Quinolizines, Indolizines and Imidazopyridines.	12	5

Recommended books:

1. Heterocyclic Chemistry, T.L. Gilchrist.
2. An Introduction to the Chemistry of Heterocyclic compounds, R.M.Acheson.
3. Heterocylic chemistry, J.A.Joule & K. Mills.
4. Principals of Modern Heterocyclic Chemistry, A.Paquette.
5. Heterocyclic Chemistry, J.A. Joule & Smith.
6. Hand book of Heterocyclic Chemistry, A.R.Katritzky
7. Heterocyclic Compounds. R. Jain, A. Sahay, U. Soni, S. Pimplpure
8. Heterocyclic Chemistry, R. Bansal

Semester-VIII

Program	**Subject**	**Year**	**Semester**
Int. M.Sc.	Chemistry	4	VIII
Course Code	Course Title		Course Type
CL801	**Chemistry Laboratory**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	-	-	10

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):

The objective of this course is to acquire a thorough understanding of environmental analysis, proportionality relation and student can also learn about detection of various ions via different techniques.

Course Outcomes (CO):-

CO No.	**Expected Course Outcomes At the end of the course, the students will be able to:**	**CL**
1	Student will gain the knowledge regarding detection of various types of ions using Mohr's Method and Spectrophotometer.	**An**
2	Understand about proportionality relation between concentration and redox potential using cyclic voltametry.	**An**
3	Determination the acidity of various samples.	**An**

4	Gain the knowledge the composition of Fe^{3+} salicylic acid complex in solution by Job's Method.	**An**
5	Student can learn about environmental analysis (chemical oxygen demand)	**An**

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	3	2	3	2	1	3	3	3	3	1	3	3
CO2	3	3	3	2	3	2	3	2	2	3	3	3	3	2	3	3
CO3	3	3	3	1	3	2	3	2	1	3	3	3	3	1	3	3
CO4	3	3	3	2	3	2	3	2	2	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: CL801 (CHEMISTRY LABORATORY)

Unit No.	Topics	No.of Lect.	CO No.
I	Determination of chloride ion concentration in a given sample by Mohr's method.	30	1
II	Determine the phosphate ion ($PO4^{3-}$) in given sample by spectrophotometer.	30	2
III	Determine the acidity of given water sample.	20	3
IV	Determination of the composition of a complex (Fe^{3+}) by Job's method.	30	4
V	To prove the direct proportionality relation between concentration and oxidation and reduction potential using $ZnSO_4$, $K_2Cr_2O_7$, $Cu(CH_3COO)_2$ and $FeCl_3$.	40	5

Suggested Books and References:

(1) J. Mendham, R. C. Denny, J. D. Barnes, M. Thomas, B. Sivasakar, Vogel's textbook of Quantitative Chemical Analysis.
(2) J. N Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments.
(3) J. Singh, R.K. P. Singh, J. Singh, L. D. S. Yadav, I. R. Siddiqui, J. Shrivastava. Advanced Practical Chemistry.
(4) ACS Journal of Chemical Education
(5) J. B. Yadav, Advanced Physical Chemistry

SEMESTER - IX

Chemistry PG Dissertation/ Project

Program	**Subject**	**Year**	**Semester**
Int. M.Sc.	Chemistry	5	IX
Course Code	Course Title		Course Type
CPGD901	Chemistry PG Dissertation/ Project		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
20	-	-	-

Scheme for evaluation of Project/Dissertation work for 9th semester CBS

The Center for Basic Sciences (CBS) offers 5 Year Integrated M.Sc. program (total credits-240) in Chemistry. The complete program is for duration of 10 semesters. Each semester from 1-VIII carries 25 credits and semester IX to X will carry 20 credits each. As per the course structure of Int M.Sc. 9th semester, students have to carry out a project/Dissertation in their respective subjects for successful completion of the program. The project has to be carried out in recognized National/State laboratories/Institute/Universities. The proposed evaluation scheme for Integrated M.Sc. 9th semester projects/Dissertation in subject Chemistry (CPGD 901) is as follows:

S. No.	Distribution	Marks
1	**Project/Dissertation (certified by the supervisor of the Institute)**	**150**
2	**Seminar based on Project/ Dissertation**	**150**
3	**Viva-Voce based on Project report/ Dissertation and Seminar**	**100**
	Total Marks	**400**

The valuation of all the projects/Dissertation will be done by the external examiner, internal examiner of the respective subjects and Director (CBS) or nominee of the Director.

SEMESTER - X

CE1- Environmental Chemistry

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	5	IX
Course Code	Course Title		Course Type
CE1	Environmental Chemistry		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	-

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

This course demonstrates knowledge of environment in monitoring, analyzing, and controlling various environmental pollutants, including air quality assessment, soil and water quality standards.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Gain proficiency in monitoring and analyzing environmental pollutants, including air and water quality standards, soil contamination, and pollutants from industrial sources, enabling them to assess and control environmental pollution effectively.	**Ap**

2	Determine the causes of water pollution about hydrological cycle, water quality criteria for different uses, BIS and WHO standards, variety of pollutants.	**An**
3	Classify the industrial waste water, principles of waste water treatments, methods for purification of water.	**An**
4	Develop skills in chemical analysis relevant to various environmental pollution like in water Color, odor, conductivity, TDS, pH, acidity, alkalinity, chloride, hardness, trace metal analysis, elemental analysis, ammonia, nitrite, nitrate, fluoride, sulphide, phosphate, phenols, surfactants, BOD, COD, DO, TOC in air analysis of CO, nitrogen oxides, sulphur oxides, hydrocarbons and particulate matter and in soil sample analysis	**An**
5	Develop the evaluation skill by the understanding and analyzing the different environmental sample and can create something new devices to monitor and control it.	**E**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C** Create).

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	2	3	3	3	2	3	3	3	3	2	3	3
CO2	3	3	3	-	2	3	3	3	2	3	3	3	3	-	3	3
CO3	3	3	3	2	2	3	3	3	2	3	3	3	3	2	3	3
CO4	3	3	3	2	2	3	3	3	2	3	3	3	3	2	3	3
CO5	3	3	3	1	2	3	3	3	2	3	3	3	3	1	3	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: Environmental Chemistry

Unit No.	Topics	No.of Lect.	CO No.
I	**Scope:** Environmental pollution, structure of atmosphere, biogeological cycles – oxygen, nitrogen, carbon, phosphorous, sulphur ; biodistribution of elements, air pollutions - reactions in atmosphere, primary pollutants, air quality standards, analysis of CO, nitrogen oxides, sulphur oxides, hydrocarbons and particulate matter, particulate pollution - control methods, green house effect and global warming, climatic changes, ozone, photochemical smog, acid rain, sampling, monitoring & control.	15	1
II	**Hydrosphere:** Water pollution, hydrological cycle, chemical composition, sea water composition, water quality criteria for domestic and industrial uses, BIS and WHO standards, ground water pollution, surface water pollution - lake and river water, eutrophication, marine pollution, water pollutants - biodgradeability of detergents – pestisides - endosulfan and related case studies.	15	2
III	**Classification of industrial waste waters:** Principles of water and waste water treatment - aerobic and anaerobic treatment, industrial waste water treatment, heavy metal pollution, hard water - softening - purification of water for drinking purposes, water treatment for industrial use, electrodialysis, reverse osmosis, other purification methods, chemical speciation of elements.	15	3
IV	**Water analysis**: Color, odor, conductivity, TDS, pH, acidity, alkalinity, chloride, residual chlorine, hardness, trace metal analysis, elemental analysis, ammonia, nitrite, nitrate, fluoride, sulphide, phosphate, phenols, surfactants, BOD, COD, DO, TOC, nondispersive IR spectroscopy, anode stripping, ICP, AES, Chromatography, ion selective electrodes, neutron activation analysis.	15	4
V	**Soil pollution:** Soil humus, soil fertility, inorganic and organic components in soil, acid, base and ion exchange reactions in soils, micro and macro nutrients, wastes and pollutants in soil, introduction to geochemistry, solid waste management,	15	5

	treatment and recycling soil analysis, radioactive pollution, disposal of radioactive waste.		

References and Text Books

1. H. Kaur, Environmental Chemistry, 6th Edn, Pragathi Prakashan, Meerut, 2011.
2. K.H.Mancy and W,.J.Weber Jr. Wiley, Analysis of Industrial Waste Water, Interescience New York, 1971.
3. L.W. Moore and E. A. Moore, Environmental Chemistry, McGraw Hill Publication, New York, 2002.
4. S. M. Khopkar, Environmental Pollution Analysis, New Age International (P) Ltd, 1993.
5. Colid Baird. Environmental Chemistry, W. H. Freemand and Company, 1995.

SEMESTER - X (ELECTIVES)

CE2- Inorganic Rings, Cages and Clusters

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	5	X
Course Code	Course Title		Course Type
CE2	**Inorganic Rings, Cages and Clusters**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to equip students with deep understanding of Structure and properties of rings, Cages and clusters of different type molecules in main group and transition metal as well as the knowledge of daily life uses inorganic polymers which are useful in our daily life

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understanding the knowledge of structure and properties of rings, Cages and clusters of different type molecules in main group and transition metal as well as about the inorganic homo – heterocycle ring system.	**U**
2	Analyze and predict the various type clusters structure of transition metal and main group elements using different electron counting rule.	**An**
3	Analyze the Isobal analogy in homonuclear, p- block, d-block, cubanes and zintl clusters, cubanes structural prediction of organometallic clusters.	**An**
4	Understand the synthesis, structure and reactivity of inorganic homo and heterocycles, properties of borazines and phosphazenes, concept of multiple bonds and cluster variety of transition metals.	**U**
5	Practically polymers are essential part of todays life so inorganic polymers like P, Si, S, N, & O based polymers, poly-phosphazenes, poly-thiazenes, poly-siloxanes and poly-silanes are very important to future aspects.	**Ap**

CL: Cognitive Levels (**R**- Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-

Evaluate; **C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	1	3	2	-	3	2	3	1	2	1	3
CO2	3	3	3	1	1	2	3	2	-	3	2	3	2	1	1	3
CO3	3	3	3	1	1	1	3	2	-	3	2	3	2	1	1	3
CO4	3	3	3	1	1	2	3	2	-	3	2	3	2	1	1	3
CO5	3	3	3	1	1	1	2	2	-	2	2	3	2	3	1	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: Inorganic Rings, Cages and Clusters

Unit No.	Topics	No.of Lect.	CO No.
I	**Main group clusters:** Geometric and electronic structure, three - four and higher connect clusters, the closo-, nido-, arachno- borane structural paradigm, Wade-Mingos and Jemmis electron counting rules, clusters with nuclearity 4-12 and beyond 12. Structure, synthesis and reactivity.	15	1
II	**Transition metal clusters:** Low nuclearity metal carbonyl clusters and 14n+2 rule, high nuclearity metal carbonyl clusters with internal atoms, structure, synthesis and reactivity - capping rules.	15	2
III	**Isobal analogy**: Heteronuclear clusters - carboranes and heteroboranes, metal clusters - structural prediction of organometallic clusters, main group transition metal clusters: Isolobal analogs of p-block and d-block clusters - interstitial systems - cubanes and zintl clusters.	15	3
IV	**Inorganic homo- & heterocycles:** Synthesis, structure and reactivity - structural variety & properties of borazins and phosphazenes, borides, carbides, silicides, nitrides, phosphides, oxides and sulphides of transition elements, multiple bonds and cluster variety of transition metals	15	4
V	**Inorganic rings and polymers**: Definition, variety and merits, P, Si, S, N, & O based polymers, poly-phosphazenes, poly-thiazenes, poly-siloxanes and poly-silanes.	15	5

References:

1. D. M. P. Mingos and D. J. Wales, Introduction to Cluster Chemistry, Prentice Hall, 1990.
2. N. N. Greenwood and E. A. Earnshaw, Chemistry of Elements, Pergaman Press, 1984.
3. I. Haiduc & D. B. Sowerby (Eds.), Inorganic Homo-and Heterocycles Vols. 1 & 2, Academic Press, 1987. 4. J. E. Mark, R. West & H. R. Allcock, Inorganic Polymers, Academic Press, 1992.
5. T. P. Fehlner, J. F. Halet and J-Y. Saillard, Molecular Clusters: A Bridge to Solid-State Chemistry, Cambridge University Press, 2007.
6. P. Braunstein, L. A. Oro, P. R. Raithby, Ed. Metal Clusters in Chemistry, John Wiley and sons, 1999.
7. T. Chivers, I. Manners, Inorganic Rings and Polymers of the p-Block Elements, from Fundamentals to Applications, RSC Publishing, 2009.

SEMESTER - X (ELECTIVES)

CE3- Medicinal Chemistry

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	5	X

Course Code	Course Title		Course Type
CE3	**Medicinal Chemistry**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to equip students with deep knowledge of structures of different type of pharmaceutical drugs, their action and gives a brief introduction of medicinal chemistry.

Course Outcomes (CO): -

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Develop the skill about drugs and their respective delivery system with their actions.	**U**
2	Acquire knowledge of enzyme inhibitors, enzyme-drug interaction, DNA-protein and protein–Drug interaction and understanding of pharmaceutical development and optimization.	**An**
3	Develop a comprehensive understanding of various pharmaceutical agents mechanism of action of lactam antibiotics and non-lactam anti biotics, antiviral agents, stereochemistry, biosynthesis and degradation.	**U**
4	Elucidation of enzyme structure via various mechanism, kinetics, spectroscopy and stereochemical studies.	**An**
5	Provide a brief introduction to pharmacology, target identification, pre-clinical and clinical development of a drug candidate, DNA-protein interaction, mechanism of drug action.	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	2	2	3	2	2	3	2	3	2	2	2	2
CO2	3	3	3	2	2	2	3	2	2	3	2	3	2	2	2	2
CO3	3	3	3	2	2	2	3	2	2	3	2	3	2	2	2	2
CO4	3	3	3	2	2	2	3	2	2	3	2	3	2	2	2	2
CO5	3	3	3	2	2	2	3	2	2	3	2	3	2	2	2	2

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: Medicinal Chemistry

Unit No.	Topics	No.of Lect.	CO No.
I	**Introduction:** History of medicinal chemistry, general mechanism of drug action on lipids, carbohydrates, proteins and nucleic acids, drug metabolism and inactivation, receptor structure and sites, drug discovery development, design and delivery systems, gene therapy and drug resistance.	15	1
II	**Classification:** Drugs based on structure or pharmacological basis with examples, synthesis of important drugs such as α - methyl dopa, chloramphenicol griseofulvin, cephelosphorins and nystatin. Molecular	15	2

	modeling, conformational analysis, qualitative and quantitative structure activity relationships		
III	**General introduction to antibiotics:** Mechanism of action of lactam antibiotics and non lactam anti biotics, antiviral agents, chemistry, stereochemistry, biosynthesis and degradation of penicillins - An account of semisynthetic penicillins, acid resistant, penicillinase resistant and broad spectrum semisynthetic penicillins	15	3
IV	**Elucidation of enzyme structure:** Mechanism, kinetic, spectroscopic, isotopic and stereochemical studies. Chemical models and mimics for enzymes, design, synthesis and evaluation of enzyme inhibitors.	15	4
V	**Interactions:** DNA-protein interaction and DNA-drug interaction. Introduction to rational approach to drug design, physical and chemical factors associated with biological activities, mechanism of drug action.	15	5

Recommended books:

1. I. Wilson, Giswald and F. Doerge, Text Book of Organic Medicinal and Pharmaceutical Chemistry, J.B. Lippincott Company, Philadelphia, 1971.
2. A. Burger, Medicinal Chemistry, Wiley Interscience, New York, Vol. I and II, 1970.
3. Bentley and Driver's Text Book of Pharmaceutical Chemistry revised by L.M. Artherden, Oxford University Press, London, 1977.
4. A. Gringauz, Introduction to Medicinal Chemistry, How Drugs Act and Why?, John Wiley and Sons, 1997.
5. G. L. Patrick, Introduction to Medicinal Chemistry, Oxford Univeristy Press, 2001.

SEMESTER - X (ELECTIVES)

CE4- Nanochemistry and Nanoscience

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	5	X
Course Code	Course Title		Course Type
CE4	**Nano chemistry and nanoscience**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course is to provide a comprehensive understanding of nano-chemistry, characterization methods, and practical applications in nanotechnology, with a focus on the preparation and properties of nanoparticles, various characterization techniques, and their application in various fields, and emphasizing the fundamental principles and practical utilization of nanoscale materials and technologies.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Provide the knowledge of basic and advanced nanotechnology their preparations methods, fundamental physicochemical principles, size dependence of the properties of nanostructured matter, their quantum confinement, single electron charging, the central importance of nanoscale morphology.	**U**

2	Provide the knowledge of synthesis of various type of nanoparticle viz metal nano-particles, quantum dots, carbon nanotubes.	**C**
3	Understand the different characterization methods, including Scanning electron microscopy (SEM), TEM, EDAX analysis, X-ray diffraction, atomic force microscopy (AFM), optical microscope UV-VIS-IR spectrophotometers and their description, operational principle and application for analysis of nanomaterials.	**Ap**
4	Characterize the metal nanoparticles, control in size, study of their different properties viz. optical, electronic, magnetic. Various applications in other fields.	**An**
5	Analyze and evaluate the potential future directions and advancements in nanotechnology, including its impact on various scientific and medical applications	**An**

CL:CognitiveLevels(**R**-Remember;**U**-Understanding;**Ap**-Apply;**An** Analyze;**E**Evaluate;**C**Create).

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	3	3	3	2	3	2	3	3	3	2	3
CO2	3	3	3	3	2	3	3	3	2	3	2	3	3	3	2	3
CO3	3	3	3	3	2	3	3	3	2	3	2	3	3	3	2	3
CO4	3	3	3	3	2	3	3	3	2	3	2	3	3	3	2	3
CO5	3	3	3	3	2	3	3	3	2	3	2	3	3	3	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: Nanochemistry and Nanoscience

Unit No.	Topics	No.of Lect.	CO No.
I	**Introduction to nanoscience and nanotechnology:** Underlying physical principles of nanotechnology, Nanostructured Materials, Size is Everything: Fundamental physicochemical principles, size dependence of the properties of nanostructured matter, quantum confinement, single electron charging, the central importance of nanoscale morphology, Societal aspects of nanotechnology: Health, environment, hype and reality.	15	1
II	**The advent of the nanomaterial:** Top down and bottom-up approaches to building materials, Properties of nanomaterials such as nanoparticles, carbon nanotubes, Overview of self-assembly, Inert gas condensation, arc discharge, RF plasma, plasma arc technique, ion sputtering, laser ablation, laser pyrolysis, ball milling, molecular beam epitaxy, chemical vapour deposition method and electro deposition.	15	2
III	**The basic tools of nanotechnology:** Scanning electron microscopy (SEM), TEM and EDAX analysis and X-ray diffraction, A brief historical overview of atomic force microscopy (AFM) and an introduction to its basic principles & applications, Optical microscope and their description, operational principle and application for analysis of nanomaterials, UV-VIS-IR spectrophotometers, Principle of operation and application for band gap measurement.	15	3
IV	**Metal nanoparticles:** Size control of metal nanoparticles and their characterization, study of their properties, optical, electronic, magnetic. Surface plasmon band and its applications, role in catalysis, alloy nanoparticles, stabilization in sol, glass, and other media, change of band gap, blue shift, colour change in sol, glass, and composites, plasmon resonance.	15	4
V	**Carbon nano structures:** Introduction, Fullerenes, C60, C80 and C240 nanostructures, Properties & applications (mechanical, optical and electrical), Functionalization of carbon nanotubes, reactivity of carbon nanotubes, Nanosensors: Temperature sensors, smoke sensors, sensors for aerospace and	15	5

	defense. Accelerometer, pressure sensor, night vision system, nano tweezers, nano-cutting tools, integration of sensor with actuators and electronic circuitry biosensors.		

Recommended books:

1. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill, New Delhi, 2007.
2. G. Cao, Nanostructures and Nanomaterials – Synthesis, Properties and Applications, Imperial College Press, London, 2004, chapters 3, 4 and 5.
3. C. N. R. Rao, A. Muller and A. K. Cheetham, The Chemistry of Nanomaterials, Volume 1, Wiley –VCH Verlag GmbH & Co. KgaA, Weinheim, 2004, Chapter 4

SEMESTER - X (ELECTIVES)

CE5- Surface Chemistry

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	5	X
Course Code	Course Title		Course Type
CE5	**SURFACE CHEMISTRY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to provide the knowledge of chemical reaction that occurs at the interface between two surfaces and gives a brief introduction of surface physical chemistry.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Gather knowledge of basic and applied areas of surface chemistry phenomenon like micellization, CMC and its determination. Shape and structure of micelles, effect of additives on micellization, thermodynamics of micellization, solubilization. Provide the systematic outline about the applications of micellization.	**U**
2	Understanding very important research aspect of surface chemistry i.e. Membranes and their applications artificial and natural membranes, Donnan membrane equilibrium, transport of electrolytes, membrane potential and ion selective electrodes	**U**
3	Understand the adsorption on solid and porous materials through various models, estimation of specific area of pores.	**U**
4	Understand the colloidal systems, concept of electrical double layers, various theories to explain stability of colloids.	**U**
5	Understand and apply the various type of interfacial detection technique viz ATR-FTIR spectroscopy, SFG Spectroscopy	**An**

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E** Evaluate;**C** Create).

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	2	3	2	1	3	2	3	2	1	2	3
CO2	3	3	3	1	2	2	3	2	1	3	2	3	2	1	2	3

CO3	3	3	3	1	2	2	3	2	1	3	3	3	2	1	2	2
CO4	3	3	3	1	2	2	3	2	1	3	3	3	2	1	2	3
CO5	3	3	3	3	2	2	3	2	1	3	3	3	2	3	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: Surface Chemistry

Unit No.	Topics	No.of Lect.	CO No.
I	**Surface and Interface Chemistry:** Classifications, micellization, CMC and its determination. Shape and structure of micelles, effect of additives on micellization, thermodynamics of micellization, solubilization and applications, effect of electrolytes on solubilization. Macro and micro emlusions, dispersion and aggregation of solids by surfactants.	15	1
II	**Membranes and their applications:** Artificial and natural membranes, Donnan membrane equilibrium, transport of electrolytes, membrane potential and ion selective electrodes.	15	2
III	**Adsorption on solids and porous materials:** Model for multilayer adsorption, BET isotherm and application to different types of adsorbents, adsorption by porous, non-porous and microporous solids, Estimation of specific surface area and pore size distribution.	15	3
IV	**Colloid systems and their properties:** Origin of the charges, electro-kinetic phenomena, electrophoresis, electroosmosis, sedimentation and streaming potential. The concept of electrical double layer and various models to explain its structure and properties, DLVO theory and stability of colloids. Smoluchowski theory of kinetics of coagulation and distribution of colloids aggregates. Organic and inorganic gels and clay colloids.	15	4
V	**Methods to detect interfacial phenomena:** Principle and instrumentation and applications of ATR-FTIR spectroscopy, SFG Spectroscopy.	15	5

Recommended books:

1. Hunter, R.J., *"Foundation of colloid Science"*, Oxford University,Press,2009
2. Lyklema,J., *"Fundamentals of Interface and Colloid Science"*,Academic press San Diego,2000
3. Adamson, A.W., *"Physical Chemistry of Surface"*,5th Ed.,Jhon Wiley and Sons, NewYork, 1990
3. Kruyt, H.R., *"Colloid Chemistry"* Vol. I and II. Elsevier Press,1991
4. Gerg, S.J. and Singh, K.S.W., *"Adsorption, Surface Area and Porosity"*, 2nd Ed., Academic Press.,U.K. 1982.

SEMESTER - X (ELECTIVES)

CE6-Computational Chemistry

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	5	x
Course Code	Course Title		Course Type
CE6	**Computational Chemistry**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course aims to develop student's skill about advance quantum chemistry and computational chemistry.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Student will gain understanding the concept of wave function, oscillators, time dependent perturbation theory.	**U**
2	Gather the knowledge of Hartee-fock theory with reference to computation aspects and the electronic properties of molecules by Semi-empirical method, density functional method and configuration interaction and its limitations with applications.	**An**
3	Understanding different electronic properties like dipole moments, electrostatic potential. Understand the population, Mulliken and Lowdin analysis. Effect of solvents.	**U**
4	Understand the various simulation methods like molecular mechanics, Monte carlo and molecular simulations, calculation of thermodynamics of properties.	**U**
5	This course gives the theoretical knowledge of chemistry and its application.	**Ap**

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO mapping for the course:

PO /CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	3	2	3	2	-	3	2	3	1	3	2	2
CO2	3	3	3	3	3	2	3	2	-	3	2	3	2	3	2	2
CO3	3	3	3	3	3	2	3	2	-	3	2	3	2	3	2	2
CO4	3	3	3	3	3	2	3	2	-	3	2	3	2	3	2	2
CO5	3	3	3	3	3	2	2	2	-	3	2	3	2	3	2	2

"3"–Strong;"2"–Moderate;"1"-Low;"-"NoCorrelation

Detailed Syllabus: Computational Chemistry

Unit No.	Topics	No.of Lect.	CO No.
I	**Fundamentals of electronic structure-I:** Basis function-hydrogen-like, Slater type and Gaussian type orbitals, classification of basis sets–minimum, double zeta, triple zeta, split-valence, polarization and diffuse basis sets, correlation consistent basis sets,	15	1
II	**Fundamentals of electronic structure-II:** Basis set super position error, energy minimization methods-derivative and non-derivative methods-simplex method, steepestdescentsmethod, Newton-Rapshon method, minima,maximaand saddle points.	15	2
III	**Semi empirical and Abinitio methods:** Approximation methods, self-consistent field treatmentof polyatomic molecules, closed shell systems-restricted Hartree-Fock calculations, open shellsystems ROHF and UHF calculations, The Roothan – Hall equations, Koopman's theorem, HF limit and electron correlation, introduction to post Hartree- Fock and density functional methods.	15	3
IV	**Electronic properties:** Dipole moments, electrostatic potential, frequencies, population analysis,Mulliken and Lowdin analysis, solvent effects, polarizable and non polarizabel models.	15	4

V	**Introduction to simulation methods:** Molecular mechanics, Montecarlo and molecular dynamics simulations, periodic boundary conditions, radial distribution function, calculation of thermodynamics properties.	15	5

Recommended books:

(1) C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, John Wiley &Sons, 2002.

(2) David Young, Computational Chemistry: A practica Guide for applying Techniques to Real World Problems, Wiley Interscience, 2001.

(3) J.B.Foresman, A. Frisch, Exploring Chemistry with Electronic Structure Methods. Gaussian Inc.,1996.

(4) M.P. Allen and D.J. Tildesley, Computer Simulations of Liquids, Oxford,1987.

(5) F.Jensen,Introduction to Computational Chemistry, John Willey & Sons Ltd, 1999.

(6) A. Leach, Molecular Modeling: Principles and Applications, Prentice Hall, 2001.

(7) I. N. Levine, Quantum Chemistry,7th Ed., PHI Learning Pvt. Ltd., Delhi, 2013.

SEMESTER - X (ELECTIVES)

CE7- Advanced Polymer Chemistry

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	5	x
Course Code	Course Title		Course Type
CE7	**Advanced Polymer Chemistry**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	0

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

The course provides a comprehensive understanding of organic polymers, including their importance, classification, structural aspects, and properties of commercial and natural polymers, with an emphasis on practical applications in various fields such as materials science, engineering, and biomedicine.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Understand the fundamental concepts of commercial polymers like Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers – Fire retarding polymers and electrically conducting polymers.	**Ap**
2	Apply and analyze the polymer Preparation and application of polymer supported catalysts, acids, bases, phase transfer catalysts, transition metal complexes	**An**
3	Understand and apply the Bio-medical polymers – contact lens, dental polymers, artificial heart, kidney, skin and blood cells and natural polymers, polymer additive ,degradation and stabilization	**Ap**
4	Acquire knowledge of natural polymer like Cellulose nitrate, cellulose acetate. Viscose rayon, starch, silk, Rubber and modified rubber.	**U**

5	Understand the degradation and stabilization of polymers, various type of degradation including physical, chemical and biodegradation	**U**

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C** Create).

CO-PO/PSO mapping for the course:

PO /CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	2	3	2	1	3	2	3	3	1	2	3
CO2	3	3	3	1	2	2	3	2	1	3	2	3	3	1	2	3
CO3	3	3	3	1	2	2	3	2	1	3	2	3	3	1	2	3
CO4	3	3	3	1	2	2	3	2	1	3	2	3	3	1	2	3
CO5	3	3	3	1	2	2	3	2	1	3	2	3	3	1	2	3

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: - Advanced Polymer Chemistry

Unit No.	Topics	No.of Lect.	CO No.
I	**Properties of commercial polymers** Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers – Fire retarding polymers and electrically conducting polymers, Bio-medical polymers – contact lens, dental polymers, artificial heart, kidney, skin and blood cells.	15	1
II	**Polymer Additives:** Role of additives in polymers, Fillers, plasticizers, anti-oxidants and stabilizers, Flame-retardants, colourants.	15	2
III	**Natural polymers: Cellulose:** Cellulose nitrate, cellulose acetate. viscose rayon, starch, silk, Rubber and modified rubber.	15	3
IV	**Polymer supported reagents in organic chemistry**: Preparation and application of polymer supported catalysts, acids, bases, phase transfer catalysts, transition metal complexes etc. Polymer supported reagents and polymer supported protecting groups including “Solid Phase” peptide synthesis.	15	4
V	**Polymer Degradation and Stabilization:** Types of degradation – Physical and chemical degradation. **Types of Physical degradation:** a)Thermal degradation b) Photodegradation and stabilization c) Mechanical degradation. **Types of Chemical degradation:** a) Solvolytic degradation b) hydrolytical degradation c) Oxidative degradation and stabilization d) biodegradation.	15	5

Recommended books:

1. Text book of Polymer science; F.w.Billmeyer J.Willey
2. Polymer science, V.R.Gowarikar, N. V. Vishwanathan and J. Sreedhar, Wiley Eastern
3. Principles of Polymerization, George Odian III.Ed.
4. Organic Polymer Chemistry, K.J.Saunders
5. Polymer Chemistry, Golding
6. Principles of Polymer Chemistry, Flory
7. Physical Chemistry of Macromolecules, D.D.Deshpande, Vishal Publications,1985
8. Functional monomers and polymers, K.Takemoto, V.Inaki and R.M.Ottanbrite

Skill Enhancement/ Value Added Courses: (Offered to the students of CBS)

The candidates who have joined the 5-Year Integrated M.Sc. Programme in Chemistry at Center for Basic Sciences shall undergo Skill Enhancement Course /Value Added Course (only qualifying in nature).

Chemdraw

Program	Subject	Year	Semester
Int. M.Sc.	Chemistry	4	VIII
Course Code	Course Title		Course Type
SECL801	**Chemdraw**		**Skill Enhancement Course**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	4

Maximum Marks	CIA	ESE
100	60	40

Learning Objective (LO):-

Acquire skills on usage of ChemDraw Software to draw the chemical structures. Also, predict physical and chemical properties like bond angles, bond lengths, stereochemistry, polarity, H-NMR, C-13 NMR and Mass Spectral Data.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Acquaint the knowledge of chemdraw, installation of software and application. Uses of the tools present in the software.	**U**
2	Apply the software for converting the IUPAC name to chemical structure, find the stereochemistry, molecular weight and formula, predict the NMR spectra.	**Ap**
3	Apply the software for converting the 2D structure to 3D, finding the bond length and bond angles,	**Ap**
4	Finding the electronic surface of the molecule and Application of internet to draw the chemical molecules	**Ap**
5	This course gives a favor or weightage to the students during the interview in securing jobs or research opportunities.	**Ap**

CL: Cognitive Levels (**R**-Remember;**U**-Understanding;**Ap**-Apply;**An**-Analyze;**E**-Evaluate;**C**-Create).

CO-PO/PSO mapping for the course:

PO/CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	1	3	2	2	3	3	3	1	3	2	2
CO2	3	3	3	3	2	1	3	2	2	3	3	3	1	3	2	2
CO3	3	3	3	3	2	1	3	2	2	3	3	3	1	3	2	2
CO4	3	3	3	3	2	1	3	2	2	3	3	3	1	3	2	2
CO5	3	3	3	3	2	1	3	2	2	3	3	3	1	3	2	2

"3"–Strong;"2"–Moderate;"1"-Low;"-"No Correlation

Detailed Syllabus: - Chemdraw

Unit No.	Topics	No.of Lect.	CO No.
I	About ChemDraw 2. Installation and applications 3. Usage of tools present in the ChemDraw 4. Drawing of Chemical molecules with ChemDraw 5. Drawing of chiral centered molecules 6. Checking the correctness of structures drawn	6	1
II	Convert the structures into IUPAC name, Convert the IUPAC name into structure, Find the stereochemistry of molecules, Find the molecular weight and chemical formulae. Predict the 1H NMR spectra and chemical shift values	6	2
III	Predict the 13C NMR spectra and chemical shift values Checking the correctness of structures drawn. Predict the melting point, boiling point and logP value. Convert the 2D structure into 3D structure.	6	3
IV	Find the bond lengths and bond angles. Save the molecules in different formats 4. Insert the molecular structures into MS word and PPTs. About standard ChemDraw settings for different scientific organizations. Convert the 3D structure into ball and stick model.	6	4
V	Convert the 3D structure into mesh model. Find the electronic surface of the molecule. Application of internet to draw the chemical molecules. Standard parameters for drawing molecules. Export and import chemical molecules. Summary of ChemDraw.	6	5