FACULTY OF SCIENCE AND HUMANITIES

ACADEMIC CURRICULA

POSTGRADUATE DEGREE PROGRAMME
(REGULATIONS - 2025)

MASTER OF SCIENCE IN ORGANIC CHEMISTRY

Two Years (Full-Time)

National Education Policy

Learning Outcomes based Curriculum Framework (LOCF)

National Credit Framework

Academic Year 2025 -2026

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

TABLE OF CONTENTS

DEPARTMENT OF CHEMISTRY

1. Department Vision Statement	
Stmt - 1	To be a nationally and an internationally acclaimed hub for high-level teaching in chemistry
Stmt - 2	To Implement the global standards and nurturing the students through innovation and quality education.

2. Department Mission Statement	
Stmt - 1	To motivate the next generation graduates to effectively contribute to the advancement of society with integrity and commitment.
Stmt - 2	To expose the students to a breadth of experimental techniques using modern instrumentation.
Stmt - 3	To contribute to industry and address problems of societal importance.
Stmt - 4	To attain entrepreneurship and self-empowerment in the field of chemical sciences.
Stmt - 5	To provide comprehensive specialist expertise in the domain of chemistry

3. Program Education Objectives (PEO)	
PEO - 1	To develop critical analysis and problem-solving skills required in the field of Chemistry
PEO - 2	To prepare students with a working knowledge of experimental techniques and instrumentation required to work independently in research or industrial environments.
PEO - 3	To develop student strength in organizing and presenting acquired knowledge coherently both orally and in written discourse.
PEO - 4	To prepare the students to successfully compete for current employment opportunities
PEO - 5	To develop an ability to be socially intelligent with good SIQ (Social Intelligence Quotient) and EQ (Emotional Quotient)

4. Consistency of PEO's with Mission of the Department

	Mission Stmt. - 1	Mission Stmt. - 2	Mission Stmt. - 3	Mission Stmt. - 4	Mission Stmt. - 5
PEO - 1	Medium	High	High	High	Medium
PEO - 2	High	High	High	Medium	Medium
PEO - 3	High	High	High	Medium	Medium
PEO - 4	Medium	Medium	Medium	High	High
PEO - 5	High	Medium	Medium	High	High

3 – High Correlation, 2 – Medium Correlation, 1 – Low Correlation

5. Consistency of PEO's with Program Learning Outcomes (PO)

	Program Learning Outcomes (PO)											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethical Practices & Social Responsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
PEO - 1	3	3	3	3	2	3	2	3	3	3	1	3
PEO - 2	3	2	3	3	3	1	2	3	3	3	1	3
PEO - 3	2	3	3	3	3	2	1	3	3	3	1	2
PEO - 4	3	3	3	3	2	2	3	3	2	3	2	3
PEO - 5	2	3	2	1	2	3	3	3	3	3	2	2

3 – High Correlation, 2 – Medium Correlation, 1 – Low Correlation

6. PG Programme Structure (Total Credits:80)

1. Professional Core Courses (C)
(10 Courses)

Course Code	Course Title	Hours/ Week L	T*	P	C
PCY25101J	Chemical Kinetics, Electrochemistry and Surface Chemistry	2	0	4	4
PCY25102J	Chemistry of d- and f-Block Elements	2	0	4	4
PCY25103T	Organic Chemistry: Structure and Reactivity	3	1	0	4
PCY25104T	Chemical Bonding, Molecular Geometry and Group Theory	3	1	0	4
POC25201T	Spectroscopy and Applications in Organic Chemistry	3	1	0	4
POC25202T	Transformations in Organic Chemistry	3	1	0	4
POC25203T	Heterocyclic Chemistry and Total Synthesis of Natural Products	3	1	0	4
POC25204T	Modern Methods of Organic Synthesis, Pericyclic and Photochemistry	3	1	0	4
POC25301T	Modern Synthetic Reagents and Rearrangements	3	1	0	4
POC25302T	Bioorganic Chemistry	3	1	0	4
Total Learning Credits					**40**

2. Discipline Elective Courses (D)
(3 Courses)

Course Code	Course Title	Hours/ Week L	T	P	C
PCY25D04T	Nanomaterials and Nanochemistry	3	1	0	4
POC25D01T	Advanced Green Chemistry				
POC25D02T	*Asymmetric and Enzymatic Synthesis*				
POC25D03T	Medicinal Chemistry and Drug Design	3	1	0	4
PCY25D02T	Materials Chemistry				
PCY25D03T	Advanced Polymer Science				
PCY25D05T	Supramolecular Chemistry and Crystal Engineering	3	1	0	4
POC25D04T	Organometallic Chemistry and Catalysis				
POC25D06T	Industrial Organic Chemistry				
Total Learning Credits					**12**

3. Generic Elective Courses (G)
(Any 1Course)

Course Code	Course Title	Hours/ Week L	T	P	C
PPY25G01T	LASER Physics	3	1	0	4
PPY25G02J	Semiconductor Virtual Nanofabrication	3	0	2	4
PCY25G01T	Research Skills and Learning	3	1	0	4
Total Learning Credits					**4**

4. Skill Enhancement Courses(S)
(3 Courses)

Course Code	Course Title	Hours/ Week L	T	P	C
PCY25S01J	Fundamentals and Practical Aspects of Computational Chemistry	1	0	2	2
POC25S01L	Organic Chemistry Practical: Functional Group Analysis and Synthesis	0	0	6	3
POC25S02L	Advanced Organic Chemistry Practical	0	0	6	3
Total Learning Credits					***8***

5. Project Work, Internship In Industry / Higher Technical Institutions(P)

Course Code	Course Title	Hours/ Week L	T	P	C
POC25I01L	Internship	0	0	0	2
POC25P01L	Project Work	0	0	20	10
Total Learning Credits					***12***

6.Ability Enhancement Courses (AE)
(2 Courses)

Course Code	Course Title	Hours/ Week L	T	P	C
PCD25AE1T	Comprehensive Skills in Quantitative and Logical Reasoning	2	0	0	2
PCD25AE2T	Soft Skills and Verbal Mastery	2	0	0	2
Total Learning Credits					***4***

* Additional one hour as open contact hour for each core courses

Course Structure								
Semester	**Professional Core Courses (PCC)**	**Discipline Electives Courses (DEC)**	**Generic ElectivesCourses (GEC)**	**Skill Enhancement Courses(SEC)**	**Ability Enhancement Courses(AEC)**	**Project Work, Internship (P)**	**Total Credits**	**Total Hours**
Sem I	PCC-1(4) PCC-2 (4) PCC-3(4) PCC-4(4)			SEC-1 (2)			**20**	**25**
Sem II	PCC-5 (4) PCC-6 (4) PCC-7 (4) PCC-8 (4)	DEC-1 (4)		SEC-2 (3)	AEC-1 (2)		**25**	**28**
Sem III	PCC-9(4) PCC-10 (4)	DEC-2 (4) DEC-3 (4)	GEC-(4)	SEC-3 (3)	AEC-2 (2)	P (Internship)/ (2)	**25**	**26**
Sem IV						P (Project) (10)	**10**	**20**
Total Credits	**40**	**12**	**4**	**8**	**4**	**12**	**80**	**99**

7. Implementation Plan

Semester - I					
Course Code	Course Title	Hours/ Week			C
		L	T	P	
PCY25101J	Chemical Kinetics, Electrochemistry and Surface Chemistry	2	0	4	4
PCY25102J	Chemistry of d- and f-Block Elements	2	0	4	4
PCY25103T	Organic Chemistry: Structure and Reactivity	3	1	0	4
PCY25104T	Chemical Bonding, Molecular Geometry and Group Theory	3	1	0	4
PCY25S01J	Fundamentals and Practical Aspects of Computational Chemistry	1	0	2	2
PCD25AE1T	Comprehensive Skills in Quantitative and Logical Reasoning	2	0	0	2
	Total Learning Credits				20
	Total Number of Hours				25

Semester - II					
Course Code	Course Title	Hours/ Week			C
		L	T	P	
POC25201T	Spectroscopy and Applications in Organic Chemistry	3	1	0	4
POC25202T	Transformations in Organic Chemistry	3	1	0	4
POC25203T	Heterocyclic Chemistry and Total Synthesis of Natural Products	3	1	0	4
POC25204T	Modern Methods of Organic Synthesis, Pericyclic and Photochemistry	3	1	0	4
PCY25D04T	Nanomaterials and Nanochemistry	3	1	0	4
POC25D01T	Advanced Green Chemistry				
POC25D02T	Asymmetric and Enzymatic Synthesis				
POC25S01L	Organic Chemistry Practical: Functional Group Analysis and Synthesis	0	0	6	3
PCD25AE2T	Soft Skills and Verbal Mastery	2	0	0	2
	Total Learning Credits				25
	Total Number of Hours				28

Semester – III					
Course Code	Course Title	Hours/ Week			C
		L	T	P	
POC25301T	Modern Synthetic Reagents and Rearrangements	3	1	0	4
POC25302T	Bioorganic Chemistry	3	1	0	4
POC25D03T	Medicinal Chemistry and Drug Design	3	1	0	4
PCY25D02T	Materials Chemistry				
PCY25D03T	Advanced Polymer Science				
PCY25D05T	Supramolecular Chemistry and Crystal Engineering	3	1	0	4
POC25D04T	Organometallic Chemistry and Catalysis				
POC25D06T	Industrial Organic Chemistry				
PPY25G01T	LASER Physics	3	1	0	4
PPY25G02J	Semiconductor Virtual Nanofabrication	3	0	2	
PCY25G01T	Research Skills and Learning	3	1	0	
POC25S02L	Advanced Organic Chemistry Practical	0	0	6	3
POC25I01L	Internship	0	0	0	2
	Total Learning Credits				25
	Total Number of Hours				26

Semester - IV					
Course Code	Course Title	Hours/ Week			C
		L	T	P	
POC25P01L	Project Work	0	0	20	10
	Total Learning Credits				10
	Total Number of Hours				20

Total Number of Subjects: 21
Total Number of Credits: 80

8. Programme Articulation Metrix

Course Code	Course Name	Programme Learning Outcomes											
		Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethical practices & Social Responsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
PCY25101J	*Chemical Kinetics, Electrochemistry and Surface Chemistry*	3	3	3	3	2	2	2	2	2	2	3	3
PCY25102J	*Chemistry of d- and f-Block Elements*	3	3	3	3	1	2	1	2	3	3	3	3
PCY25103T	*Organic Chemistry: Structure and Reactivity*	3	3	3	3	2	3	2	2	2	3	2	2
PCY25104T	*Chemical Bonding, Molecular Geometry and Group Theory*	2	2	3	3	3	2	3	3	3	2	2	2
POC25201T	*Spectroscopy and Applications in Organic Chemistry*	3	3	3	3	3	3	3	3	3	2	1	1
POC25202T	*Transformations in Organic Chemistry*	3	3	3	2	2	2	3	3	3	3	2	2
POC25203T	*Heterocyclic Chemistry and Total Synthesis of Natural Products*	3	3	3	3	1	2	1	2	2	2	3	3
POC25204T	*Modern Methods of Organic Synthesis, Pericyclic and Photochemistry*	3	3	3	3	1	2	1	2	2	2	3	3
POC25301T	*Modern Synthetic Reagents and Rearrangements*	3	2	3	3	1	2	1	2	3	3	3	3
POC25302T	*Bioorganic Chemistry*	3	3	3	3	2	3	2	2	2	3	2	2
PCY25D04T	*Nanomaterials and Nanochemistry*	3	3	3	3	1	2	1	2	2	2	3	3
POC25D01T	*Advanced Green Chemistry*	3	3	3	3	1	2	1	2	3	3	3	3
POC25D02T	*Asymmetric and Enzymatic Synthesis*	3	3	3	3	2	3	2	2	2	3	2	3
POC25D03T	*Medicinal Chemistry and Drug Design*	3	3	3	3	1	2	1	2	2	2	3	3
PCY25D02T	*Materials Chemistry*	2	2	3	3	3	2	3	3	3	2	2	2
PCY25D03T	*Advanced Polymer Science*	3	3	3	3	1	2	1	2	2	2	3	3
PCY25D05T	*Supramolecular Chemistry and Crystal Engineering*	2	2	3	3	3	2	3	3	3	2	2	2
POC25D04T	*Organometallic Chemistry and Catalysis*	2	3	3	2	3	2	3	3	3	3	2	2
POC25D06T	*Industrial Organic Chemistry*	3	3	3	3	1	2	1	2	2	2	3	2
PPY25G01T	*LASER Physics*	3	3	3	3	1	2	1	2	3	3	3	3
PPY25G02J	Semiconductor Virtual Nanofabrication	3	3	3	3	2	3	2	2	2	3	2	2
PCY25G01T	*Research Skills and Learning*	2	3	3	2	3	2	3	3	3	3	2	2
PCY25S01J	*Fundamentals and Practical Aspects of Computational Chemistry*	3	3	3	3	1	2	1	2	2	2	3	2
POC25S01L	*Organic Chemistry Practical: Functional Group Analysis and Synthesis*	3	3	3	3	1	2	1	2	3	3	3	3
POC25S02L	*Advanced Organic Chemistry Practical*	3	3	3	3	2	3	2	2	2	3	2	2
POC25I01L	*Internship*	2	3	3	2	3	2	3	3	3	3	2	2
POC25P01L	*Project Work*	3	3	3	3	1	2	1	2	2	2	3	3
PCD25AE1T	*Comprehensive Skills in Quantitative and Logical Reasoning*	2	2	3	3	3	2	3	3	3	2	2	3
PCD25AE2T	*Soft Skills and Verbal Mastery*	3	3	3	3	2	3	2	2	2	3	2	2
PCY25G02T	Chemistry of Biomolecules	3	3	3	3	3	1	2	1	2	3	3	2
	Program Average	3	3	3	3	1	2	1	2	3	3	3	2

3 – High Correlation, 2 – Medium Correlation, 1 – Low Correlation

SEMESTER I

Course Code	PCY25101J	Course Title	Chemical Kinetics, Electrochemistry and Surface Chemistry	Category	C	Core Course	L	T	P	C
							2	0	4	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Help the student to understand the basic principles of chemical kinetics.																			
CLR-2	Probe the chemical reaction in solutions and the factors influencing reaction kinetics.																			
CLR-3	Gather basic knowledge about acid base catalyzed reaction and enzyme catalyzed reaction.																			
CLR-4	Learn the electroanalytical methods, interfacial electrochemistry, phase rule and phase equilibria.																			
CLR-5	Understand the mechanism of surface adsorption process in terms of thermodynamics and chemical kinetics.																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand the basic principles of chemical kinetics.	✓	✓	✓	-	4	85	75	3	-	3	-	-	-	3	-	-	-	-	-
CLO-2	Gain knowledge about fast reaction kinetics.	✓	✓	✓	-	4	85	70	-	3	3	-	-	-	-	-	2	-	-	-
CLO-3	Understand the mechanisms of chemical reactions in gas and liquid phases.	✓	✓	✓	✓	4	85	70	3	-	-	3	-	-	3	-	-	-	-	-
CLO-4	Gain knowledge about the fundamental concepts of electrochemistry and the phase diagrams of multi-component systems.	✓	✓	✓	✓	4	85	70	3	-	3	-	-	-	-	-	-	-	-	3
CLO-5	Understand the basic principles of adsorption, kinetics of chemisorption of gases and BET related isotherms.	✓	✓	✓	✓	4	85	60	-	3	3	-	-	-	2	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Reaction kinetics	Reaction rate descriptors and related effects	EMF determination and interfacial electrodics	Electroanalytical methods and phase equilibria	Adsorption isotherms
	18	18	18	18	18

SLO-1	Simple collision theory.	Solvent effects on reaction rates, and cage effect.	Electromotive force - measurement of EMF.	Introduction to voltammetry techniques, types of electrochemical reactions and interpretation.	Adsorption of gases and vapors on solids.
SLO-2	Absolute reaction rate theory (ARRT) Application of ARRT to simple bimolecular process.	Factors determining the reaction rates in solution (based on transition state theory).	Reversible cells - types of half cells - classification of cells.	Important electrochemical equations such as Randel-Sevick equation, and Cottrell equation.	Langmuir adsorption isotherm.
SLO-3	Thermodynamic treatment, potential energy surfaces.	Ion-dipole and dipole-dipole interactions.	The standard EMF of a cell - electrochemical potential - standard electrode potentials.	Butler-Volmer equation and derivation.	Kinetic and statistical derivation of Langmuir adsorption isotherm.
SLO-4-6	Practice: Introduction and demonstration of the lab instruments.	Practice: Determination of E_a of saponification of ester by conductometry method.	Practice: Determination of strength of an acid by conductometry.	Practice: Repeat class.	Practice: Adsorption of acetic acid on charcoal – determination of strength of acetic acid using Langmuir adsorption isotherm.
SLO-7	Chain reactions, general characteristics.	Structure, significance of volume and entropy of activation, and pressure effect.	Nernst equation and its applications.	Introduction to phase rule and its components.	Adsorption entropies.
SLO-8	Study of kinetics of chain reaction like H_2-Br_2 reaction.	Primary and secondary salt effects.	Concentration cells.	Degree of freedom, conditions for equilibrium between phases.	Lateral interactions.
SLO-9	Decomposition of acetaldehyde and N_2O_5. Theory of unimolecular reactions.	Kinetics of photophysical and photochemical processes. Complex photochemical processes, Homogeneous catalysis.	The concept of liquid junction potential.	Derivation of Gibbs phase rule. Phenol-water one component system.	BET and related isotherms.
SLO-10-12	Practice: Determination of rate constant of acid hydrolysis of an ester.	Practice: Determination of molecular weight of substance by transition temperature method.	Practice: Potentiometric titration of a redox reaction.	Practice: Determination of critical solution temperature (CST) of phenol- water system.	Practice: Adsorption of oxalic acid on charcoal – determination of strength of acetic acid using Freundlich adsorption isotherm.
SLO-13	Lindemann and Hinshelwood mechanisms for gas-phase unimolecular reactions.	General catalytic mechanisms, acid-base catalysis.	Decomposition voltages, concentration polarization and over voltage.	Phase diagram of sulphur.	Derivation of BET equation and its related properties.
SLO-14	Steady state approximation.	Catalysis by enzymes, influence of concentration (single substrate, double substrate).	Kinetics of electrode process. Electrical aspects of surface chemistry.	Phase diagram of two component system.	Thermodynamics of adsorption, chemisorption and catalysis.
SLO-15	Principle of microscopic reversibility and detailed balancing.	Influence of concentration (single substrate, double substrate).	Electrical double layer, Stern treatment of the electrical double layer, free energy of a diffuse double layer.	Formation of compounds with congruent and incongruent melting points.	Kinetics of chemisorption.

SLO-16-18	Practice: Kinetics of iodine clock reaction.	Practice: equivalent conductance, degree of dissociation and dissociation constant of weak acid by conductometry.	Practice: Determination of strength of an iron solution by potentiometric method.	Practice: Determination of solubility diagram for a three-component system.	Practice: Repeat class.

Resources

1.	*K.J. Laidler, Chemical Kinetics, 2nd Edition, Tata-McGraw Hill, Inc., New York, 1973.*	5.	*J.O.M. Bockris and A.K.N. Reddy, Modern Electrochemistry, Volumes 1 & 2, Plenum Press, New York. 1988*
2.	*Gurdeep Raj, Chemical Kinetics, Goel Publishing House, 2002.*	6.	*S. Glasstone, Electrochemistry, Affiliated East-West Press, Pvt., Ltd., New Delhi, 1974.*
3.	*P.Atkins, J.D. Paula, Physical Chemistry, W. H. Freeman and Company New York, 8th Ed., 2018.*	7.	*M. Soustelle, An Introduction to Chemical Kinetics, John Wiley and Sons, 2005.*
4.	*A.J.Bard and L.R. Faulkner, Electrochemical methods –Fundamentals and Applications,2nd Ed., John Wiley and Sons, 2001.*	8.	*J. U. Keller and, R. Staudt, Gas adsorption equilibria, experimental methods and adsorptive isotherm, Springer nature, 2005.*

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1 (10 %)		CLA – 2 (10 %)		CLA – 3 (20 %)		CLA – 4* (10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	15	15	15	10	10	10	10	15	15
2	Understand	15	15	15	15	10	10	10	10	15	15
3	Apply	20	25	25	20	25	25	25	25	25	25
4	Analyze	20	25	25	20	25	25	25	25	25	25
5	Evaluate	15	10	10	15	15	15	15	15	10	10
6	Create	15	10	10	15	15	15	15	15	10	10
Total (%)		100	100	100	100	100	100	100	100	100	100

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers					
Professional Experts		**Higher Institution Experts**		**Internal Experts**	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Arun Prakash P and Dr. Anandhakumar S, Department of Chemistry, SRMIST Email id: arunprap1@srmist.edu.in; anandhas2@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	PCY25102J	Course Title	Chemistry of *d*- and *f*-Block Elements	Category	C	Core Course	L	T	P	C
							2	0	4	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment			Program Outcomes (PO)												
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Motivate the learners to understand the different types coordination complexes.																			
CLR-2	Distinguish and intervene the theories of coordination complexes of d-block elements with variable configurations.																			
CLR-3	Identify as well as to predict the feasibility and stability of coordination complexes																			
CLR-4	Compare the physicochemical properties of the complexes against spectroscopic and magnetic properties.																			
CLR-5	Study the synthetic strategies based on the reactivity with respect to structural and fundamental factors.																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Deduce the structure of different types of coordination complexes.	✓	✓	✓	-	4	85	75	-	3	-	2	-	-	3	-	-	-	-	-
CLO-2	Correlate the gradational development of theories of coordination complexes due to splitting of orbitals.	✓	✓	✓	-	4	85	70	-	3	-	3	-	-	-	-	-	-	-	2
CLO-3	Predict the spectroscopic and magnetic properties of the metal-ligand coordination spheres.	✓	✓	✓	✓	4	85	70	-	3	-	3	-	-	3	-	-	-	-	-
CLO-4	Conclude the type of reactions to be occurred with the variety of the metal complexes	✓	✓	✓	✓	4	85	70	-	3	-	2	-	-	-	-	-	-	-	3
CLO-5	Understand the versatile mechanistic pathways associated with the reactions of different coordination sphere	✓	✓	✓	✓	4	85	60	-	3	-	3	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Introduction to Coordination Chemistry	Valence Bond Theory	Magnetic Properties	Inorganic Reaction Mechanism	Lanthanides and Actinides
	18	18	18	18	18
SLO-1	Introduction monodentate, bidentate, and polydentate ligands, coordination sphere, coordination number	Valence bond theory: hybridization, Geometry, magnetism, drawbacks of VBT	Magnetic properties of tetrahedral and octahedral complexes	Ligand substitution reactions in octahedral, square planar complexes	Lanthanides: lanthanide series, abundance and natural isotopes

SLO-2	Nomenclature of mononuclear and dinuclear complexes	Crystal field theory: crystal field effects, assumptions of crystal field theory, crystal field splitting in octahedral and tetrahedral geometries, qualitative crystal field splitting diagrams, high-spin and low-spin complexes	Para, dia, ferromagnetism and antiferro magnetism, determination of magnetic properties, Gouy's method	Labile and inert complexes (application of VBT, MOT), dissociation, association mechanism, Mechanism of hydrolysis reactions, acid hydrolysis, base hydrolysis	Lanthanide contraction, similarity in properties, occurrence, oxidation states
SLO-3	Chelate effect, Werner's theory and Sidgwick theory	**c**rystal field splitting in octahedral and tetrahedral geometries, qualitative crystal field splitting diagrams, high-spin and low-spin complexes	Anomalous magnetic moment, thermal effects, single molecular magnets, spin and orbital contribution quenching	*trans* effect, *trans* influence, *trans* effect and its application	Chemical properties of Ln(III) cations, magnetic properties, colour and electronic spectra of lanthanide compounds
SLO-4-6	Practice: Introduction to Inorganic Chemistry Lab	Practice: Synthesis of metal acetylacetonate complex	Practice: *Cis* and *trans* isomers of $[Co(en)_2Cl_2]Cl$	Practice: Preparation of Ferrocene	Practice: Preparation of triphenyl phosphene (Ph_3P), and transition metal complexes
SLO-7	EAN and formation of metal-metal bond in dimers	CFSP and factors affecting it, computation of CFSE, evidences of crystal field splitting, spectrochemical series	Spin cross over rule, microstates of electron configuration in free atoms and ions, Term symbols for equivalent and nonequivalent electrons, possible term symbols for given configuration	Theories of trans effect, thermodynamic and kinetic stability of complexes, factors affecting stability of metal complexes	Separation of lanthanides, solvent extraction, ion exchange method
SLO-8	Stability of complexes, determination of stability constants	CFSP and factors affecting it, computation of CFSE, evidences of crystal field splitting, spectrochemical series	p^2 -d^2 splitting of terms in square planar, tetrahedral, octahedral fields, electronic spectra of various complexes	Electron transfer reactions, one electron transfer reactions, inner and outer sphere mechanism	Actinides: actinide series, abundance and natural isotopes, occurrence
SLO-9	Jobs method, stepwise stability constant, Overall stability constant, factors affecting stability of coordination compounds	Jahn-Teller theorem, crystal field splitting in tetragonally distorted octahedral geometry and in square planar geometry	Selection rules, spin orbit coupling, assignment and intensities of transitions	Marcus theory and its applications, two electron transfer reactions complementary and non - complementary electron transfer reactions	Preparation of actinides, oxidation states, general properties, the later actinide elements
SLO-10-12	Practice: Determination of Cr(III) complexes. $[Cr(H_2O)_6]NO_3.3H_2O$; $[Cr(H2O)_4Cl_2]Cl.2H_2O$; $[Cr(en)_3]Cl_3$; $Cr(acac)_3$	Practice: Preparation of Tin(IV) iodide, Tin(IV) chloride, and Tin(II) iodide	Practice: (*N*,*N*)-bis(salicyldehyde)ethylenediamine Salen H_2; and its cobalt complex [Co(Salen)]	Practice: Reaction of Cr(III) with multidentate ligands, a kinetics experiment - Vanadyl acetylacetonate	Practice: Reaction of Mixed valence dinuclear complex of Mangenese(III, IV)
SLO-13	Charge of central metal ion, size of central metal ion, chelate ring size, steric effects	Covalency in transition metal complexes, evidences for covalency	Orgel (d^1 to d^9 octahedral and tetrahedral complexes) and Tanabe Sugano diagrams (d^1, d^6 complexes and its applications)	Synthesis of coordination compounds using electron transfer reactions, metal assisted reactions	Uranium-occurrence, metallurgy; chemical properties of hydrides, oxides, and halides
SLO-14	Isomerism: linkage, ionization, hydrate, coordination, coordination position isomerism,	Intensity of d-d transitions, spin-spin splitting, hyperfine splitting, adjusted crystal field theory	Calculation of D_0 and D_t and Racah parameters, examples from d^2, d^3 d^7, d^8 octahedral complexes	Synthesis of macrocyclic ligands, reaction of coordinated ligands, template effect	Uranium-occurrence, metallurgy; chemical properties of hydrides, oxides, and halides

SLO-15	Geometrical (*cis* and *trans*, and *fac* and *mer*) and optical isomerism	MO Theory: metal orbitals and LGOs suitable for σ and π bonding in octahedral geometry, Construction of qualitative MO energy level diagram for bonding in octahedral geometry.	Charge transition spectra of metal complexes	Synthesis of macrocyclic ligands, reaction of coordinated ligands, template effect	Complexes of lanthanides and actinides
SLO-16-18	Practice: Synthesis of inorganic complexes characterization by physicochemical methods, viz. FT-IR, UV-vis, NMR and magnetic susceptibility	Practice: Any one new novel synthesis reported in recent literature	Practice: Analysis of metal complexes to deduce its structure	Practice: pH meter-based measurements	Practice: Repeat experiment

Resources

1	D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rdEd., W. H. Freeman and Co, London, 1999.	6.	Vogel's Inorganic Qualitative Analysis, 7th Impression by G. Svehla, Pearson Education, New Delhi, 2009.
2	J. E. Huheey, E. A. Kieter and R. L. Keiter, Inorganic Chemistry, 4thEd., Harper Collins, New York, 1993.	7.	J. D. Lee, Consise Inorganic Chemistry, Wiley, 5th Edition, 2021.
3	F. A. Cotton, G. Wilkinson and P.L.Gaus, Basic Inorganic Chemistry, 3rd Ed., John Wiley, New York, 2008.	8.	R. P. Sarkar, General and Inorganic Chemistry: Volume II, New Central Book Agency (P) Limited, 2009.
4	N. N. Greenwood and A.Earnshaw, Chemistry of the Elements, 2nd Ed., Pergamon Press, Oxford, 2005.	9.	R.D. Madan, Modern Inorganic Chemistry, S.Chand & Company limited, 2017.
5	B.Douglas, D.McDaniel and J.Alexander, Concepts and Models of Inorganic Chemistry, 3rd Ed., Wiley, 2013.	10	J. Chem. Educ. 1977, **54**, 443.

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	15	15	15	10	10	10	10	15	15
2	Understand	15	15	15	15	10	10	10	10	15	15
3	Apply	20	25	25	20	25	25	25	25	25	25
4	Analyze	20	25	25	20	25	25	25	25	25	25
5	Evaluate	15	10	10	15	15	15	15	15	10	10
6	Create	15	10	10	15	15	15	15	15	10	10
Total (%)		100	100	100	100	100	100	100	100	100	100

✓

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts	Higher Institution Experts	Internal Experts
1 Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1 Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1 Dr. Tarak Nath Mandal, Department of Chemistry, SRMIST Email id: taraknam@srmist.edu.in
	2 Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2 Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	PCY25103T	Course Title	Organic Chemistry: Structure and Reactivity	Category	C	Core Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment			Program Outcomes (PO)											
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	gain exposure to the field of aromatic compounds																			
CLR-2	gain knowledge about the mechanism of a reaction																			
CLR-3	learn about the reaction intermediates																			
CLR-4	gain insight about how a molecule arrange in 3D space																			
CLR-5	know different types of reactions like substitution and elimination																			
Outcomes (CLO)	**At the end of this course, learners will be able to:**	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand the concept of aromaticity	✓	✓	✓	-	2	75	60	3	3	-	2	-	-	3	-	-	-	-	-
CLO-2	Recognize reaction mechanism	✓	✓	✓	-	2	80	70	2	3	-	3	-	-	-	-	-	-	-	2
CLO-3	Realize reaction pathways	✓	✓	✓	✓	2	70	65	3	3	-	3	-	-	3	-	-	-	-	-
CLO-4	Visualize molecules in 3D space and understand the arrangements of different atoms around a carbon center	✓	✓	✓	✓	2	70	70	3	3	-	2	-	-	-	-	-	-	-	3
CLO-5	Know how carbonyl compounds cab ne utilized in organic transformation	✓	✓	✓	✓	2	80	70	2	3	-	3	-	-	-	-	-	-	-	3

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Aromaticity and introduction to reaction mechanism	Conformations in organic compounds	Mechanism of aliphatic and aromatic substitution reactions	Introduction to elimination reactions, ring opening and hydrogenation reactions	Introduction to carbonyl compounds and reactions
	12	12	12	12	12
SLO-1	Aromaticity, anti-aromaticity and Non aromatic compounds, Hückel's rule of aromaticity	conformational analysis: acyclic system, conformational analysis: acyclic system	SN1, SN2, SNi and NGP, nucleophilic substitutions at allylic, aliphatic and vinyl carbons	E2, E1, E1cb and E2C mechanisms, stereochemistry	Introduction to carbonyl compounds, Nucleophilic addition to carbonyl compounds
SLO-2	homo-aromaticity, aromatic systems (3, 4, 5, and 7- membered ring systems)	cyclic systems	effect of substrate, nucleophile, leaving group, and medium, stereochemistry, ambident nucleophiles	Hoffmann and Saytzeff rules, effect of substrate, base, leaving group and medium, pyrolytic eliminations,	stereochemistry of nucleophilic additions, Cram's rule, Felkin-Anh model

SLO-3	annulenes and fused rings systems, heteroannulenes, aromaticity of heterocycles	effect of conformation on reactivity	Aromatic electrophilic substitution, mechanism and reactivity, selectivity and orientation, the effect of leaving group	Chugaev reaction, Cope elimination, Bamford-Stevens reaction, Peterson Olefination	chemistry of imines, enolates, keto-enol tautomerism
SLO-4	Tutorial : homo-aromaticity, aromatic systems, Types of mechanisms, transition states and intermediates, thermodynamic and kinetic requirements,	Tutorial : conformational analysis and cyclic systems	Tutorial : nucleophilic substitutions at allylic, aliphatic and vinyl carbons	Tutorial : Hoffmann and Saytzeff rules	Tutorial : chemistry of imines,
SLO-5	Hammond postulate, Curtin-Hammett principle, methods of determining mechanisms, isotopic effects,	elements of symmetry, chirality, molecules with more than one chiral center, projection formulae (i) Fischer (ii) Sawhorse	nitration, nitrosation and diazonium coupling, sulphonation, chlorination, bromination, Friedel-Crafts alkylation	Addition reactions to double bonds, triple bonds, electrophilic, nucleophilic additions	condensation reactions of carbonyl compounds, aldol condensations (acid and base catalyzed aldol condensation, crossed aldol condensation
SLO-6	Hammett equation and linear free energy relationship (sigma-rho) relationship, Taft equation and its application	(iii) Newman (iv) Flying Wedge, threo and erythro isomers, methods of resolution, specific rotation, optical purity and enantiomeric excess	Friedel-Crafts acylation, arylation, aromatic nucleophilic substitutions: SNAr, SN1, benzyne mechanisms	free radical additions, orientation and reactivity, stereochemistry of addition reactions	Claisen-Schmidt condensation, directed aldol condensations, Mukaiyama aldol condensation, Claisen ester condensation
SLO-7	Reaction intermediates: Generation, structure, stability, and reactivity, carbocations	enantiotopic and diastereotopic atoms, groups and faces,	Sommelet-Hauser, Von Richter and Smiles rearrangement	Ring opening of cyclopropanes, Addition of hydrogen halides (Markownikov's rule) and bromine, halohydrin formation, hydroboration (anti-Markownikov's rule)	Dieckmann reaction, Stobbe condensations,Acyloin condensation, Knoevenagel condensations, 1,4-conjugate additions (Michael addition), Robinson annulation
SLO-8	Tutorial: Hammett equation and linear free energy relationship	Tutorial : projection	Tutorial : Friedel-Crafts acylation, arylation reactions	Tutorial : free radical additions, orientation and reactivity,	Tutorial : condensation reactions
SLO-9	Carbanions, free radicals,	enantiotopic and diastereotopic atoms, groups and faces	Bucherer and Rosenmund reactions, aliphatic substitution mechanisms, SE2, SEi and SE1	hydrozirconation, iodolactonization, bromolactonization, oxymercuration	Wittig reactions, Mannich reactions, nucleophilic addition to isocyanates and isothiocyanates,
SLO-10	carbenes, nitrenes	stereospecific and stereoselective reactions	addition-elimination and cyclic mechanisms, halogenations of ketones, aldehydes and carboxylic acids, aliphatic diazonium coupling, sulphonation, sulphenylation,	hydrogenation reactions (hydrogenation of C=C double bonds, triple bonds, and aromatic rings)	esterification reactions, ester hydrolysis,
SLO-11	benzyne, non-classical carbocations	optical activity in the absence of chiral carbon	acylation, Stork enamines, carbene and nitrene insertions, Kolbe-Schmidt reaction	Koch reaction	Mcmurry coupling, Tabbe reagent, Pinacol Coupling Reaction, haloform reaction.
SLO-12	Tutorial: Carbanions and non-classical carbocations	Tutorial : enantiotopic and diastereotopic atoms	Tutorial : addition-elimination and cyclic mechanisms,	Tutorial : hydrogenation reactions	Tutorial : Mcmurry coupling

Resources

1	*M. B. Smith and J. March, March's Advance Organic Chemistry, 6th Ed., John Wiley and Sons, Inc.*	4	*T. W. G. Solomons and C. B. Fryhle, Organic Chemistry 10th Ed.,John Wiley and Sons, Inc.*
2	*J. Clayden, N. Greeves, and S. Warren, Organic Chemistry 2nd Ed., Oxford*	5	*I. L. Finar and A. L. Finar, Organic Chemistry Vol. 2, Addison-Wesley*
3	*J. McMurry, Organic Chemistry 5th Ed., Thomson*	6	*D. N. Nasipuri, Stereochemistry of Organic Compounds: Principles & Applications, 3rd edition, South Asia Books 2012*

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)		✓
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*				
		(10 %)		(10 %)		(20 %)		(10%)				
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	
1	Remember	15	-	15	-	10	-	10	-	15	-	
2	Understand	15	-	15	-	10	-	10	-	15	-	
3	Apply	20	-	25	-	25	-	25	-	25	-	
4	Analyze	20	-	25	-	25	-	25	-	25	-	
5	Evaluate	15	-	10	-	15	-	15	-	10	-	
6	Create	15	-	10	-	15	-	15	-	10	-	
Total (%)		100	-	100	-	100	-	100	-	100	-	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Susnata Pramanik, Department of Chemistry,SRMIST, Email: susmatap@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	PCY25104T	Course Title	Chemical Bonding, Molecular Geometry and Group Theory	Category	C	Core Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment			Program Outcomes (PO)											
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Recite the types of bonds and illustrate the structure of crystals																			
CLR-2	Solve the radius ratio of the crystals, enthalpy of formation of ionic compound and identify the various crystal defects																			
CLR-3	Summarize the molecular geometry, structure of covalent compounds and various weak chemical forces and bonding in metals																			
CLR-4	Discuss the acidity and basicity of acids and bases based on various concepts																			
CLR-5	Explore the mathematical calculation based on group theory and find its application in chemistry																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibilit	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Define the types of bonds, structures of crystals and calculate radius ratio and enthalpy of formation of ionic compounds	✓	✓	✓	-	4	75	60	3	3	1	2	-	-	-	-	-	-	-	-
CLO-2	Explain the molecular topologies of covalent compounds and illustrate the MOT	✓	✓	✓	-	4	80	70	3	3	3	3	-	-	-	-	-	-	-	2
CLO-3	Relate the Weak chemical bonding forces in predicting the properties of compounds and metals	✓	✓	✓	✓	4	70	65	3	3	2	3	-	-	-	-	-	-	-	-
CLO-4	Distinguish the acidity and basicity of acids and bases	✓	✓	✓	✓	4	70	70	1	3	3	2	-	-	-	-	-	-	-	3
CLO-5	Identify the molecular vibrations and chirality in compounds using group theory	✓	✓	✓	✓	4	80	70	3	3	2	3	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Chemical bonding and crystal structure	Ionic Compounds and Properties	Concepts in Bonding	Acid-Base Chemistry	Symmetry in Chemistry
	12	12	12	12	12
SLO-1	Chemical bond-types of bonds	covalent character in ionic compounds, polarization	orbital mixing, heteronuclear diatomic molecules	proton transfer equilibria under aqueous conditions	Symmetry elements and Symmetry operations
SLO-2	Ionic compounds-Properties, factors favoring the formation	Fajan's rules, effects of polarization, solubility, melting points and thermal stability of typical ionic compounds	polar bonds, ionic compounds, and molecular orbitals, molecular orbitals of polyatomic molecules	non-aqueous solvents and acid-base strength, periodic trends in aqua acid strength,	Point groups

SLO-3	ionization potential, electron affinity and electronegativity	Crystal defects: Schottky defects, controlled valency, F-Center, Frenkel defect, non-stoichiometric, interstitial and electron deficient compounds	Vander Waals forces, inclusion compounds, Layer and Channel structures	oxoacids, anhydrous oxides	Point groups
SLO-4	Tutorial: Problem-Solving in Bonding and Ionic Compounds: Energetics and Trends	Tutorial: Problem-Solving in Polarization and Properties of Ionic Compounds	Tutorial: Solving problems involving polar bonds and their relationship to molecular orbitals.	Tutorial: Comparing acid-base behavior in non-aqueous solvents.	Tutorial: Identifying Symmetry Elements, Symmetry Operations, and Point Groups
SLO-5	packing of ions in crystals and crystal structures, ccp, hcp, bcc, fcc.	Molecular topologies: shared and lone pairs, Lewis structures, isoelectronic and isolobal relationships	cage structures (gas hydrates and clathrates)	Bronsted-Lowry acidity of aqueous cations,	groups and classes of symmetry operations
SLO-6	radius ratio and structure of ionic lattices, Stoichiometry and crystal structures	VSEPR model: Hybridization and geometry	Hydrogen bonding: non-conventional hydrogen bonding, associated molecules, molecular self- assembly	Lewis acid- base concept and frontier orbitals,	non-degenerate representations, degenerate representations
SLO-7	Geometrical method of computing radius ratios, relation between radius ratio and coordination number.	VSEPR model: Hybridization and geometry	supramolecular architectures formed by weak chemical forces	quantification of Lewis basicity, inductive and steric effects on Lewis acidity and basicity,	Great Orthogonality theorem
SLO-8	Tutorial: Problem-Solving in Crystal Structures: Packing, Radius Ratios, and Stoichiometry	Tutorial: Applying VSEPR theory to determine hybridization and molecular geometry.	Tutorial: Solving problems on gas hydrates and clathrates	Tutorial: Quantifying Lewis Acidity and Basicity: Steric and Inductive Effects	Tutorial: Symmetry Groups, Representations, and the Great Orthogonality Theorem
SLO-9	Lattice energy: definition, Born- Lande equation, factors affecting energy	Molecular orbital Theory, Linear Combination of Atomic orbitals	Bonding in metals: packing of atoms in metals, band theory of metals and metallic properties.	frustrated Lewis pairs	Construction of character table
SLO-10	Born-Haber cycle, enthalpy of formation of ionic compounds and stability	bonding, antibonding and non-bonding molecular orbitals	insulators and semiconductors	hard and soft acids and bases,	reduction formula, character of matrices
SLO-11	calculation of ionic radius, Pauling's method and Linde's method, effective nuclear charge, Slater's rule.	MOs of homonuclear diatomic molecules	Bronsted-Lowry concept	thermodynamic acidity parameters, superacid and superbase.	applications to molecular vibrations (IR and Raman activity) and chirality
SLO-12	Tutorial: Problem-Solving in Lattice Energy, Ionic Radii, and Stability of Ionic Compounds	Tutorial: Constructing molecular orbital diagrams using the Linear Combination of Atomic Orbitals (LCAO) approach.	Tutorial: Applying band theory to explain metallic properties, insulators, and semiconductors.	Tutorial: Advanced Concepts in Acid-Base Chemistry: FLPs, HSAB, and Superacids	Tutorial: Character Tables and Molecular Vibrations

Resources			
1	*D. F.Shriver, P. W.Atkins and C. H. Langford, Inorganic Chemistry, 3rdEd., Oxford University Press, London, 2001*	*6*	*R. B. Jordan, Reaction mechanisms of Inorganic and Organo metallic systems, OUP, 1991.*
2	*J. E.Huheey, E. A.Keiter and R. L. Keiter, Inorganic Chemistry, 4thEd., Harper and Row, NewYork, 1983*	*7*	*Miessler, G. L. and Tarr, D. A. Inorganic Chemistry III Edition, 2004*
3	*Purcell, K.F and Kotz, J.C – Inorganic chemistry, WB saunders Co., USA(1977)*	*8*	*A.Vincent,Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications, JohnWiley& Sons Ltd, 1977*
4	*M.C. Day and J. Selbin, 1974, Theoretical Inorganic Chemistry, Van Nostrand Co. NY*	9	*F. Albert Cotton, Chemical Applications of Group Theory, 2ndEd., John Wiley & Sons, 1971*
5.	*A.F. Wells, - 1984, Structural Inorganic Chemistry, V. Edition, Oxford*	10	K.V.Raman, 1990, Group Theory and its applications to chemistry, Tata Mc.Graw Hill

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	15	-	15	-	15	-
2	Understand	15	-	15	-	15	-	15	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	10	-	10	-	10	-
6	Create	15	-	10	-	10	-	10	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers					
Professional Experts		**Higher Institution Experts**		**Internal Experts**	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Tumpa Sadhukhan, Department of Chemistry, SRMIST Email id: tumpas@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	PCY25S01J	Course Title	Fundamentals and Practical Aspects of Computational Chemistry	Category	S	Skill Enhancement Course	L	T	P	C
							1	0	2	2

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment			Program Outcomes (PO)											
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Enable them to learn the principles of computer aided chemical information tools and techniques																			
CLR-2	Explore the data base search for the molecules and its access for the chemical reactions																			
CLR-3	Explore about IUPAC names, design of molecules at different platforms.																			
CLR-4	To make the students aware about the basic concepts in computational chemistry																			
CLR-5	Develop strategies of drug design and target oriented receptor interaction study																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibil	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand the basic principles of computer aided drug design through chemistry approaches.	✓	✓	✓	-	4	85	75	3	3	3	2	3	-	-	-	-	-	-	-
CLO-2	Explain the concept of HF method and DFT Methods	✓	✓	✓	-	4	85	75	3	3	2	3	3	-	-	-	-	-	-	2
CLO-3	Gain knowledge about the chemical databases	✓	✓	✓	✓	4	85	75	3	3	2	3	3	-	-	-	-	-	-	-
CLO-4	Acquaint the student with the fundamental concepts of drug discovery and different stages	✓	✓	✓	✓	4	85	75	3	3	3	2	3	-	-	-	-	-	-	3
CLO-5	Understand the principles of modeling tools and concepts In molecular modeling and drug design	✓	✓	✓	✓	4	85	75	3	3	3	3	3	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Chemical Structures	Electronic Structure	Density Functional Theory	Molecular Mechanics	Molecular Dynamics
	9	9	9	9	9
SLO-1	Concepts in Molecular Modelling and chemical representation of molecules	Introduction to Ab-initio methods and Electronic structure calculations	Theorems and Functionals in DFT	Introduction to Molecular Mechanics and combinatorial optimization approach	Development of drug and drug development time lines and stages of drug discovery
SLO-2	Practice Design of chemical structures	Practice: Small molecules energy calculation at HF method	Practice: Gaussian model chemistry I	Practice: PyMol software with examples case study	Practice: Protein Modelling using PDB database
SLO-3	Practice: Molecular Modelling	Practice: Small molecules energy calculation at HF method	Practice: Gaussian model chemistry I	Practice: PyMol software with examples case study	Practice:: Protein Modelling using PDB database

SLO-4	Structure design and search parameters	Discussion on post Hartree-Fock Methods and basis sets	Time independent DFT	Computer Assisted Drug Design and Structure-based library	Introduction to force fields
SLO-5	Practice: Open database creation of CIFs	Practice: Small molecules frequency calculation at HF level of theory	Practice: Application of DFT in UV-Vis spectroscopy	Practice: PDB data base – Protein preparation	Practice: Protein molecular dynamics in Gromacs
SLO-6	Practice: Crystallographic Open Database COD	Practice: Small molecules binding energy calculation at HF level of theory	Practice: Application of DFT in UV-Vis spectroscopy	Practice: PDB data base for Ligand preparation	Practice: Protein molecular dynamics in Gromacs
SLO-7	Chemical markup languages and IUCr Crystallographic Information Framework	Potential energy surface and PDB Ligand Explorer Chemspider, Other Data Bases	Basics of spectroscopy principles	QSAR Drug design and Target Identification and Validation	Introduction to Molecular Dynamics
SLO-8	Practice: CIF creation and analysis with examples	Practice: Generation of PES at HF level of theory	Practice: Application of DFT in IR spectroscopy	Practice: Docking with Autodock Vina	Practice: Protein molecular dynamics in Gromacs
SLO-9	Practice: Analysis of CCDC structures and parameters with examples	Practice: Generation of PES at HF level of theory	Practice: Application of DFT in NMR spectroscopy	Practice: Docking with Autodock Vina	Practice: Protein molecular dynamics in Gromacs

Resources

1	*An Introduction to Cheminformatics", Revised Edition, Springer Publication, 2007.*	6	*Silverman, Richard B., and Mark W. Holladay. The organic chemistry of drug design and drug action.Academic press, 2014.*
2	*Johann Gasteiger, Dr. Thomas Engel, "Cheminformatics", Wiley-VCH Press, 2003.*	7	*Bajorath, Jurgen. Chemoinformatics for Drug Discovery. John Wiley & Sons, 2013.*
3	*Jurgen Bajorath, "Cheminformatics: Concepts, Methods and Tools for Drug Discovery", Humana Press, 2004*	8	*Engel, T., & Gasteiger, J. (2018). Cheminformatics: Concepts, Workflows, and Applications. Wiley-VCH*
4	*F. Jensen, Introduction to Computational Chemistry, (Wiley, New York, 1999). Good introductory textbook covering a variety of topics.*	9	*Young, D. C. (2001). Computational Chemistry: A Practical Guide for Applying Techniques to Real-World Problems. Wiley-Interscience*
5	Tudor. L.Oprea, "Cheminformatics in Drug Discovery", Wiley-VCH Press, 2005	10	*Hehre, W. J., Radom, L., Schleyer, P. R., & Pople, J. A. (1986). Ab Initio Molecular Orbital Theory. Wiley*

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	15	15	15	10	10	10	10	15	15
2	Understand	15	15	15	15	10	10	10	10	15	15
3	Apply	20	25	25	20	25	25	25	25	25	25
4	Analyze	20	25	25	20	25	25	25	25	25	25
5	Evaluate	15	10	10	15	15	15	15	15	10	10
6	Create	15	10	10	15	15	15	15	15	10	10
Total (%)		100	100	100	100	100	100	100	100	100	100

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		-
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Tumpa Sadhukhan, Department of Chemistry, SRMIST, Chennai Email: tumpas@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. M. Prakash Department of Chemistry, SRMIST Email id: prakashm4@srmist.edu.in
				3.	Prof. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Codes	PCD25AE1T	Course Title	Comprehensive Skills in Quantitative and Logical Reasoning	Category	AE	Ability Enhancement Course	L	T	P	C
							2	0	0	2

Offering Department	Career Guidance	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CR)	The purpose of learning this course is to:
CR-1	Build a strong foundation in numerical concepts and arithmetic techniques, enabling learners to solve mathematical problems accurately and efficiently.
CR-2	Equip learners with essential skills for understanding and solving financial and proportional reasoning problems relevant to real-life scenarios and career needs.
CR-3	Develop problem-solving skills in time, work, speed, distance, and ratio-based applications, enabling learners to tackle real-world mathematical challenges efficiently..
CR-4	Enhance learners' logical reasoning and data interpretation skills, enabling them to solve real-life problems involving clocks, calendars, directions, relationships, and data analysis.
CR-5	Sharpen learners' logical thinking and problem-solving abilities, helping them develop skills in tackling number puzzles, logical puzzles, reasoning-based problems, and coding challenges.

Outcomes (CO)	At the end of this course, learners will be able to:	Depth				Attainment			Program Outcomes (PO)												
		Conceive	Design	Implement	Operate	Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	
CO-1	Apply numerical methods to solve problems involving number classification, divisibility tests, progressions, HCF & LCM, simplification techniques, and vinculum-based calculations.	✓	✓	✓	✓	1	85	75	-	3	1	3	1	-	-	-	2	-	-	-	
CO-2	Calculate interest, analyze profit and loss, and solve problems related to percentages, discounts, permutations, combinations, and probability, enhancing their quantitative reasoning skills.	✓	✓	✓	✓	3	85	75	-	3	1	3	1	-	-	-	2	-	-	-	
CO-3	Solve problems related to time and work, speed and distance, boats and streams, mixtures and alligations, height and distance, and age-based calculations with accuracy and efficiency.	✓	✓	✓	✓	4	85	75	-	3	1	3	1	-	-	-	2	-	-	-	
CO-4	Solve problems related to clocks, calendars, directions, blood relations, and interpret data from various graphical representations, including tables, bar charts, pie charts, and line graphs, with accuracy and clarity.	✓	✓	✓	✓	4	85	75	-	3	1	3	1	-	-	-	2	-	-	-	
CO-5	Solve number puzzles, logical puzzles, sequential output tracing, and reasoning problems, as well as alphanumeric series and coding/decoding problems, with precision and speed.	✓	✓	✓	✓	5	85	75	-	3	1	3	1	-	-	-	2	-	-	-	

Title & Session Outcomes	Numbers and Basic Arithmetic	Business Mathematics and Applications	Applied Arithmetic Problems	Logical Reasoning and Data Interpretation	Reasoning and Puzzle Solving
Duration (hour)	6	6	6	6	6
SO-1	Classification of Numbers & Tests of Divisibility	Problems on Averages and Percentage	Time and work - Problems	Clock - Problems	Number Puzzles - Problems
SO-2	Unit Digit & Trailing Zeroes	Problems on Discount	Time, Speed and Distance Problems	Problems on Calendar	Logical Puzzles –Problems
SO-3	Arithmetic Progression Geometric Progression	Problems on Simple Interest and Compound Interest	Boats and Streams - Problems	Direction Sense - Problems	Sequential Output Tracing - Problems
SO-4	Highest Common Factor (HCF) Least Common Multiples (LCM)	Profit and Loss - Problems	Mixtures and Alligations - Problems	Blood relation-Problems	Inductive, Logical, Abstract and Diagrammatic Reasoning - Problems
SO-5	Simplification - Problems	Permutation and Combination – Problems	Height and Distance - Problems	Data Interpretation – Table and Bar chart	Alphanumeric Series - Problems
SO-6	Virnaculum - Problems	Problems on Probability	Problems based on Ages	Data Interpretation – Pie Chart and Line graph	Coding and Decoding - Problems

Assessment

Level of Thinking		Continuous Learning Assessment (CLA) (100 % weightage)							
		CLA– 1 (20%)		CLA– 2 (20%)		CLA– 3 (30%)		CLA – 4 (30%)	
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	40	-	30	-	30	-	40	-
2	Understand								
3	Apply	40	-	40	-	40	-	40	-
4	Analyze								
5	Evaluate	20	-	30	-	30	-	20	-
6	Create								
Total%		100		100		100		100	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	✓	Case Studies	-	No Poverty	-
Emulations	-	Group Discussion	✓	Zero Hunger	-
Prototypes	-	Hands-on Practice	✓	Good Health & Well Being	--
Hands-on Practice Tools	✓	Inquiry Learning	✓	Quality Education	✓
Mathematical Computing Tools	✓	Interactive Lecture	✓	Gender Equality	-
Field Visit	-	Leading Question	✓	Clean Water & Sanitation	-
		Mind Map	-	Affordable & Clean Energy	-
		Minute Paper	-		
		Peer Review	-		
		Problem Based Learning	✓		

Resources			
1	Dr. Agarwal.R.S, Quantitative Aptitude for Competitive Examinations, S. Chand and Company Limited, 2018 Edition	2	Archana Ram, PlaceMentor: Tests of Aptitude for Placement Readiness, Oxford University Press, Oxford, 2018
3	Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Tata McGraw Hill, 5th Edition	4	Edgar Thrope, Test Of Reasoning for Competitive Examinations, Tata McGraw Hill, 6th Edition

Designers					
Professional Experts		**Higher Institution Experts**		**Internal Experts**	
1	Mr. Varadha Rajan M (External Expert), Assistant Manager – Human Resources, Justdial Limited, Chennai – 600015 varadha1723@gmail.com	1	Dr. Premavathy M, Associate Professor , Department of English Center for Distance and Online Education, Bharathidasan University, Tiruchirappalli – 620024 drmpremavathy@bdu.ac.in	1	Dr. Deepalakshmi S, HoD, Department of Career Guidance Cell, FSH, SRMIST
				2	Dr. Sathish K, Assistant Professor, Department of Career Guidance Cell, FSH, SRMIST
				3	Dr. Aarthi S, Assistant Professor, Department of Career Guidance Cell, FSH, SRMIST

SEMESTER II

Course Code	POC25201T	Course Title	Spectroscopy and Applications in Organic Chemistry	Category	C	Core Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment			Program Outcomes (PO)												
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Understand the fundamentals and importance of UV and photoluminescence spectroscopy																			
CLR-2	Understand the fundamental, importance and instrumentation of FTIR spectroscopy																			
CLR-3	Understand the fundamentals and importance of Mass spectroscopy																			
CLR-4	Understand the fundamentals and importance of NMR spectroscopy																			
CLR-5	Provide a basic understanding of the concepts involved in various chromatographic techniques																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Describe the physical and chemical changes at the molecular level during a Mass, IR, or NMR experiment.	✓	✓	✓	-	4	85	75	-	3	-	2	-	-	3	-	-	-	-	-
CLO-2	Identify different functional groups present in organic compounds using IR spectra.	✓	✓	✓	-	4	85	70	-	3	3	-	-	-	-	-	-	-	-	2
CLO-3	Explain common terms in NMR spectroscopy such as chemical shift, coupling constant, and anisotropy, and describe how they are affected by molecular structure.	✓	✓	✓	✓	4	85	70	-	3	3	-	-	-	2	-	-	-	-	-
CLO-4	Analyze and interpret ^{1}D, ^{1}H, ^{13}C NMR, and 2D NMR to determine the chemical structure of organic compounds.	✓	✓	✓	✓	4	85	70	-	3	2	-	-	-	-	-	-	-	-	3
CLO-5	Explain major fragmentation patterns of organic compounds using mass spectra	✓	✓	✓	✓	4	85	60	-	3	-	-	-	3	-	-	2	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Absorption and emission spectroscopy	Infrared spectroscopy	Mass spectroscopy	Nuclear magnetic resonance	Separation and purification techniques
	12	12	12	12	12

SLO-1	Ultraviolet and photoluminescence spectroscopy: Introduction. Interaction of electromagnetic radiation with matter.	Fourier-transform infrared spectroscopy (FTIR): Introduction to FTIR spectrometer. Units of frequency wavelength and wave number, molecular vibrations.	Mass spectroscopy: Basic Principles and Instrumentation of mass spectrometer.	Nuclear Magnetic Resonance (NMR) spectroscopy: Basics Larmor precession, resonance absorption	Separation Techniques: Solvent extraction and Ion exchange techniques principles and applications.
SLO-2	Absorption laws and selection rules, measurement of UV, fluorescence, phosphorescence, and lifetimes. Introduction to time-resolved techniques for absorption and emission measurements.	Factors influencing vibrational frequencies and selection rules. Sampling techniques for characteristic frequencies of organic molecules and interpretation of spectra.	Isotope abundances, molecular, and metastable ions. Reactions of ions in gas phase – effect of isotopes.	Magnetic fields, shielding, and chemical shifts chemical equivalence. Relaxation processes: Solution state (^{1}H, ^{13}C)	Chromatographic techniques: adsorption chromatography. Thin-layer and gas chromatography. High-performance liquid chromatography
SLO-3	Electronic energy levels: Singlet-Triplet excited states. Excited state lifetime, Steady-state, and Time-resolved emission. Factors affecting excited state energy: solvent effect, electronic transitions in organic, and molecules and application to structure elucidation	Theory of IR spectroscopy: various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear).	Nitrogen rule, determination of molecular formula. fragmentations and rearrangements - metastable ions – fragmentation of organic compounds	Spin-spin coupling AX, AX2, and AXn systems. Paramagnetic shifts and their applications	Size exclusion chromatography. Supercritical fluid chromatography
SLO-4	Tutorial: Absorption and Emission Spectroscopy	Tutorial: Discussion about FTIR Spectroscopy	Tutorial: Discussion about Mass Spectroscopy	Tutorial: Discussion about NMR spectroscopy	Tutorial: Discussion about Chromatographic techniques
SLO-5	Applications of UV spectroscopy to Conjugated dines, trienes, unsaturated carbonyl compounds, and aromatic compounds. Excited state Kinetics: quantum yield expressions, excimer and exciplex, formation, energy transfer, FRET.	Various ranges of IR (Near, Mid, Fingerprint, and far) and their usefulness. Instrumentation (Only the sources and detectors used in different regions).	Instrumentation, various ionization methods (field ionization, field desorption, FAB, MALDI,).	Instrumentation of NMR spectroscopy. chemical shift, calculations of chemical shifts of aliphatic, olefinic, alkyne, aromatic, hetero aromatic, and carbonyl carbons. Factors affecting chemical shifts.	Electrophoresis.
SLO-6	Woodward -Fieser rules for calculating absorption maxima (λ_{max}) for dienes and carbonyl compounds. Fieser and Kuhn rules Effects of auxo chromes and effects of conjugation on the absorption maxima.	Instrumentation (Only the sources and detectors used in different regions)	Different detectors - magnetic analyzer	APT, INEPT, DEPT Homo nuclear (^{13}C, ^{13}C) and Hetero nuclear (^{13}C, ^{1}H) coupling constants.	Thermal methods of analysis - thermal methods of analysis and evolution of analytical data
SLO-7	Difference in the absorption and emission spectra of organic	Sample preparation techniques (Gas, Liquid, and solid)	Ion cyclotron analyzer, Quadrupole mass filter, time of flight (TOF)		TGA - principles, instrumentation, and applications

	and inorganic compounds and complexes. Different shifts of emission peaks (Bathochromic, hypsochromic, hypochromic, hyperchromic).			2D NMR Techniques: General idea about two-dimensional NMR spectroscopy	
SLO-8	Tutorial: Applications of UV and fluorescence spectroscopy	Tutorial: Discussion about the techniques of FTIR and the theory of FTIR.	Tutorial: Various methods of Mass spectrometry.	Tutorial: General discussion about the chemical shift	Tutorial: Discussion about various types of Chromatography
SLO-9	Instrumentation for single-beam and double-beam UV and fluorescence spectrophotometer.	Qualitative analysis of alkanes, alkenes.	Rules of fragmentation for different functional groups	Correlation spectroscopy (COSY)-Homo COSY (^{1}H, ^{1}H)	DTA - principles, instrumentation, and applications.
SLO-10	Application in organic molecules using UV and fluorescence analyses Optical rotatory dispersion and circular dichroism: Phenomena of ORD and CD. Classification of ORD and CD Curves.	Qualitative analysis of carbonyl compounds.	Factors controlling fragmentation	TOCSY, Hetero COSY (HMQC, HMBC). Homo and Hetero nuclear 2D resolved spectroscopy	DSC - principles, instrumentation, and applications. Types of errors.
SLO-11	Cotton effect curves and their application to stereochemical problems. The Octant rule and its application to alicyclic ketones.	Organic functional group identification through IR spectroscopy.	Introduction: HRMS	NOESY and 2D-INADEQUATE experiments and their applications.	Evaluation of analytical data statistical methods.
SLO-12	Tutorial: Instrumentation and effect of UV and fluorescence	Tutorial: Quantitative analysis of organic functional group	Tutorial: Rules of fragmentation for different functional groups	Tutorial: Correlation spectroscopy COSY and NOESY	Tutorial: Discussion about the Thermoanalytical techniques.

Resources

1	Fundamentals of Molecular Spectroscopy. C. N. Banwell and E. M. McCash, Tata McGraw Hill publishing	5.	D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, McGraw Hill, 6th edition 2007.
2	Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, Fourth Ed., Brooks/Cole Thomson Learning 2009.	6.	Spectroscopic Methods in Organic Chemistry. Fourth Edition D.M. Williams and I. Fleming Tata - McGraw Hill, New Delhi, 1990. For all spectral methods except ORD and CD and ESR.
3	R. M. Silverstein, F. X. Webster, D. J. Kiemle, Spectrometric identification of organic compounds, 7th edition, John Wiley, 2005.	7.	Organic Spectroscopy, Second Edition, W. Kemp, ELBS Macmillan, 1987 for ORD and CD.
4	Organic Spectroscopy, W. Kemp, 3rd edition, Macmillan, 2011.	8.	Molecular Fluorescence: Principles and Applications, B. Valeur, Wiley-VCH Verlag GmbH, Weinheim, 2002.

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyse	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

✓

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) case studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Ravindran E, Department of Chemistry, SRMIST Email id: ravindre@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25202T	Course Title	Transformations in Organic Chemistry	Category	C	Core Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Understand various C-C bond forming reactions and alkene chemistry																			
CLR-2	Gain knowledge of transition metal catalysis																			
CLR-3	explore oxidation/reductions reactions as elegant synthetic methods																			
CLR-4	Introduce to the reactivity radical																			
CLR-5	Introduce to the chemistry and application of the polycyclic aromatic hydrocarbons (also heteroatom based)																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand boron, silicon and tin chemistry	✓	✓	✓	-	4	85	75	-	3	-	2	-	-	3	-	-	-	-	-
CLO-2	Understand transition metal-based C-C bond formation	✓	✓	✓	-	4	85	70	-	3	-	3	-	-	-	-	-	-	-	2
CLO-3	Comprehend Oxidation and reduction methods in chemistry	✓	✓	✓	✓	4	85	70	-	3	-	3	-	-	3	-	-	-	-	-
CLO-4	Understand reactivity and usefulness of radicals	✓	✓	✓	✓	4	85	70	-	3	-	2	-	-	-	-	-	-	-	3
CLO-5	Know polyaromatic hydrocarbons and heteroatom based polyaromatic hydrocarbons and their applications	✓	✓	✓	✓	4	85	60	-	3	-	3	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Organometallic compounds	Various oxidation reactions	Reduction reactions and applications	Reactions involving free radicals	Synthesis and applications of various aromatic and heteroaromatic
	12	12	12	12	12
SLO-1	Grignard reagents, cuprates (Gilman reagent) and other conjugate reactions	Metal-based and non-metal based oxidations of alcohols to carbonyls	Catalytic hydrogenation (Heterogeneous: palladium/platinum/rhodium/nickel, etc.)	Introduction, natural sources, radical reactions in body	Origin of fused aromatics hydrocarbons, naphthalene, anthracene, acenaphthene, phenanthrene, pyrene

SLO-2	Olefination and cyclopropanation reaction, Bayliss Hillman reaction	Corey-Kim oxidation, Dess-Martin oxidation	Catalytic hydrogenation (Homogeneous: Wilkinson). Noyori asymmetric hydrogenation)	Reactions involving free radical intermediates	Aromatic stabilization, electron delocalization
SLO-3	Organoboron compounds, synthesis of organoboranes, carbonylation	Swern oxidation, phenols (Fremy's salt, silver carbonate)	Metal based reductions using Li/Na/Ca in liquid ammonia	Generation of radical intermediates	Synthesis
SLO-4	Tutorial: Grignard reagents, Organoboron compounds	Tutorial: Corey-Kim, Dess-Martin and Swern oxidation.	Tutorial: Homogeneous/Heterogeneous hydrogenations	Tutorial: Various ways for generating free radicals	Tutorial: Discussion on fused aromatic compounds
SLO-5	Other one-carbon homologation reactions, homologation via α-halo enolates	Alkenes to epoxides (peroxides/per acids based) Sharpless asymmetric epoxidation	Metal based reductions using sodium, magnesium, zinc etc. Birch reduction, dehalogenation and deoxygenation	Nucleophilic and electrophilic radicals	Reactivity
SLO-6	Stereoselective alkene synthesis, nucleophilic addition of allylic groups from boron compounds	Introduction to asymmetric synthesis, Sharpless asymmetric epoxidation, Jacobsen epoxidation, Shi epoxidation	Hydride transfer reagents from Group III and Group IV in reductions. $NaBH_4$, triacetoxyborohydride	Mechanisms of radical reactions, solvent and neighboring group effects	heteroatomic polycyclic hydrocarbons, indole, benzofuran, benzothiophene, quinoline, phenanthroline
SLO-7	Organosilicon compounds, general features carbon-carbon bond forming reactions of organosilicon compounds	Alkenes to diols (manganese, osmium based), Sharpless asymmetric dihydroxylation, Prevost reaction and Woodward modification	Hydride transfer reagents from Group IV in reductions. L-selectride, Kselectride	Free radical substitutions at aliphatic substrates	aromatic stabilization, electron delocalization
SLO-8	Tutorial: Stereoselective alkene synthesis, Organosilicon compounds	Tutorial: Different Oxidation reactions	Tutorial: Various metal-based reductions	Tutorial: Mechanism of free radical reactions	Tutorial: Different heteroatomic polycyclic hydrocarbons
SLO-9	Acylation reactions, conjugate addition reactions.	Alkenes to carbonyls with bond cleavage (manganese, osmium, ruthenium and lead based, ozonolysis)	Luche reduction, LiAlH4, DIBAL-H, and Red-Al, MPV reduction)	Free radical substitutions at aromatic substrates	Synthesis
SLO-10	Organotin compounds, synthesis of organostannanes	Alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, etc.	Stereo/enantioselective reductions (chiral boranes, Corey-Bakshi-Shibata reduction)	Cyclization of free radical intermediates, additions to C=N double bonds	Reactivity
SLO-11	carbon-carbon bond forming reactions using tin reagents	ketones to ester/lactones (Baeyer-Villiger)	Clemmenson and Wolff-Kishner reduction	Fragmentation and rearrangement reactions, intramolecular functionalization by radical reactions	Applications of these compounds
SLO-12	Tutorial: Acylation reactions, Organotin compounds	Tutorial: Conversion of alkene to alcohols/carbonyl compounds	Tutorial: Luche, Clemmenson and Wolff-Kishner reduction	Tutorial: Free radical substitution reactions	Tutorial: Synthesis and reactivity of heteroaromatic compounds

Resources	
1	*J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, 1st Ed., Oxford University Press, 2001.*
2	*M.B. Smith & J. March, March's Advanced Organic Chemistry, 6thEd., John Wiley & Sons, New York, 2007.*
3	*F.A. Carey and R.A. Sundberg, Advanced Organic Chemistry, Part A and Part B, 5thEd., Kluwer Academic/Plenum Publishers, New York, 2004.*

	Unit-II: Chapter 9, 20, 22 (Clayden), Chapter 15,16, 18 (Smith), Chapter 7, 9 (Carey). *Unit-III: Chapter 9, 20, 22 (Clayden), Chapter 19 (Smith).* *Unit-IV: Chapter 41 (Clayden), Chapter 19 (Smith), Chapter 5 (Carey).*
4	*Clar, E. (1964). Polycyclic Hydrocarbons. New York, NY: Academic Press. LCCN 63012392.*

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Anjan Das, Department of Chemistry, SRMIST Email id: anjand@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25203T	Course Title	Heterocyclic Chemistry and Total Synthesis of Natural Products	Category	C	Core Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)									
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Give the student a broad understanding of the major classes of heterocyclic compounds																			
CLR-2	Introduce the nomenclature, structure, properties, syntheses, and reactions of non-aromatic heterocycles																			
CLR-3	Inculcate the nomenclature, structure, properties, syntheses, and reactions of aromatic heterocycles																			
CLR-4	Learn various nucleophilic, substitution and electrophilic reactions in heterocyclic chemistry																			
CLR-5	Learn the importance of naturally occurring alkaloids, terpenoids and antibiotics																			
Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand the structures, syntheses, reactions, and properties of the major classes of heterocyclic compounds	✓	✓	✓	-	4	85	75	3	-	3	2	-	-	-	-	-	-	-	-
CLO-2	Predict the nucleophilic and electrophilic reaction mechanisms, catalyst and rearrangements reactions	✓	✓	✓	-	4	85	70	3	-	3	-	-	-	-	-	-	-	-	2
CLO-3	Able to draw mechanisms for reactions involving heterocycles as starting materials, intermediates and products, and to propose syntheses of heterocycles from the major classes	✓	✓	✓	✓	4	85	70	3	-	3	3	-	-	-	-	-	-	-	-
CLO-4	Explain the classification of alkaloids, terpenoids and their importance and uses	✓	✓	✓	✓	4	85	70	3	-	2	-	-	-	-	-	-	-	-	3
CLO-5	To evaluate and propose syntheses of complex natural products	✓	✓	✓	✓	4	85	60	3	-	3	-	-	-	-	-	-	-	-	3

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Introduction to heterocyclic compounds	Structure and reactivity of heterocyclic compounds	Synthesis of heterocycles	Reactions of heterocycles, introduction to natural products	Natural product synthesis
	12	12	12	12	12
SLO-1	Introduction of aliphatic heterocyclic compound with four, five and six membered rings, classification based on one and more than one heteroatom containing rings.	Tautomerism in aromatic heterocycles and factors, general trends in the reactivity of aromatic heterocycles-furan, pyrrole, thiophene	Synthesis of azirines	Reactions of pyrrole, furan, thiophene and pyrazole	Total synthesis of forskolin

SLO-2	The replacement nomenclature, the Hantzsch-Widman nomenclature for Monocyclic heterocycles	Strain in small ring heterocycles, consequences of bond angle strain in small ring heterocycles	Synthesis of pyrrole, furan and thiophene	Reactions of imidazole, oxazole, thiazole, pyrimidine and pyrazine	Importance and uses of reserpine, retrosynthetic synthesis of reserpine
SLO-3	The Hantzsch-Widman nomenclature for fused and bridged heterocycles, effect of heteroatoms on organic reactions in comparison with carbogenic compounds-their Properties	Conformation of six-membered heterocycles	Synthesis of pyrazole	Reactions of benzofuran, indole, benzothiophene, pyridine, quinoline and isoquinoline	Woodward's synthesis of reserpine
SLO-4	Tutorial : Hantzsch-Widman nomenclature	Tutorial : General trends in the reactivity of aromatic heterocycles-furan, pyrrole, thiophene	Tutorial : Synthesis of pyrrole, furan and thiophene	Tutorial : Reactions of pyrrole, furan, thiophene	Tutorial : Woodward's synthesis of reserpine
SLO-5	Comparison of basicity of pyrrolidine, piperidine and morpholine, heterocycles in organic synthesis	Barrier to ring inversion, pyramidal inversion	Synthesis of imidazole	Synthesis of six membered rings containing two heteroatoms	Introduction to decalin as a segment in cholesterol, importance and uses of cholesterol
SLO-6	Heterocycles in biomolecules, oxidation in heterocyclic chemistry	1,3-diaxial interactions, factors affecting anomeric effect	Synthesis of oxazole and thiazole	Introduction and importance of natural products, introduction to retrosynthetic analysis	Woodward's synthesis of cholesterol
SLO-7	Reductions in heterocyclic chemistry, aromatic heterocycles: classification	Consequences of anomeric effect, double anomeric effect, Rabbit-ear effect (lone pair-lone pair interactions)	Synthesis of pyrimidine and pyrazine	Total synthesis of Penicillin	Corey's synthesis of prostaglandins (E2, F2α), Importance and uses of Taxol
SLO-8	Tutorial : Oxidation and reduction in heterocyclic chemistry, aromatic heterocycles.	Tutorial : Factors affecting anomeric effect, consequences of anomeric effect	Tutorial : Synthesis of imidazole, oxazole and thiazole	Tutorial : Total synthesis of Penicillin	Tutorial : Woodward's synthesis of cholesterol
SLO-9	Criteria of aromaticity, structural Criteria: Bond length	Repulsive-gauche effect (hockey-sticks effect), hydrogen bonding and intermolecular nucleophilic, electrophilic interactions	Synthesis of benzofuran, indole and benzothiophene	Alkaloids: Morphine - importance and uses, retrosynthetic analysis of morphine	Retrosynthetic approach of Taxol, Nicolaou's synthesis of Taxol
SLO-10	Electronic criteria: Dipole moment, Energetic Criteria: Delocalization energy	Basic principles of heterocycle synthesis, Baldwin's Rule	Synthesis of pyridine, quinoline and isoquinoline	Total synthesis of morphine	Danishefsky's synthesis of indolizomycin
SLO-11	Energetic criteria: Dewar resonance energy, magnetic criteria: Ring current and chemical shifts in 1H NMR-spectra	Synthesis of aziridines, reactions of aziridines	Reactions of azirines	Terpenes: Forskolin - importance and uses, retrosynthetic analysis of forskolin	Takasago synthesis of menthol
SLO-12	Tutorial : Electronic and magnetic criteria of heterocycles	Tutorial : Synthesis of aziridines, reactions of aziridines	Tutorial : Synthesis of benzofuran, indole and benzothiophene	Tutorial : Morphine - importance and uses, retrosynthetic analysis of morphine	Tutorial : Danishefsky's synthesis of indolizomycin

Resources			
1	*T. L. Gilchrist, Heterocyclic Chemistry, 3rd Ed., Prentice Hall, 1997.*	4	*D. T. Davies, Aromatic Heterocyclic Chemistry, Oxford Chemistry Primers, 1992.*
2	*A. R. Katritzky, and C. W. Rees, Comprehensive Heterocyclic Chemistry, Pergamon Press, 1996.*	5	*K. C. Nicolaou, Classics in total synthesis, Wiley, 1996.*
3	*R. R. Gupta, M. Kumar, and V. Gupta, Heterocyclic Chemistry, Vo1.1-3, Springer Verlag, 2008.*		

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1 (10 %)		CLA – 2 (10 %)		CLA – 3 (20 %)		CLA – 4* (10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Gopal Chandru Senadi, Dr. P. Gopinath Department of Chemistry, SRMIST Email id: chandrug@srmist.edu.in, gopinatp1@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25204T	Course Title	Modern Methods of Organic Synthesis, Pericyclic and Photochemistry	Category	C	Core Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment			Program Outcomes (PO)												
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Strengthen the knowledge of the students in organic reactions.																			
CLR-2	explore new methodology of organic transformations through the knowledge of the core content.																			
CLR-3	get a significant exposure in research and development for future development.																			
CLR-4	Express their capabilities as an organic chemist in pharmaceutical industries.																			
CLR-5	Strengthen the skill in the area of organic synthesis.																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibili	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Acquaint students with the fundamental concepts of Pericyclic reactions, Molecular orbital symmetry and Cycloaddition reactions.	✓	✓	✓	-	4	85	75	-	3	-	2	-	-	3	-	-	-	-	-
CLO-2	Understand the basic principles of photochemistry.	✓	✓	✓	-	4	85	70	-	3	-	3	-	-	-	-	-	-	-	2
CLO-3	Understand the concept of retrosynthetic analysis	✓	✓	✓	✓	4	85	70	-	3	-	3	-	-	3	-	-	-	-	-
CLO-4	Gain knowledge about the in multistep organic synthesis.	✓	✓	✓	✓	4	85	70	-	3	-	2	-	-	-	-	-	-	-	3
CLO-5	Acquaint students with the understanding of designing easily achievable cost-effective synthetic route.	✓	✓	✓	✓	4	85	60	-	3	-	3	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Pericyclic reaction	Different pericyclic reactions	Common light driven reactions	Rearrangement reactions	Concept of organic synthesis
	12	12	12	12	12
SLO-1	Molecular orbital symmetry, Frontier orbitals of several organic molecules	Introduction to cycloaddtions reactions, Antarafacial additions	Methods of preparative photochemistry, Photochemistry of alkenes and related compounds: isomerization	Favorskii rearrangement in various system	Basic Concepts in organic synthesis, Linear and convergent synthesis
SLO-2	Frontier orbitals of several organic molecules, Classification of pericyclic reactions	Suprafacial additions, Notation of cycloadditions	Methods of preparative photochemistry, Photochemistry of alkenes and related compounds: isomerization	Methods of preparative photochemistry, Fries Rearrangement, McLafferty rearrangement	Linear and convergent synthesis, Disconnection approach

SLO-3	Introduction to FMO approach	Cycloadditions of (4n), (4n+2) (2+2) and (4+4) systems	Di-π-methane rearrangement and cycloadditions, Photochemistry of aromatic compounds: ring isomerization	Hoffman, Curtius rearrangement, Schmidt and Lossen rearrangements.	Disconnection approach, Functional group interconversions (FGI)
SLO-4	Tutorial: FMO approach	Tutorial: Cycloaddition reactions	Tutorial: Photochemistry of alkenes	Tutorial : Fries Rearrangement, McLafferty	Tutorial : linear and convergent synthesis
SLO-5	Woodward- Hoffman correlation diagram method, Introduction to Perturbation of molecular (PMO) approach	(2+2) Cycloaddition reactions, additions of ketones, Chelotropic reactions	Photochemistry of aromatic compounds: cyclization reactions, Norrish type-I cleavage of acyclic, cyclic, and unsaturated carbonyl compounds	Beckmann rearrangement, Baeyer–Villiger rearrangement	Functional group interconversions (FGI), Functional group addition (FGA)
SLO-6	Introduction to Perturbation of molecular (PMO) approach, Explanation of pericyclic Reactions under thermal condition	FMO approach for the explanation of sigmatropic rearrangements, PMO approach for the explanation of sigmatropic rearrangements	Norrish type-I cleavage of acyclic, cyclic, and unsaturated carbonyl compounds, Norrish type-II cleavage	Dakin reaction	Functional group addition (FGA), Functional group removal (FGR)
SLO-7	Explanation of pericyclic Reactions under Photochemical condition, Introduction to Electrocyclic reactions	Suprafacial and antarafacial shifts of hydrogen, sigmatropic shift involving carbon moieties	Hydrogen abstraction: intramolecular and intermolecular hydrogen abstraction, Photoenolization	Dienone-phenol rearrangement, Hofmann-Martius Rearrangement	Functional group removal (FGR), Importance of order of events in organic synthesis
SLO-8	Tutorial: FMO and PMO approaches	Tutorial: Sigmatropic reactions	Tutorial: Norrish type-I and II type reactions	Tutorial : Dakin, Dienone-phenol rearrangement	Tutorial : FGI, FGA and FGR
SLO-9	Condolatory and Motions, Disrotatory motions	(3,3) sigmatropic rearrangements, (5,5) sigmatropic rearrangements	Photocyclo-addition of ketones with unsaturated compounds, Paterno-Buchi reaction, Barton reaction	Fischer-Hepp Rearrangement,	One and two group C-X disconnections, Chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity
SLO-10	Electrocyclic reaction for 4n system, Electrocyclic reaction for (4n+2) system	Claisen rearrangements, Cope rearrangements	Photodimerisation of α, β unsaturated ketones, Rearrangement of enones and dienones	Fritsch–Buttenberg–Wiechell rearrangement, Neber rearrangement	Concept of umpolung, Generation of acyl anion equivalent using 1, 3-dithianes
SLO-11	Electrocyclic reaction of allyl systems and secondary effects	Fluxional tautomerism, Aza-Cope rearrangements	Photo-Fries rearrangement	Koch-half carbonylation, Stevens Rearrangement	Generation of acyl anion equivalent using methyl thiomethyl sulfoxides, cyanide ions, Generation of acyl anion equivalent using cyanohydrin ethers, nitro compounds and vinylated ethers
SLO-12	Tutorial: Different electrocyclic reactions	Tutorial: Sigmatropic reactions	Tutorial: Paterno-Buchi and Barton reaction	Tutorial : Fischer-Hepp, Fritsch–Buttenberg–Wiechell rearrangment	Tutorial : Various organic synthesis

Resources

1	*J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, 1st Ed., Oxford University Press, 2001.*	6	*S. 2. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, 1st Ed., Macmillan India Ltd., New Delhi, 1990.*
2	*2.B. Smith & J. March, March's Advanced Organic Chemistry, 5th Ed., John Wiley & Sons, New York, 2001.*	7	*T.3. Lowry and K.S. Richardson, Mechanism and Theory in Organic Chemistry, 3rd Ed., Addison–Wesley.*
3	*F.A. Carey and R.A. Sundberg, Advanced Organic Chemistry, Part A and Part B, 5th Ed., Kluwer Academic/Plenum Publishers, New York, 2004*		
4	*P. G. 2. Wuts, Greene's Protective Groups in Organic Synthesis, 5th Ed., Wiley, 2014.*		

5	*Peter Sykes, A Guide book to Mechanism in Organic Chemistry, 6th Ed., Orient ongman Ltd., New Delhi, 1997.*	

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	-	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts	Higher Institution Experts	Internal Experts
1 Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1 Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1 Dr. Priyadip Das, Department of Chemistry, SRMIST Email id: priyadip@srmist.edu.in
	2 Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2 Dr. Gopal Chandru Senadi, Department of Chemistry, SRMIST Email id: chandrug@srmist.edu.in

Course Code	PCY25D04T	Course Title	Nanomaterials and Nanochemistry	Category	D	Discipline Elective Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)									
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Acquire sound knowledge about nanophenomena																			
CLR-2	Learn various synthetic routes of nanomaterials																			
CLR-3	Gain deep knowledge about the analytical techniques used to characterize the nanomaterials																			
CLR-4	Learn carbon nanostructures and their properties																			
CLR-5	Learn the applications of nanomaterials in catalysis																			
Outcomes (CLO)	**At the end of this course, learners will be able to:**	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Apply various phenomena underlying the nanoscale materials for new designs	✓	✓	✓	-	2	75	60	2	-	3	-	-	-	1	-	-	-	-	-
CLO-2	Identify the suitable methods for the synthesis of any specific nanomaterial	✓	✓	✓	-	2	80	70	3	-	2	-	1	-	-	-	-	-	-	-
CLO-3	Apply the suitable technique to characterize nanomaterial and understand the results obtained	✓	✓	✓	✓	2	70	65	2	-	3	-	3	-	-	-	-	-	-	-
CLO-4	Rationalize the carbon nanomaterials and their properties	✓	✓	✓	✓	2	70	70	3	-	2	-	-	-	1	-	-	-	-	-
CLO-5	Understand the parameters responsible for the catalytic efficiency of nanomaterials.	✓	✓	✓	✓	2	70	70	3	-	2	-	-	-	2	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Fundamentals of Nanochemistry	**Synthesis of Nanomaterials**	**Characterization of Nanomaterials**	**Functional Nanomaterials**	**Applications of Nanomaterials**
	12	**12**	**12**	**12**	**12**
SLO-1	History, fundamentals, and scope of nanoscience and nanotechnology.	Synthesis strategies of nanoscale materials. Top-down and bottom-up approaches.	Characterization methods of nanomaterials - Importance and advancements.	Functional nanomaterials: overview. Classical examples and importance of applied nanomaterials.	Nanocatalysts: fundamentals. Design principle of nanostructures for catalysis applications.
SLO-2	Nanoscale phenomena: Surface area to volume ratio (SAVR). Calculation of SAVR for cube and sphere.	Gas phase, liquid phase, solid phase synthesis. Merits and challenges of these methods.	Physical characterization of nanostructures: XRD. Phase, crystallinity, and particle size analyses.	Carbon nanostructure: Allotropes of carbon. Structural differences in the allotropes of carbon.	Essential properties of nanomaterials for energy conversion reactions. Factors influencing energy conversion reactions.

SLO-3	Nanoscale phenomena: Quantum confinement effect. Quantization of energy states.	Co-precipitation and sol-gel method. Nucleation and growth processes in the co-precipitation and sol-gel route.	Microscopic characterization of nanostructures: SEM and TEM. Size, shape, morphology, and compositional analyses.	Carbon nanostructure: Graphene, Structural properties of graphene.	Nanomaterials are used for photocatalytic water splitting. Examples: HER and OER
SLO-4	Tutorial: Nanoscale phenomena.	Tutorial: Synthesis strategies.	Tutorial: Characterization methods.	Tutorial: Functional nanomaterials	Tutorial: HER and OER
SLO-5	Nanoscale phenomena: Surface plasmon resonance effect. Mechanism of light and plasmon interaction.	Hydrothermal and solvothermal methods. Merits and challenges of these temperature and pressure-assisted methods.	Microscopic characterization of nanostructures: STEM and AFM. Thickness and roughness analyses.	C60 (Fullerenes). Structural properties of C60.	Nanomaterials for electrocatalytic water splitting and Examples.
SLO-6	Nanoscale phenomena: Nano-self-assembly effect. Self-assembly factors at nanoscale.	Self-assembly, template-assisted, and micro-emulsion methods. Merits and challenges of these methods.	Spectroscopic characterization of nanostructures: XPS. Composition and oxidation state. Mechanism of light and plasmon interaction analyses.	Carbon nanotubes: SWCNTs and MWCNTs.	Nanomaterials for dye degradation. Basic principles and examples
SLO-7	Nanoscale phenomena: Quantum tunneling effect. Features of quantum tunneling at nanoscale.	Electrodeposition and CVD methods. Regulation strategy of the deposition process and scope.	Surface area characterization of nanostructures: BET. Surface area and pore-size distribution analysis.	Arrangement and orientation of hexagons in CNTs. Structure-property relationship.	Mechanism of photocatalytic reaction at nanointerface. Examples of nanostructured materials for photocatalysis.
SLO-8	Tutorial: Conductor and semi-conductor properties at the nanoscale	Tutorial: Synthesis of special nanostructures: Quantum dots. Unique steps involved in the QDs synthesis route.	Tutorial: SEM Demonstration	Tutorial: Carbon nanowires	Tutorial: Nanomaterials uses
SLO-9	Physical and electronic properties at the nanoscale. The boiling, melting point, and density of energy states vary at the nanoscale.	Photochemical and Microwave-assisted synthesis. Light and wave interaction of molecules during nanostructure formations and scope of the methods.	Thermal characterization of nanostructures: TGA. Stability vs temperature profile analysis.	Chemical modification of SWCNTs and MWCNTs. Mechanism of surface modification in CNTs.	Nanomaterials for water treatment. Example nanomaterials for water treatment.
SLO-10	Conductor and semi-conductor properties at the nanoscale. Band gap variation upon size reduction.	Synthesis of special nanostructures: CNT. Unique steps involved in the CNT synthesis route.	Surface charge characterization: Zeta potential analyzer. Charge distribution analyses	Carbon nanowires. Finalization of carbon nanowires.	Nanomaterials for CO_2 capture. Unique requirements of nanostructures for CO_2 capture
SLO-11	Magnetic and mechanical properties at the nanoscale. Examples of nanomaterials exhibiting changes in magnetic and mechanical properties.	Synthesis of special nanostructures: core-shell morphology. Turing of core-shell thickness: steps.	Spectrophotometer analysis: UV-visible and fluorescence. Absorption and emission properties of nanostructures.	Conductive/semiconductive oxide nanostructures: Structure-property relationship.	Nano-catalysis: Applied nanomaterials in industry. Scope and challenges of nano-catalysis.
SLO-12	Tutorial: Physical and electronic properties.	Tutorial: Quantum dots	Tutorial: UV-visible analysis.	Tutorial: CNT structures	Tutorial: Applied nanomaterials.

Resources			
1.	C. N. R. Rao, A. Muller and A. K. Cheetham, (Eds): The Chemistry of Nanomaterials, 2004	6	U. Heiz, and U. Landman, Nanocatalysis, Springer, New York, 2006
2.	C. P. Poole, and Jr. F. J. Owens, Introduction to Nanotechnology, Wiley Inter-science, New Jersey. 2003		
3.	K. J. Klabunde, Nanoscale Materials in Chemistry, Wiley- Inter-science, New York, 2001		
4.	T. Pradeep, Nano: The Essentials in Understanding Nanoscience and Nanotechnology, Tata McGraw Hill, New Delhi, 2007		
5.	T. Tang and P. Sheng, Nano Science and Technology – Novel Structures and Phenomena, Taylor & Francis, New York, 2004		

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1 (10 %)		CLA – 2 (10 %)		CLA – 3 (20 %)		CLA – 4* (10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	-	Hands-on Practice	-	Gender Equality	-
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts	Higher Institution Experts	Internal Experts
1 Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1 Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1 Dr. N. Clament Sagaya Selvam, Department of Chemistry, SRMIST Email id: clamentn@srmist.edu.in
	2 Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2 Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25D01T	Course Title	Advanced Green Chemistry	Category	D	Discipline Elective Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Gains extensive conceptual knowledge on green and sustainable process with energy efficiency																			
CLR-2	Gains extensive conceptual knowledge on less hazardous chemical synthesis																			
CLR-3	Develop strategies to design and produce cost-competitive chemical products and processes																			
CLR-4	Minimize the environmental impact with atom economical approach																			
CLR-5	Design chemicals that degrade and can be discarded easily.																			
Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand the basic principles of green chemistry.	✓	✓	✓	-	4	85	75	3	-	2	-	-	-	3	-	-	-	-	-
CLO-2	gain ability for applying green synthetic methodology to conventional reactions for energy efficiency	✓	✓	✓	-	4	85	70	3	-	3	-	-	-	-	-	-	-	-	2
CLO-3	Understand the sustainable process for essential chemicals with atom economical route	✓	✓	✓	✓	4	85	70	3	-	3	-	-	-	3	-	-	-	-	-
CLO-4	Acquaint the student with the fundamental concepts of sustainable chemical synthesis with environmental factor	✓	✓	✓	✓	4	85	70	3	-	2	-	-	-	-	-	-	-	-	3
CLO-5	Gain knowledge about the development of sustainable route of synthesis with greener approach	✓	✓	✓	✓	4	85	60	3	-	3	-	-	-	-	-	-	-	-	3

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Introduction to green synthesis	Green synthesis reagents	Green synthesis methods	Green synthesis reactions	Industrial green synthesis
	12	12	12	12	12
SLO-1	Green synthesis – introduction, prevention of waste by products	Green reagents-introduction, use of dimethylcarbonate	Various green synthetic methods-introduction, microwave mediated synthesis – introduction	Aqueous phase reactions – introduction, oxidation reactions	Green synthesis in industrial applications – introduction, adipic acid - synthesis
SLO-2	Maximum incorporation of the reactants into the final product,	Use of polymer supported reagents-peracids, use of NBS	Microwave assisted reactions in water, MW-assisted synthesis of heterocycles	Reduction reactions, chemicals from renewable raw materials - introduction	Catechol synthesis, methyl methacrylate - synthesis

	prevention or minimization of hazardous products				
SLO-3	Designing safer chemicals and examples.	Use of chromic acid, thioanisole resin	MW-assisted synthesis of ionic liquids (ILs), examples	Carbohydrates as renewable raw materials, production of ethanol and furfural	Aromatic amines – synthesis, examples
SLO-4	Tutorial : Maximum incorporation of the reactants into the final product, prevention or minimization of hazardous products	Tutorial : Use of polymer supported reagents-peracids, NBS, chromic acid, thioanisole resin	Tutorial : Microwave mediated synthesis – heterocycles, ionic liquids.	Tutorial : Carbohydrates as renewable raw materials, production of ethanol and furfural	Tutorial : Catechol synthesis, methyl methacrylate - synthesis
SLO-5	Energy requirements for synthesis, E factors and atom efficiency	Polystyrene carbodiimide, polystyrene anhydride, sulfonazide polymer, polystyrene, Wittig reagent	Microwave assisted solid state reactions, MW-assisted Suzuki and Heck reactions using supported Pd-catalyst	Environmentally benign synthesis via mechanochemical mixing, mechanically induced organic transformations in a ball-mill.	Acetaldehyde – synthesis, furfural synthesis
SLO-6	Selection of appropriate solvent - examples	Green catalysts – introduction, acid catalysts, oxidation catalysts	Ultrasound assisted synthesis-introduction, applications of ultrasound	Synthesis of heterocycles,	(S)-metolachlor synthesis, ibuprofen synthesis
SLO-7	Selection of starting materials, Use of protecting groups.	Basic catalysts, polymer supported catalysts	Biocatalyst in organic synthesis, microbial production of ethanol	Polymerization reactions	Paracetamol synthesis, green aspects of scale-up synthesis of some APIs
SLO-8	Tutorial : Energy requirements for synthesis, E factors and atom efficiency	Tutorial : Green catalysts – introduction, acid catalysts, oxidation catalysts, Basic catalysts, polymer supported catalysts	Tutorial : MW-assisted Suzuki and Heck reactions using supported Pd-catalyst	Tutorial : Environmentally benign synthesis via mechanochemical mixing, mechanically induced organic transformations in a ball-mill.	Tutorial : Paracetamol synthesis, green aspects of scale-up synthesis of some APIs
SLO-9	Use of catalyst, design of biodegradable products	Catalysts in continuous-flow reactors, examples	Photochemical reactions, formation of a carbon–carbon bond	Examples of green photochemical reactions	Drug candidates under development or their critical intermediates, tofacitinib Citrate
SLO-10	Designing of manufacturing plants	Polymer supported photosensitizers, Phase transfer catalysis – introduction	Formation of C–C bonds via coupling reactions, examples	Photoinduced alkylation of alkenes, alkynes by alkanes, alcohols and alkyl halides	Trelagliptin succinate, cetirizine dihydrochloride
SLO-11	Strengthening of analytical techniques - examples	Synthesis of phase transfer catalysts, applications of PTC in organic synthesis	Electrochemical synthesis, examples	Electrochemical synthesis, solvent free solid phase organic synthesis.	3-phenyl catechol, nicotinic acid
SLO-12	Tutorial : Use of catalyst, design of biodegradable products	Tutorial : Phase transfer catalysis – introduction, synthesis of phase transfer catalysts, applications of PTC in organic synthesis	Tutorial : Photochemical reactions, formation of a carbon–carbon bond via coupling reactions	Tutorial : Electrochemical synthesis, solvent free solid phase organic synthesis	Tutorial : Trelagliptin succinate, cetirizine dihydrochloride, 3-phenyl catechol, nicotinic acid.

Resources

1	*Green Chemistry, theory and practice, Paul T. Anastas and John C. Warner..*	6	*Biotransformation in organic chemistry, Kurt Faber, Springer.*
2	*New Trends in Green chemistry, V. K. Ahluwalia and 2. Kidwai.*	7	-
3	*Organic Synthesis: Special techniques, V. K. Ahluwalia and Renu Aggarwal*	8	-
4	*Introduction to Green Chemistry by V.Kumar.*	9	-
5	*Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer Verlag.*	10	-

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
	Total (%)	100	-	100	-	100	-	100	-	100	-

✓

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Baburaj Baskar, Department of Chemistry, SRMIST Email id: baskarb@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Dr. P. Gopinath, Department of Chemistry, SRMIST Email id: gopinatp1@srmist.edu.in

Course Code	POC25D02T	Course Title	Asymmetric and Enzymatic Synthesis	Category	D	Discipline Elective Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	enable them to learn idea of asymmetric synthesis																			
CLR-2	enable them to think of multistep synthesis of important organic molecules																			
CLR-3	help to understand the role of organocatalysts in organic synthesis																			
CLR-4	explore them to the enzyme structure and reactivity																			
CLR-5	learn about the applications of enzymes in organic synthesis.																			
Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResp	Individual & Team Work	Communication	Project Management &	Life Long Learning
CLO-1	Understand the methods and fundamentals of asymmetric synthesis	✓	✓	✓	-	4	85	75	3	-	3	2	-	-	-	-	-	-	-	-
CLO-2	Understand the use of organocatalysts in organic synthesis	✓	✓	✓	-	4	85	70	3	-	3	-	-	-	-	-	-	-	-	2
CLO-3	Understand the preparation and use of NHC	✓	✓	✓	✓	4	85	70	3	-	3	3	-	-	-	-	-	-	-	-
CLO-4	Comprehend biocatalysis and their role in organic synthesis	✓	✓	✓	✓	4	85	70	3	-	2	-	-	-	-	-	-	-	-	3
CLO-5	Gain knowledge about the different organocataly	✓	✓	✓	✓	4	85	60	3	-	3	-	-	-	-	-	-	-	-	3

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Introduction to asymmetric synthesis	Asymmetric organocatalysis - I	Asymmetric organocatalysis - II	Enzyme catalysis	Biocatalysis
	12	12	12	12	12
SLO-1	Asymmetric synthesis: chiral auxiliaries, methods of asymmetric induction	Introduction to organocatalysis	Carbenes as organocatalysts	Introduction to biocatalysts, advantages and disadvantages of biocatalysts	Biocatalytic oxidation reactions of alcohols and aldehydes
SLO-2	Substrate, reagent and catalyst controlled reactions	Lewis acid catalysis	Types of different NHCs and their synthesis	Isolated enzymes vs. whole cell systems, brief overview of structure of enzymes	Biocatalytic carbon-carbon bond formations, aldol reaction, Michael-type additions,
SLO-3	Determination of enantiomeric and diastereomeric excess, enantiodiscrimination	Lewis base catalysis	NHC catalyzed umpolung, NHC catalyzed transesterification reactions	Mechanistic aspects of enzyme catalysis	Thiamine-dependant benzoin condensation

SLO-4	Tutorial : Substrate, reagent and catalyst controlled reactions	Tutorial : Lewis acid and base catalysis	Tutorial : Carbenes as organocatalysts, NHC catalysis	Tutorial : Mechanistic aspects of enzyme catalysis	Tutorial : Biocatalytic carbon-carbon bond formations, aldol reaction, Michael-type additions,
SLO-5	Resolution – optical and kinetic	Iminium catalysis	Oxidative NHC catalysis	Classification and nomenclature	Cyanohydrin formation, amino transfer reaction
SLO-6	Asymmetric oxidation [epoxidation: Sharpless, Jacobsen, Shi)	Enamine catalysis	Cooperative catalysis with metal catalysts	Coenzymes, enzyme sources	Halogenations and dehalogenations
SLO-7	Dihydroxylation (Sharpless)]	Bronsted acid catalysis	Cooperative catalysis with other organocatalysts	Biocatalysed hydrolytic reactions, hydrolysis of amides, esters	Enzymes in organic solvents, ester synthesis, lactone synthesis
SLO-8	Tutorial : Asymmetric oxidation [epoxidation: Sharpless, Jacobsen, Shi)	Tutorial : Iminium, enamine and Bronsted acid catalysis	Tutorial : Oxidative NHC catalysis, cooperative catalysis with metal catalysts	Tutorial : Coenzymes, enzyme sources	Tutorial : Enzymes in organic solvents, ester synthesis, lactone synthesis
SLO-9	Asymmetric reduction (Noyori, Corey, Pfaltz)	Bronsted base catalysis	Homo and cross benzoin type reactions	Biocatalytic hydrolysis of epoxides and nitriles	Amide synthesis, peptide synthesis
SLO-10	Stereoselective aldol reactions (Cram's rule and Felkin Anh models)	Quaternary ammonium salts as catalyst and phase transfer catalyst	Stetter reaction, enolate chemistry, homoenolate derived reactions	Biocatalytic reduction reactions, recycling of cofactors	Artificial enzyme mimics,
SLO-11	Auxillary controlled stereoselection, evans oxazolidones	Physical influence in asymmetric synthesis	Addition to ketenes and analogs	Reduction of aldehydes, ketones and C=C bonds	Catalytic antibodies
SLO-12	Tutorial : Stereoselective aldol reactions (Cram's rule and Felkin Anh models)	Tutorial : Bronsted base, quaternary ammonium salts as catalyst and phase transfer catalyst	Tutorial : Stetter reaction, enolate chemistry, homoenolate derived reactions	Tutorial : Biocatalytic reduction reactions, recycling of cofactors, reduction of aldehydes, ketones and C=C bonds	Tutorial : Artificial enzyme mimics, catalytic antibodies

Resources	
1	*R. Gawley and J. Aube, Principles of Asymmetric Synthesis, 2nd Ed., Elsevier, 2012.*
2	*K. Faber, Biotransformations in Organic Chemistry, 6th Ed., Springer, 2011.*
3	*Seayad, Jayasree, and Benjamin List. "Asymmetric organocatalysis." Organic & biomolecular chemistry 3.5 (2005): 719-724.*
4	*Hopkinson, Matthew N., et al. "An overview of N-heterocyclic carbenes." Nature 510.7506 (2014): 485-496.*
5	*Flanigan, Darrin M., et al. "Organocatalytic reactions enabled by N-heterocyclic carbenes." Chem. Rev 115.17 (2015): 9307-9387.*

Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)		✓
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*				
		(10 %)		(10 %)		(20 %)		(10%)				
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	
1	Remember	15	-	15	-	10	-	10	-	15	-	
2	Understand	15	-	15	-	10	-	10	-	15	-	
3	Apply	20	-	25	-	25	-	25	-	25	-	
4	Analyze	20	-	25	-	25	-	25	-	25	-	
5	Evaluate	15	-	10	-	15	-	15	-	10	-	
6	Create	15	-	10	-	15	-	15	-	10	-	
	Total (%)	100	-	100	-	100	-	100	-	100	-	

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Gopal Chandru Senadi, Department of Chemistry, SRMIST Email id: chandrug@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25S01L	Course Title	Organic Chemistry Practical: Functional Group Analysis and Synthesis	Category	S	Skill Enhancement Course	L	T	P	C
							0	0	6	3

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Gain exposure to the practical knowledge of organic reactions																			
CLR-2	Gain insight about setting up a basic reaction for synthesis of simple compounds																			
CLR-3	Learn about the analysis of different organic functional groups																			
CLR-4	Gain knowledge about the structural elucidation of synthesized compounds using different techniques																			
CLR-5	Know how to maintain the record of experiments conducted																			
Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand different purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.	✓	✓	✓	-	4	85	75	-	3	3	2	-	-	-	-	-	-	-	-
CLO-2	Get awareness of safety techniques and handling of chemicals.	✓	✓	✓	-	4	85	70	-	2	-	3	-	-	3	-	-	-	-	-
CLO-3	Understand how to carry out different types of reactions and their workup methods.	✓	✓	✓	✓	4	85	70	-	3	3	-	-	-	3	-	-	-	-	-
CLO-4	Understand the principles of mass spectroscopy, gas chromatography and HPLC	✓	✓	✓	✓	4	85	70	-	3	3	-	2	-	-	-	-	-	-	-
CLO-5	Apply the techniques for structure determination of organic molecules.	✓	✓	✓	✓	4	85	60	-	3	3	2	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Spectroscopic technique	Synthesis 1	Synthesis 2	Qualitative sepatration	Structural analysis
	18	18	18	18	18
SLO-1 -6	**Introduction** Spectroscopic Techniques: Compounds to be synthesized by one step reaction have to be characterized by modern spectroscopic techniques (UV-Vis, FT-IR, NMR).	3. 4-Nitrobenzoic acid to 4-nitrobenzanilide (Substitution)	6. Cyclohexanone → Phenyl hydrazone → 1,2,3,4-Tetrahydrocarbazole	3. Mixture 3	6. Mixture 6
SLO-6-12	2,4,6-Trinitrophenol(picric acid) from phenol (nitration)	*4. o*-Chlorobenzoic acid from anthranillic acid (Sandmeyer reaction)	Analysis of an organic mixture containing two components: Mixture 1	4. Mixture 4	Repeat Class -1

SLO-13-18	Benzophenoneoxime from benzophenone (addition reaction)	5. 4-Nitro toluene → 4-Nitro benzoic acid → 4-Amino benzoic acid	2. Mixture 2	5. Mixture 5	Repeat Class -2

Rresources	
1	*Vogel, A Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, 1996.*
2	*Fieser and Fieser, Reagents in Organic Synthesis, Wiley, 2006.*
3	*Mann &Saunders, Practical Organic Chemistry, 4thEd., Longmans, 1960.*
4	*H. T. Clarke., A Handbook of Quantitative & Qualitative Analysis, Arnold Heinemann, 1975.*

Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1 (10 %)		CLA – 2 (10 %)		CLA – 3 (20 %)		CLA – 4* (10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	-	15	-	15	-	15	-	15	-	15
2	Understand	-	15	-	15	-	15	-	15	-	15
3	Apply	-	20	-	20	-	20	-	20	-	20
4	Analyze	-	20	-	20	-	20	-	20	-	20
5	Evaluate	-	15	-	15	-	15	-	15	-	15
6	Create	-	15	-	15	-	15	-	15	-	15
	Total (%)	-	100	-	100	-	100	-	100	-	100

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	✓	Gender Equality	✓
		Debate	-		
		Interactive Lecture	-		
		Brainstorming	-		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts	Higher Institution Experts	Internal Experts
1 Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1 Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1 Dr. Baburaj Baskar, Department of Chemistry, SRMIST Email id:baskarb@srmist.edu.in
	2 Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2 Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	PCD25AE2T	Course Title	Soft Skills and Verbal Mastery	Category	AE	Ability Enhancement	L	T	P	C
							2	0	0	2

Offering Department	Career Guidance	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	

Rationale (CR)	The purpose of learning this course is to:
CR-1	Help individuals develop key skills for personal and professional growth
CR-2	Prepares individuals to navigate daily challenges with confidence, professionalism, and a positive mindset
CR-3	Create a strong resume, participate in group discussions, and perform well in interviews
CR-4	Enhance vocabulary and verbal reasoning skills
CR-5	Develop the skills needed for effective communication and critical thinking in both written and spoken language

Outcomes (CO)	At the end of this course, learners will be able to:	Depth				Attainment			Program Outcomes (PO)											
		Conceive	Design	Implement	Operate	Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethical practices &Social Responsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CO-1	Gain a deeper understanding of self, including emotional intelligence and career aspirations	✓	✓	✓	✓	3	85	75	1	-	3	-	3	3	-	-	3	3	2	3
CO-2	Apply effective presentation skills for clear, engaging communication	✓	✓	✓	✓	6	85	75	1	3	3	-	3	2	-	-	3	3	2	3
CO-3	Participate confidently and effectively in group discussions and interviews	✓	✓	✓	✓	3	85	75	1	3	1	-	3	2	-	-	3	3	2	3
CO-4	Enhance their ability to understand and use language effectively in different contexts	✓	✓	✓	✓	2	85	75	1	-	-	-	1	-	-	-	-	3	2	2
CO-5	Improve language comprehension and accuracy	✓	✓	✓	✓	5	85	75	1	-	-	-	1	-	-	-	-	3	2	2

Title & Session Outcomes	Personal Development	Mastering Workspace Dynamics	Career Essentials	Verbal Ability	Verbal Reasoning and Comprehension
Duration (hour)	6	6	6	6	6
SO-1	Self-analysis through SWOT, The Johari Window	Personal, Professional and Social Etiquette	Resume Preparation and Activity	Synonyms and Antonyms	Statement and Assumption
SO-2	Goal Setting Importance, Goal Setting based on the Principle of SMART	Professional Communication - Presentation Skills	E-mail Drafting and Practice	One Word Substitution	Paragraph Summary
SO-3	Emotional Intelligence (Identifying, Managing and Understanding Emotions)	Presentation for Internal and External Communication - online & offline Meetings	Techniques to Follow in Group Discussion	Word Analogy	Idioms and Phrases
SO- 4	Process of Career Exploration	Time Management and Planning Tools	Mock Group Discussion	Verbal Classification	Cloze Test
SO-5	STAR Technique (situation, task, approach and response) for Facing an Interview	Decision Making Skills	Interview Techniques	Spotting Errors	Theme Detection
SO-6	Professional Attitude – Entrepreneurial, Rational, Optimistic Attitude	Teamwork in Workspace - Resilience and Stress Management	Mock Personal Interview	Sentence Correction	Reading Comprehension

Assessment

Level of Thinking		Continuous Learning Assessment (CLA) (100 % weightage)							
		CLA – 1 (20 %)		CLA – 2 (20 %)		CLA – 3 (30 %)		CLA – 4 (30%)	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
1	Remember	25%	-	20%	-	30%	-	50%	-
2	Understand								
3	Apply	50%	-	50%	-	40%	-	25%	-
4	Analyze								
5	Evaluate	25%	-	30%	-	30%	-	25%	-
6	Create								
Total%		100 %		100 %		100 %		100 %	

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	✓	Case Studies	✓	No Poverty	
Emulations	✓	Group Discussion	✓	Zero Hunger	
Prototypes		Hands-on Practice	✓	Good Health & Well Being	
Hands-on Practice Tools	✓	Inquiry Learning	✓	Quality Education	✓
Mathematical Computing Tools		Interactive Lecture	✓	Gender Equality	
Field Visit		Leading Question	✓	Clean Water & Sanitation	
		Mind Map	✓	Affordable & Clean Energy	
		Minute Paper			
		Peer Review	✓		
		Problem Based Learning	✓		

Resources			
1	"The Johari Window: A Model for Self-awareness and Personal Growth" by Joseph Luft & Harrington Ingham	4	Campus Recruitment complete Reference , Praxis Groups
2	"The 7 Habits of Highly Effective People" by Stephen R. Covey	5	A Modern Approach to Verbal and Non Verbal Reasoning – Dr A S Agarwal
3	"SMART Goals: How to Set and Achieve Your Personal and Professional Goals" by S.J. Scott	6	Verbal Ability & Reading Comprehension for CAT - Arun Sharma

Designers					
Professional Experts		**Higher Institution Experts**		**Internal Experts**	
1	Mr. Varadha Rajan M (External Expert), Assistant Manager – Human Resources, Justdial Limited, Chennai – 600015 varadha1723@gmail.com	1	Dr. Premavathy M, Associate Professor , Department of English Center for Distance and Online Education, Bharathidasan University, Tiruchirappalli – 620024 drmpremavathy@bdu.ac.in	1	Dr. Deepalakshmi S, HoD, Department of Career Guidance Cell, FSH, SRMIST
				2	Dr. Muthu Deepa M, Assistant Professor, Department of Career Guidance Cell, FSH, SRMIST
				3	Dr. Sam Israel S, Assistant Professor, Department of Career Guidance Cell, FSH, SRMIST
				4	Dr Elamathiyan E, Assistant Professor, Department of Career Guidance Cell, FSH, SRMIST

Semester-III

Course Code	POC25301T	Course Title	Modern Synthetic Reagents and Rearrangements	Category	C	Core Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)									
CLR-1	enable them to learn about different types of Organic reagents and methods used in modern organic synthesis.	1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-2	Develop the skills in designing synthetic strategies for various targets.																			
CLR-3	explore the use of several important reagents and their implication in the modern organic transformations.																			
CLR-4	get a significant exposure in research and development for future development.																			
CLR-5	Develop capabilities as an organic chemist in pharmaceutical industries.																			
Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsib	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Gain knowledge about various molecular rearrangement reactions.	✓	✓	✓	-	2	70	65	-	3	-	2	-	-	3	-	-	-	-	-
CLO-2	Acquaint students with the use of protecting groups in organic synthesis.	✓	✓	✓	-	2	80	70	-	3	-	3	-	-	-	-	-	-	-	2
CLO-3	Gain knowledge about various important reagents and methods in organic Synthesis.	✓	✓	✓	✓	2	70	65	-	3	-	3	-	-	3	-	-	-	-	-
CLO-4	Understand the principles of asymmetric synthesis.	✓	✓	✓	✓	2	70	70	-	3	-	2	-	-	-	-	-	-	-	3
CLO-5	Gain knowledge about the in multistep organic synthesis.	✓	✓	✓	✓	2	80	70	-	3	-	3	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Functional group transformations and organic reactions	Coupling reactions in organic synthesis	Introduction to Protecting group in organic synthesis	Rearrangement in organic synthesis	Asymmetric transformations in organic synthesis
	12	12	12	12	12
SLO-1	Functional group transformations using various oxidizing reagents (PCC, PDC, PFC, CTAP, RuO4, $KBrO_3$)	Role of Palladium and Nickel catalyst in organic reactions	Introduction to Protecting group in organic synthesis, Qualities of a Good Protecting Group in Organic Synthesis	Wagner-Meerwein Rearrangement, Nametkin Rearrangement	Principles of asymmetric synthesis, Introduction, the chiral pool in Nature
SLO-2	Functional group transformations using Reducing reagents	Heck, Negishi reaction, Suzuki- Miyaura, Kumada, Buchwald-Hartwig coupling for the carbon-heteroatom bond formation	Qualities of a Good Protecting Group in Organic Synthesis, Protecting groups for N.	Pinacol Pinacolone Rearrangement and retropinacol, Benzil-Benzilic acid rearrangements	Methods of asymmetric induction, Substrate controlled reactions

	(NaCNBH$_3$, Bu$_3$SnH, Et$_3$SiH and Hydrazine)	reaction			
SLO-3	Functional group transformations using the reagents $SOCl_2$, PBr_3, PPh_3-CCl_4, LiBr, NaI, NBS, PPh_3-X_2	Organocatlysis: Lewis base catalysis, iminium catalysis, enamine catalysis, Lewis acid catalysis, Brønsted acid and base catalysis. Carbenes as organocatalysts,	Protecting groups for O, Protecting groups for Sulphur like alcohol	Rearrangement involving diazomethane	Reagent and catalyst controlled reactions, Synthesis of L-DOPA [Knowles's Mosanto process]
SLO-4	Tutorial : oxidizing and reducing reagents	Tutorial : Organocatlysis	Tutorial : Give the topic of the session	Tutorial : Pinacol Pinacolone Rearrangement and retropinacol, Benzil-Benzilic acid rearrangements	Tutorial : Reagent and catalyst controlled reactions
SLO-5	Lawesson's reagent, Mitsunobu reagent, Use of CH_2N_2, $TMSCHN_2$,	Different NHCs and their synthesis, NHC catalyzed umpolung, NHC catalyzed transesterification reactions	Use of TMSI, TBAF, TBDMS, BnBr, DHP, CbzCl	Baker–Venkataraman rearrangement, Bamberger rearrangement, Carroll rearrangement, Chapman Rearrangement	Asymmetric reactions with mechanism: Aldol and related reactions, Cram's rule, Felkin-Anh model
SLO-6	Barbier-Weiland degradation, Conversion of aldehyde to ketone and vice versa	Homo and cross benzoin type reactions, Stetter reaction	Use of Boc. anhydride, Fmoc-Cl, acetals as protecting	Overman Rearrangement	Sharpless enantioselective epoxidation and Sharpless enantioselective hydroxylation
SLO-7	Conversion of aldehyde to cyanide, Conversion of cyanide to ester	Enolate chemistry, homo enolate derived reactions, Addition to ketenes and analogues	Protection of carbonyl groups in aldehydes and ketones	Gabriel–Colman rearrangement	Amino-hydroxylation
SLO-8	Tutorial : Lawesson's reagent, Mitsunobu reagent	Tutorial : Enolate chemistry	Tutorial : Give the topic of the session	Tutorial : Baker–Venkataraman rearrangement, Bamberger rearrangement	Tutorial : Sharpless enantioselective synthesis
SLO-9	Conversion of ketone/aldehyde to phenol, Conversion of ketone to enone	Oxidative NHC catalysis	Protection of the carboxyl group, Protection of double and triple bonds.	Stevens rearrangement	Diels-Alder reaction, Use of chiral auxiliaries in diastereoselective reductions,
SLO-10	Synthetic utility of Samarium iodide in organic synthesis, Synthetic utility of Samarium Ruthenium in organic synthesis (Ring closure reaction	Cooperative catalysis with metal catalysts	Applications of the protection and deprotection of the hydroxyl, carbonyl functional group in organic synthesis	Sommelet rearrangement	Use of chiral BINOLs, BINAPs and chiral oxazolines
SLO-11	Continued (Metathesis-RCM) , Synthetic utility of Samarium Cobalt in organic, synthesis (Pauson-Khand reaction and Nicholas reaction).	Cooperative catalysis with other organo catalysts	Applications of the protection and deprotection of the amino and carboxyl functional groups in organic synthesis	Wittig rearrangements	Asymmetric transformations
SLO-12	Tutorial : RCM and Synthetic utility of Samarium iodide in organic synthesis	Tutorial : Cooperative catalysis with metal catalysts	Tutorial : Give the topic of the session	Tutorial : Stevens and Sommelet rearrangement	Tutorial : Asymmetric transformations

Resources			
1	*J. Clayden, N.Greeves, S. Warren and P. Wothers, Organic Chemistry, 1st Ed., Oxford University Press, 2001.*	5	*Peter Sykes, A Guide book to Mechanism in Organic Chemistry, 6th Ed., Orient Longman Ltd., New Delhi, 1997.*
2	*M.B. Smith & J.March, March's Advanced Organic Chemistry, 5th Ed., John Wiley & Sons, New York, 2001.*	6	*Modern Methods of Organic Synthesis, Fourth edition by William Carruthers and Iain Coldham.*
3	*F.A. Carey and R.A. Sundberg, Advanced Organic Chemistry, Part A and Part B, 5th Ed., Kluwer Academic/Plenum Publishers, New York, 2004*	7	*T.H. Lowry and K.S. Richardson, Mechanism and Theory in Organic Chemistry, 3rdEd., Addison–Wesley*
4	*P. G. M. Wuts, Greene's Protective Groups in Organic Synthesis, 5th Ed., Wiley, 2014.*		

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)		✓
		CLA – 1 (10 %)		CLA – 2 (10 %)		CLA – 3 (20 %)		CLA – 4* (10%)				
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	
1	Remember	15	-	15	-	10	-	10	-	15	-	
2	Understand	15	-	15	-	10	-	10	-	15	-	
3	Apply	20	-	25	-	25	-	25	-	25	-	
4	Analyze	20	-	25	-	25	-	25	-	25	-	
5	Evaluate	15	-	10	-	15	-	15	-	10	-	
6	Create	15	-	10	-	15	-	15	-	10	-	
	Total (%)	100	-	100	-	100	-	100	-	100	-	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Priyadip Das, Department of Chemistry, SRMIST, Email: priyadip@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25302T	Course Title	Bioorganic Chemistry	Category	C	Core Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)									
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Understand the structure, function, and chemical properties of amino acids, peptides, and proteins, which are fundamental to biological systems and biochemical processes.																			
CLR-2	Provide a comprehensive understanding of enzymes, their catalytic mechanisms, reactions, and inhibition, enabling advancements in biochemistry and drug design.																			
CLR-3	Understand the role of co-enzymes in enhancing organic reactions and their application in efficient and sustainable synthetic chemistry.																			
CLR-4	Explore the structure, function, and reactivity of nucleic acids, emphasizing their role in bioorganic chemistry and their applications in molecular biology and drug design																			
CLR-5	Study the structure, reactivity, and transformations of carbohydrates, emphasizing their role in bioorganic chemistry and chemical applications.																			
Outcomes (CLO)	**At the end of this course, learners will be able to:**	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Classify amino acids, describe peptide bond formation, and explain the structural and functional roles of proteins	✓	✓	✓	-	3	75	60	3	3	-	2	-	-	3	-	-	-	-	-
CLO-2	Analyze enzymatic mechanisms, classify reactions, and evaluate enzyme inhibition for applications in biochemistry and pharmaceutical sciences	✓	✓	✓	-	3	80	70	2	3	-	3	-	-	-	-	-	-	-	2
CLO-3	Develop the ability to utilize co-enzymes in bioorganic reactions, optimizing synthetic strategies and advancing sustainable methodologies in organic chemistry.	✓	✓	✓	✓	3	70	65	3	3	-	3	-	-	3	-	-	-	-	-
CLO-4	Gain knowledge about the nucleic acids and there role in biomolecule structures	✓	✓	✓	✓	4	70	70	3	3	-	2	-	-	-	-	-	-	-	3
CLO-5	Analyze carbohydrate structures and reactivity, applying this knowledge to bioorganic chemistry and chemical synthesis.	✓	✓	✓	✓	3	80	70	2	3	-	3	-	-	-	-	-	-	-	3

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Amino acids, Peptides and Proteins	Classification and organic reactions based on enzymes	Co-enzymes in organic synthesis	Nucleic acids	Carbohydrates

	12	12	12	12	12
SLO-1	Amino acids: acid base properties, isoelectric point, separation, resolution of racemic mixtures of amino acids	Classification of enzymes, enzyme catalysis and kinetics	Niacin and its role in redox reactions	Nucleic acids: nucleosides and nucleotides	Classification of carbohydrates, configuration, redox reactions of monosaccharides
SLO-2	asymmetric synthesis Peptide bonds: peptide secondary structures and their stabilization	nucleophilic, acid, base and metal-ion catalysis, the catalytic triad	mechanisms for pyridine nucleotide coenzymes	conformation of sugar-phosphate backbone	configuration, redox reactions of monosaccharides,
SLO-3	strategies for peptide synthesis, automated peptide synthesis	mechanisms of carboxypeptidase A	flavin adenine dinucleotide and flavin mononucleotide, mechanisms for flavin nucleotide coenzymes	hydrogen bonding by bases, the double helix, A, B, and Z double helices	Kiliani Fischer synthesis
SLO-4	Tutorial : Isoelectric point, strategies for peptide synthesis	Tutorial : nucleophilic, acid, base and metal-ion catalysis	Tutorial : flavin adenine dinucleotide	Tutorial : hydrogen bonding by bases	Tutorial : Kiliani Fischer synthesis
SLO-5	Proteins structure: primary, secondary, Tertiary structure	serine proteases, Lysozyme	thiamine pyrophosphate and its role in the pyruvate decarboxylase	stability of double helix, Replication	Ruff degradation, hemiacetals of monosaccharides
SLO-6	quaternary structures	enzyme inhibition	biotin and its role in the pyruvate decarboxylase system	Transcription, Translation	hemiacetals of monosaccharides, cyclic structure of monosaccharides
SLO-7	protein denaturation, natural βamino acids	drug design	pyridoxal phosphate , its role in decarboxylation	DNA intercalators	Glycosides, anomeric effect,
SLO-8	Tutorial : Proteins structure: primary, secondary, Tertiary structure	Tutorial : enzyme inhibition	Tutorial : pyridoxal phosphate	Tutorial : Transcription, Translation	Tutorial : hemiacetals of monosaccharides
SLO-9	β-peptides	enzymes in organic synthesis	Transamination, racemization of amino acids,	chemical synthesis of DNA, catalytic RNA, siRNA, micro RNA	Reducing sugars and non-reducing sugars
SLO-10	β-turn peptidomimetics	Antibody introduction	C-C bond cleavage	synthesis and applications of unnatural nucleosides, fluorescently labeled nucleosides and oligonucleotide probes	disaccharides
SLO-11	β-lactam based peptidomimetics	antibody catalyzed organic reactions	α, β-elimination of C-C bond	microarray based DNA detection, basics of peptide nucleic acids	polysaccharides
SLO-12	Tutorial : β-peptides, β-turn peptidomimetics, β-lactam based peptidomimetics	Tutorial : antibody catalyzed organic reactions	Tutorial : C-C bond cleavage	Tutorial : basics of peptide nucleic acids	Tutorial : polysaccharides

Resources

1	*P. Y. Bruice, Organic Chemistry, 5th Ed., Pearson, 2014.*	3	*T. K. Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry, 3rd Ed., Wiley 2007.*
2	*D. V. Vranken and G.A. Weiss, Introduction to Bioorganic Chemistry and Chemical Biology, 1st Ed., Garland Science, 2012.*	4	*N. Sewald and 3.D Jakubke, Peptides: Chemistry and Biology, 2ndEd. Wiley, 2009.*

Assessment													Strategies					
Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)			Technology		Pedagogy / Andragogy		Sustainable Development	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*					Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
		(10%)		(10%)		(20%)		(10%)					Presentation Tools	-	Group Discussion	✓	Quality Education	✓
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)		Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
1	Remember	15	-	15	-	10	-	10	-	15	-	✓			Debate	-		
2	Understand	15	-	15	-	10	-	10	-	15	-				Interactive Lecture	✓		
3	Apply	20	-	25	-	25	-	25	-	25	-				Brainstorming	✓		
4	Analyze	20	-	25	-	25	-	25	-	25	-							
5	Evaluate	15	-	10	-	15	-	15	-	10	-							
6	Create	15	-	10	-	15	-	15	-	10	-							
	Total (%)	100	-	100	-	100	-	100	-	100	-							

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers					
Professional Experts		**Higher Institution Experts**		**Internal Experts**	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. M. R. Ganesh, Department of Chemistry, SRMIST Email: ganeshm1@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Dr. Gopal Chandru Senadi, Department of Chemistry, SRMIST Email: chandrug@srmist.edu.in

Course Code	POC25D03T	Course Name	Medicinal Chemistry and Drug Design	Course Category	D	Discipline Elective Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	gain exposure to the field of medicinal chemistry																			
CLR-2	gain insight about the drug molecules, their action and how to design a drug molecule																			
CLR-3	gain knowledge about the structural importance in activity and how to improve their water solubility																			
CLR-4	learn about the use of computational simulation for drug design																			
CLR-5	know how drug molecules passes through the membrane, their metabolism, production and formulation																			
Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand the concept of medicinal chemistry	✓	✓	✓	-	4	85	75	-	3	-	2	-	-	3	-	-	-	-	-
CLO-2	Realize how the drug molecules are designed	✓	✓	✓	-	4	85	70	-	3	-	3	-	-	-	-	-	-	-	2
CLO-3	Know how the drug molecules are delivered in the cells	✓	✓	✓	✓	4	85	70	-	3	-	3	-	-	3	-	-	-	-	-
CLO-4	Utilize computational simulation to identify a potential drug molecule	✓	✓	✓	✓	4	85	70	-	3	-	2	-	-	-	-	-	-	-	3
CLO-5	Gain knowledge of drug metabolism and how to avoid it	✓	✓	✓	✓	4	85	60	-	3	-	3	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Concept of drug design	pharmacodynamics and pharmacokinetics, and site of action	Structural modification of better efficacy and computational approach	Synthesis and biological screening	Drug metabolism and vaccination
	12	12	12	12	12
SLO-1	introduction and definition of medicinal chemistry, general terminologies, The sites of drug action	drug discovery: history, general stages in drug discovery, Examples of local anti-infective drugs, Antimalarial, Antibiotics, Anticholinergic and CNS-active drugs	Synthesis and mechanism of action of representative examples of antitumor, anticancer, and DNA cleaving agents.	the design of combinatorial syntheses techniques	factors that affect metabolism, secondary pharmacological implications of metabolism
SLO-2	structure and functions of proteins	Synthesis, semi-synthesis, detailed mechanism of action, and structural modification of Penicillin antibiotics.	Structure-activity relationship of drugs, Changing size and shape	solid support method, encoding methods	phase I metabolic reactions, and examples, phase II metabolic reactions, and examples

SLO-3	structure and functions of nucleic acid	methods and routes of administration, sources of leads and drugs	introduction of new substituents, changing of existing substituents	combinatorial synthesis in solution	Prodrugs, drug synthesis: Some general considerations,
SLO-4	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session
SLO-5	enzyme structure and catalysis, inhibition in drug discovery	classification of drugs, stereochemistry and drug design	quantitative structure–activity relationship (QSAR)	high-throughput screening, library generation and analysis	asymmetry in syntheses
SLO-6	reversible inhibitors, irreversible inhibitors	importance of water solubility, and structure of the solute, methods of improving water solubility	molecular modeling methods, molecular mechanics	plasma membrane	designing organic syntheses
SLO-7	transition-state inhibitors, case studies	salt formation, formulation, effect of pH, surfactants and amphiphiles	molecular dynamics, Docking: de novo design	different processes of drug transfer, effect of drug on plasma membrane	partial organic synthesis of xenobiotics, General introduction on virus and mechanism of action of antiviral drugs towards DNA and RNA virus.
SLO-8	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session
SLO-9	DNA Interactive agents and chemotherapy, DNA binding agents	drug action, pharmacodynamics and pharmacokinetics	comparing 3D structures and use pharmacophores	introduction and bioassay, dereplication, structural analysis of the isolated substance	The general principle of vaccination strategy to combat viral infection, General introduction on virus and mechanism of action of antiviral drugs towards DNA and RNA virus.
SLO-10	intercalation and alkylation, DNA strand breakers	drug targets: action sites, enzymes	use of pharmacophore, modeling protein structures	active compound development, extraction procedures, fractionation methods	pharmacological testing, formulation development
SLO-11	working principle, case studies	receptors proteins, carrier proteins	three-dimensional QSAR, other uses of computers in drug discovery	fractionation methods, case studies:the story of Taxol	formulation development , Production, quality control
SLO-12	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session

Resources	
1	Gareth Thomas, Medicinal Chemistry: An Introduction, 2nd Ed., John Wiley and Sons, Ltd.
2	Richard B. Silverman and Mark W. Holladay, The Organic Chemistry of Drug Design and Drug Action, 3rd Ed., Elsevier.
3	Thomas Nogrady and Donald F. Weaver, Medicinal Chemistry: A Molecular and Biochemical Approach, 3rd Ed., Oxford University Press, Inc.

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

✓

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Susnata Pramanik, Department of Chemistry,SRMIST, Email: susmatap@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	PCY25D02T	Course Title	Materials Chemistry	Category	D	Discipline Elective Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Introduce the science of materials chemistry																			
CLR-2	Deepen the knowledge of crystalline materials with a focus on their synthesis methods																			
CLR-3	Improve the understanding of amorphous, electronic materials and their applications																			
CLR-4	Understand the fundamentals of nanomaterials and their applications																			
CLR-5	Gain knowledge about mechanical, magnetic, and electrical properties of materials along with their technological relevance and enlighten with basic principles of various analytical techniques for the characterization of materials																			
Outcomes (CLO)	**At the end of this course, learners will be able to:**	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibilit	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand different types of materials, their properties, characterization and applications	✓	✓	✓	-	2	75	60	3	-	3	-	-	-	3	3	3	-	-	3
CLO-2	Well aware of various chemical, and physical methods of crystalline materials synthesis	✓	✓	✓	-	2	80	70	3	-	3	-	-	2	-	3	3	-	-	3
CLO-3	Gain knowledge about amorphous materials, polymer materials and band theory of solids	✓	✓	✓	✓	2	65	65	3	-	2	-	-	-	3	3	3	-	-	3
CLO-4	Acquaint with the fundamental concepts of nanomaterials and their importance	✓	✓	✓	✓	2	80	70	3	-	2	-	-	-	3	3	3	-	-	3
CLO-5	Familiar with the mechanical, magnetic, and electrical properties of the materials and their technological relevance Identify suitable analytical techniques and perform the characterization of materials	✓	✓	✓	✓	2	70	70	3	-	2	-	3	-	-	3	3	-	-	3

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Introduction to Crystalline Materials	Classification of Solids	Chemistry of Nanomaterials	Functional Properties of Solids	Characterization of Solids
	12	12	12	12	12
SLO-1	Crystalline materials: Introduction	Amorphous solids: Introduction, a comparison of crystalline and amorphous materials in terms of properties and applications	Nanomaterials: Introduction, examples of a variety of nanomaterials	Mechanical properties: Introduction, various mechanical properties, and their importance	Spectroscopic methods: Introduction
SLO-2	Fundamentals of lattice and unit cell	Oxide and Chalcogenide glasses	Quantum confinement and quantum nanostructures	Ductile and Brittle fracture	UV-Vis: Instrumentation, basic working principles, and examples in analysis
SLO-3	Atomic coordinates and Bravias lattices	Amorphous carbon, diamond, graphite, alkaline graphite	Surface energy and Surface area of nanomaterials	Toughness and Impact testing	IR: Instrumentation, basic working principles, and examples in analysis

SLO-4	Tutorial: Crystalline materials	Tutorial: Amorphous carbon	Tutorial: Nanomaterials	Tutorial: Impact testing	Tutorial : UV-Vis and IR
SLO-5	Point defects, Line defects: line	Polymer compounds: Introduction, examples and applications	Fabrication methods of nanomaterials: Top-down and Bottom-up approaches	Magnetic properties of materials: Introduction, para magnetic properties	X-ray diffraction: Instrumentation, basic working principle, and examples in analysis
SLO-6	Surface defects and bulk defects	Band theory of solids	Classification of nanomaterials: 0D, 1D, and 2D. 0D nanomaterials examples and applications	Ferromagnetic and anti-ferromagnetic properties	Electron microscopy: SEM, instrumentation, basic working principles, and examples in analysis
SLO-7	Synthetic approaches for crystalline functional materials: Chemical methods	Insulators and Semi-Conductors	1D and 2D nanomaterials examples and applications	Ferri magnetic properties. Technological relevance of magnetic properties of materials with a few examples	Electron microscopy: TEM, instrumentation, basic working principles and examples in analysis
SLO-8	Tutorial: Types of Defects	Tutorial: Polymer compounds	Tutorial: Synthesis of nanomaterials	Tutorial: Ferromagnetic and Ferri magnetic materials	Tutorial : XRD, SEM and TEM
SLO-9	Synthetic approaches for crystalline functional materials: Chemical methods with applications	Superconductivity and optical properties of materials	Porous and Soft materials	Thermoelectric properties: Introduction and dielectric properties	XPS: Instrumentation, basic working principles, and examples in analysis
SLO-10	Synthetic approaches for crystalline functional materials: Physical methods	Band gap of materials and its correlation with optical properties. Concept of doping and different types of dopant materials	Amorphous and Luminescent materials	Piezoelectric properties and pyroelectric properties	Probe analysis, AFM: Instrumentation, basic working principles, and examples in analysis
SLO-11	Synthetic approaches for crystalline functional materials: Physical methods with applications	Effect of doping on optical properties of materials and devices based on optical properties of materials	Discussion on a few examples of technologies developed using nanomaterials	ferroelectric effect and technological relevance of electrical properties of material with a few examples	Peculiar examples of materials characterization
SLO-12	Tutorial: Physical methods and Chemical methods for synthetic approaches for crystalline functional materials	Tutorial: Doping and types of dopant materials	Tutorial: Porous and Soft materials	Tutorial: Thermoelectric properties	Tutorial: XPS and AFM

Resources	
1	*A.R. West, Basic Solid State Chemistry, 2nd Ed., John Wiley & Sons Ltd., 1999.*
2	*K.J. Klabunde, Nanoscale Materials in Chemistry, Wiley Interscience, New York, 2001.*
3	*C. Giacovazzo, Fundamentals of Crystallography, Oxford University Press, 2002.*
4	*W.D. Callister and D.G. Rethwisch, Materials Science and Engineering: An Introduction, 9th Ed., Wiley, 2013.*
5	*D.J. Ward, Materials Science, Lerner Classroom, 2008.*

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	15	-	15	-	15	-
2	Understand	15	-	15	-	15	-	15	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	10	-	10	-	10	-
6	Create	15	-	10	-	10	-	10	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

✓

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	-	Hands-on Practice	-	Gender Equality	-
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. N. Clament Sagaya Selvam, Department of Chemistry, SRMIST Email id: clamentn@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	PCY25D03T	Course Title	Advanced Polymer Science	Category	D	Discipline Elective Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Gain knowledge about advanced polymer systems, their structure-property relationships and applications.																			
CLR-2	Understand the concept of liquid crystallinity and the properties of different types of LCPs.																			
CLR-3	Gain knowledge on the synthesis, properties and applications of ionic polymers.																			
CLR-4	Acquire skills on the synthesis of conducting polymers and understand the significance and applications of conducting polymers.																			
CLR-5	Enrich the knowledge on biopolymers/biodegradable polymers, basic concepts of stimuli responsive polymers and their multi-applications.																			
Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Gain knowledge on advanced polymer science and different polymer systems.	✓	✓	✓	-	4	85	75	3	-	3	-	-	-	3	-	-	-	-	-
CLO-2	Learn about main-chain and side chain LCPs and their properties.	✓	✓	✓	-	4	85	70	-	3	3	-	-	-	-	-	2	-	-	-
CLO-3	Gain knowledge on ionic polymers for the preparation of ion exchange materials.	✓	✓	✓	✓	4	85	70	3	-	3	-	-	-	3	-	-	-	-	-
CLO-4	Understand the structural and electronic properties of conducting polymers.	✓	✓	✓	✓	4	85	70	3	-	3	-	-	-	-	-	-	-	-	3
CLO-5	Design stimuli responsive polymer systems based on the skills and knowledge acquired.	✓	✓	✓	✓	4	85	60	-	3	3	-	-	-	2	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Liquid crystalline polymers	Ionomers and ion exchange materials	Conducting polymers	Biopolymers and biodegradable polymers	Stimuli responsive polymers
	12	12	12	12	12
SLO-1	Introduction to LCPs, and structural requirements to exhibit liquid crystallinity.	Synthesis of ionic polymers. Properties and applications of ionic polymers.	Synthesis and properties of conducting polymers.	Introduction to biopolymers and biodegradable polymers.	Introduction and classification of smart polymers.
SLO-2	Main-chain LCPs: thermotropic and lyotropic liquid crystals.	Ionic crosslinking and ion exchange process.	Polyacetylene	Polymers in medicines and drug delivery.	Temperature and pH responsive polymers.

SLO-3	Synthesis of LC main-chain polymers.	Ionomers based on polyethylene.	Poly (p-phenylene vinylene) (PPV)	Biodegradable polymers: starch-based polymers, poly(glycolic acid) (PGA) and polylactic acid (PLA).	Photo responsive and redox-responsive polymers.
SLO-4	Tutorial: Properties of Main-chain LCPs	Tutorial: Properties and application of Ionomers based on polyethylene	Tutorial: Discuss why polyacetylene is a conducting polymer and the applications of polyacetylene and PPV.	Tutorial: Discuss the importance of biodegradable polymers compare to conventional plastics and the mechanism of biodegradation.	Tutorial: Application of temperature, pH, photo- and redox responsive polymers.
SLO-5	Structural features of side-chain LC polymers.	Ionomers based on polystyrene Ionomers based on polytetrafluoroethylene.	Polyheterocyclic and polyaromatic conducting polymers:	Poly(lactic-co-glycolide) (PLGA), and polycaprolactone (PCL).	Magnetic field responsive polymers. Shape memory polymers.
SLO-6	. Properties and applications of side-chain LC polymers.	Elastomeric ionomers and aromatic ionomers.	Polyaniline, polypyrrole and polythiphene.	Applications of pharmaceutical polymers: vinyl polymers, cellulose ethers and polyesters.	Smart polymer hydrogels.
SLO-7	Nematic and cholesteric LCPs.	Polymers with integral ions Halatotelechelic polymers (HTP's)	Poly(3,4-ethylenedioxythiophene) (PEDOT).	Silicones, polysaccharides and related polymers.	Self-healing polymers and their applications.
SLO-8	Tutorial: Difference between cholesteric and nematic and smectic phases and their applications	Tutorial: Comparison of properties of PS, PTFE, elastomeric ionomers and aromatic ionomers.	Tutorial: Coparison of properties of polyaniline, polypyrrole and polythiophene. Application of the polyaniline, polypyrrole, polythiophene and PEDOT.	Tutorial: Revise the preparation, properties and applications of PLGA, PCL, and pharmaceutical polymers.	Tutorial: Application of magnetic field responsive polymers, shape memory polymers and smart polymer hydrogels.
SLO-9	Different types of LCPs: Photochromic LCPs, chiral-photochromic LCPs, ionogenic LCPs.	Polyethyleneimine (PEI) and ion exchange materials.	Poly(p-phenylene sulfide), Poly(vinyl carbazole). Polypyrene and polyphenylene.	An overview of polymer nanomaterials – nanoparticles, nanostructures & nanocomposites. Synthesis, processing, and characterization of polymer nanocomposites.	Bioseparation, Biomedical applications of smart polymers – drug delivery, tissue engineering, medical devices, etc.
SLO-10	LC elastomers. Photomechanical LC polymers.	Polyelectrolytic complexes Biological ionic polymers.	Applications of conducting polymers: polymer rechargeable batteries.	Polymer nanocomposites for high-temperature applications.	Optoelectronics applications of smart polymers.
SLO-11	LC block copolymers and LC composites.	Inorganic ionic polymers.	Sensors – electrochemical actuators and electroluminescence	Current status, trends, and future Applications of polymer nanocomposites.	Recent advances and future perspectives of smart polymers.
SLO-12	Tutorial: Modern tools to evaluate the properties of LC polymers.	Tutorial: Estimate the degree of crosslinking in ionic polymers.	Tutorial: Methods to coat conducting polymer thin films on substrates.	Tutorial: Assess the degree of biodegradability of biopolymers.	Tutorial: Estimate the surface functionality of stimuli-responsive polymers.

Resources			
1	*X. Wang, Q. Zhou, Liquid Crystalline Polymers. N.J World Scientific: Singapore, 2004.*	7.	*A. Steinbüchel, Biopolymers, Institute of Microbiology, University of Münster, WILEY-VCH, 2004.*
2	*B.N. Hendy, Ionic polymers. In: Dyson R.W. (eds) Specialty Polymers. Springer, Boston, MA 1987.*	8.	J. H. Koo, Polymer Nanocomposites, Processing, Characterization, and Applications, 2nd Edn,,Mc Graw Hill, 2019.
3	*Matrin. T. Goosey, Plastics for Electronics, Elsevier Applied Science Publishers, 1985.*	9.	*Marek W. Urban, Handbook of Stimuli-Responsive Materials, John Wiley and Sons, Inc 2011*
4	*M.J. Bowden and S.R. Turner, Polymers for High Technology, Electronics and Photonics, American Chemical Society 1987.*	10.	*A. A. Zagorodni, Ion Exchange Materials: Properties and Applications, Elsevier, 2006/*
5	*T.A. Skotheim, J. Reynolds, Conjugated Polymers: Theory, Synthesis, Properties, and Characterization, 3rd Edition, CRC Press, 2006.*	11.	*J. R. Reynolds, B. C. Thompson, T. A. Skotheim, Handbook of Conducting Polymers, 4th Edition - 2 Volume Set, Taylor and Francis Group, 2019.*
6	*David Jones, Pharmaceutical Applications of Polymers for Drug Delivery, iSmithers Rapra Publishing, 2004.*	12.	*S. Ahmed, R. A.M. Osmani, Handbook of Biodegradable Polymers Applications in Biomedical Sciences, Industry, and the Environment, Taylor and Francis Group, 2025.*

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1 (10 %)		CLA – 2 (10 %)		CLA – 3 (20 %)		CLA – 4* (10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers					
Professional Experts		**Higher Institution Experts**		**Internal Experts**	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Samarendra Maji, SRMIST and Dr. Arun Prakash P, Department of Chemistry, SRMIST Email id: arunprap1@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	PCY25D05T	Course Name	Supramolecular Chemistry and Crystal Engineering	Course Category	S	Discipline Elective Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1 1	2	3	4 4	1	2	3 3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	*Enable them to learn the underlying principles of supramolecular chemistry*																			
CLR-2	*Strengthen the knowledge of the students in supramolecular chemistry*																			
CLR-3	*Explore noncovalent interactions to form supramolecular assembly.*																			
CLR-4	*Get a significant exposure in emerging field crystal engineering*																			
CLR-5	*Express their capabilities to find applications in molecular devices including smart actuators and molecular switches*																			
Outcomes (CLO)	**At the end of this course, learners will be able to:**	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	*Understand the basic principles of supramolecular chemistry*	✓	✓	✓	-	4	85	75	-	3	-	2	-	-	3	-	-	-	-	-
CLO-2	*Acquaint students with the fundamental concepts of Molecular recognitions in supramolecular chemistry*	✓	✓	✓	-	4	85	70	-	3	-	3	-	-	-	-	-	-	-	2
CLO-3	*Gain knowledge about various noncovalent interactions to form supramolecular assemblies*	✓	✓	✓	✓	4	85	70	-	3	-	3	-	-	3	-	-	-	-	-
CLO-4	*Understand the concept of crystal engineering*	✓	✓	✓	✓	4	85	70	-	3	-	2	-	-	-	-	-	-	-	3
CLO-5	*Gain knowledge about the Host-guest chemistry*	✓	✓	✓	✓	4	85	60	-	3	-	3	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Introduction to supramolecular chemistry	**Design and synthesis of receptors**	**Crystal engineering**	**Supramolecular self-assembly**	**Applications of supramolecular systems**
	12	**12**	**12**	**12**	**12**
SLO-1	Definition of supramolecular chemistry Various examples of supramolecular assemblies	Basic understanding of Host-guest chemistry, Synthetic strategies of macrocycles and cages	Basic understanding of crystal engineering	Self-assembly by covalent bonding: Design, synthesis and applications	Molecular electronic devices
SLO-2	Terminology and nomenclature in supramolecular chemistry	Design and synthesis of cation receptors: crown ethers, lariat ethers, podands, cryptands	Role of H-bonding, halogen bonding and other weak interactions	Self-assembly by covalent bonding: Design, synthesis and applications	Molecular wires and rectifiers

SLO-3	Chemical interactions leading to supramolecular assemblies	lariat ethers, podands, cryptands, Spherands, calixarenes,	Co-crystals, salts, polymorphs and their physico-chemical properties	Self-assembling by H-bonding, Design, synthesis and applications	Molecular switches and logic gates
SLO-4	Tutorial Session, Question answer session	Tutorial Session, Question answer session	Tutorial Session, Question answer session	Tutorial Session, Question answer session	Tutorial Session, Question answer session
SLO-5	Nature of binding interactions in supramolecular structures, Ion-ion, ion-dipole interactions	Cyclodextrins, cyclophanes, cryptophanes	Design of molecular crystals towards achieving targeted applications	metallomacrocycles	Relevance of supramolecular chemistry to mimic biological systems
SLO-6	Ion-ion, ion-dipole interactions, Dipole-dipole, H-bonding	carcerands, and hemicarcerands	Mechanical properties of molecular crystals	catenanes	cyclodextrins as enzyme mimics
SLO-7	cation-pi, anion-pi interactions	Host-guest interactions, pre-organization and complementarity	Binary and Ternary cocrystals	rotaxanes	ion channel mimics
SLO-8	Tutorial Session , Question answer Session	Tutorial Session , Question answer Session	Tutorial Session , Question answer Session	Tutorial Session , Question answer Session	Tutorial Session , Question answer Session
SLO-9	pi-pi and Van der Waals interactions	Lock and key analogy, Design and synthesis of anion receptors	Various applications of crystal engineering	helicates and knots	supramolecular catalysis
SLO-10	Halogen bonding, definition, and examples, Solvation effect, Hoffmeister effect	Design and synthesis of anion receptors	Coordination polymers	Examples of recent developments in supramolecular chemistry.	supramolecular catalysis
SLO-11	Supramolecular assemblies for various applications	Design and synthesis of neutral molecule receptors	Metal organic frameworks	Examples of recent developments in supramolecular chemistry.	Question answer Session
SLO-12	Tutorial Session, Question answer session	Tutorial Session, Question answer session	Tutorial Session, Question answer session	Tutorial Session, Question answer session	Tutorial Session, Question answer session

Resources

1	*J.M. Lehn, Supramolecular Chemistry-Concepts and Perspectives, Wiley-VCH, 1995.*	6	*G. R. Desiraju, J. J. Vittal and A. Ramanan, Crystal Engineering: A Textbook, World Scientific, 2011.*
2	*P. D. Beer, P. A. Gale and D. K. Smith, Supramolecular Chemistry, Oxford University Press, 1999.*	7	*T. W. G. Solomons and C. B. Fryhle, Organic Chemistry 10th Ed., John Wiley and Sons, Inc 2011*
3	*J. W. Steed and J. L. Atwood, Supramolecular Chemistry, 1st Ed., Wiley, 2000.*	8	*D. N. Nasipuri, Stereochemistry of Organic Compounds: Principles & Applications, 3rd edition, South Asia Books 2012*
4	*J. W. Steed, Core Concepts in Supramolecular Chemistry and Nanochemistry,1stEd., John Wiley & Sons, 2007.*	9	B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, Practical Organic Chemistry, 5th Ed., Pearson, 2012
5	*J.D. Seader, I. W. Hamley, Introduction to soft mater Synthetic and Biological self-assembly materials, Separation process principles,2nd Ed., Wiley, 2010.*	10	V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press 2000.

Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
	Total (%)	100	-	100	-	100	-	100	-	100	-

✓

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Jayanta Samanta, SRMIST, Email : jayantas@srmist.edu.in Dr. Palash Sanphui, SRMIST Email id: palashi@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25D04T	Course Name	Organometallic Chemistry and Catalysis	Course Category	D	Discipline Elective course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
CLR-1	identify the structure and bonding aspects of simple organometallic compounds.	1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-2	understand of structure-reactivity correlation of transitional metal complexes																			
CLR-3	be familiar with synthesis of transition metal complexes and their uses																			
CLR-4	gain knowledge of transition metal catalyzed C-3 activation reactions and their applications																			
CLR-5	understand different type of catalytic reactions																			
Outcomes (CLO)	**At the end of this course, learners will be able to:**	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Identify the geometry of the organometallic complexes	✓	✓	✓	-	4	85	75	-	3	-	2	-	-	3	-	-	-	-	-
CLO-2	Synthesize of a few coupling reactions with the basic knowledge of reaction mechanism	✓	✓	✓	-	4	85	70	-	3	-	3	-	-	-	-	-	-	-	2
CLO-3	Synthesize of new organometallic compounds using Rh/Ir catalyzed C-3 activation reactions	✓	✓	✓	✓	4	85	70	-	3	-	3	-	-	3	-	-	-	-	-
CLO-4	To apply $RhCl_3$ in ethylene dimerization reactions	✓	✓	✓	✓	4	85	70	-	3	-	2	-	-	-	-	-	-	-	3
CLO-5	To apply Ziegler-Natta catalyst for the synthesis of straight chain polymers	✓	✓	✓	✓	4	85	60	-	3	-	3	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Introduction to Organometallic Chemistry	**Organometallic Chemistry with π-ligands**	**Reactivity of Organometallic Compounds**	**Introduction to Catalysis**	**Organometallic and Organo-Catalysis**
	12	**12**	**12**	**12**	**12**
SLO-1	Type of ligands, 18 electron rule, Transition metal carbonyl complexes	π-Complexes of unsaturated molecules	Metal (Fe, Pd) ene, dieneand dienyl complexes	Introduction to catalysis, Homogeneous and Heterogeneous catalysis	Introduction to organocatalysis, catalysis of lewis base
SLO-2	Substitutes for carbonyl ligands, Non-carbon ancillary ligands	Synthesis of transitional metal complexes with alkenes, synthesis of cyclopentadienyl, cycloheptatriene	Metal complexes as protecting groups, Activation towards nucleophilic addition reaction	Hydrogenation, Hydroformylation, Acetic acid synthesis	catalysis of Bronsted acid and base

		complexes			
SLO-3	Ligand substitution reactions	Synthesis of benzenoid, π-allyl, and enyl systems, structure, bonding and reactivity of complexes	Rules governing nucleophilic additions, synthetic utility, Pd, Ni and Fe complexes, synthesis and their synthetic utility.	Heterogeneous catalysis	Catalysis of iminium, enamine, examples, Carbenes as organocatalysts
SLO-4	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session
SLO-5	carbene complexes, transition metal organometallics	Metathesis reactions , Migratory insertion reaction with alkynes	Various Wacker type oxidation , Cyclization reactions including asymmetric version.	Fischer-Tropsch reaction	Types of different NHCs and their synthesis NHC catalysed umpolung reactions
SLO-6	square planar complexes, Metal alkyls	C – C single bond formation reactions, Oxidative addition, Transmetallation	Metal (Co, Zr) alkyne complexes, Protection of triple bond	Ziegler-Natta polymerization	Trans-esterification reactions, Homo and cross benzoin type reactions
SLO-7	Metal alkylidenes and metal arenes	Reductive elimination, Insertion reaction, β-hydride and alkyl elimination reactions	C-C bond forming reactions e.g. Pauson-Khand reaction, Alkyne cyclotrimerization, Oligomerization reaction	Olefin oxidation, Isomerisation, Addition of HX to olefins	Stetter reaction, Enolate chemistry, Homoenolate derived reactions
SLO-8	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session
SLO-9	Vaskas complex, Applications	Reactions involving organo-copper and palladium intermediates, Reactions involving other transition metals	Metal (Cr, Fe, Ru) arene complexes, synthesis and structure, Activation of arene nucleus and side chain.	Carbonyl insertion, Hydride elimination	Addition to ketenes and analogs
SLO-10	Isolobal analogy	Suzuki coupling reactions with mechanism	Nucleophilic substitution and addition of arene.	Abstraction	Oxidative NHC catalysis
SLO-11	Fluxional properties of organometallics.	Stille coupling reactions with mechanism, Negishi and Ullman coupling reactions with mechanism	Metal (Rh, Ir) catalyzed C-3 activation reactions, Their synthetic utility	Cyclooligomerisation Ethylene dimerization using $RhCl_3$ as catalyst.	Cooperative catalysis, metal catalysts, Other organocatalysts
SLO-12	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session	Tutorial Session, Question answer Session

Resources			
1	2. Weller, T. Overton, J. Rourke and F. Armstrong, Inorganic Chemistry, 6th Edition, Oxford University Press, 2014. (South Asia Edition 2015)	5	D. Astruc, Organometallic Chemistry and Catalysis, Springer Verlag, 2007.
2	E. Huheey, E. A. Keiter, R.1. Keiter and O. K. Mehdi, Inorganic Chemistry, Principles of Structure and Reactivity, 4th Edition, Pearson, 2006.	6	2. Schlosser, Organometallics in Synthesis, A manual, John Wiley, New York, 1996.
3	D. Gupta and A. J. Elias; Basic Organometallic Chemistry: Concepts, Synthesis, and Applications, 2nd Edition, Universities Press (India), 2013.	7	1. S. Hegedus, Transition metals in the synthesis of complex organic molecules, second edition, University Science, Book, CA, 1999.
4	P Powell, Principles of organometallic Chemistry, 2nd Edition, Springer, 2009.	8	D. Astruc, Organometallic Chemistry and Catalysis, Springer Verlag, 2007.

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Rajorshi Das, Department of Chemistry, SRMIST Email : rajorshd@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25D06T	Course Title	Industrial Organic Chemistry	Category	D	Discipline Elective Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment			Program Learning Outcomes (PLO)												
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Learn about oil refinery processes from crude oil																			
CLR-2	Gain knowledge of useful gases industrially.																			
CLR-3	Acquire knowledge on synthesis of polymers and their various applications																			
CLR-4	Synthesize natural products in a controlled manner																			
CLR-5	Learn the systematic synthetic procedure of essential medicine and process thereof																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibil	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand the processes involved in oil refinery.	✓	✓	✓	-	4	85	75	3	-	3	2	-	-	-	-	-	-	-	-
CLO-2	Synthesize important derivatives of aromatic compounds	✓	✓	✓	-	4	85	70	3	-	3	-	-	-	-	-	-	-	-	2
CLO-3	Understand the importance of biodegradable plastics and its importance.	✓	✓	✓	✓	4	85	70	3	-	3	3	-	-	-	-	-	-	-	-
CLO-4	Design synthesis of natural products and essential drugs	✓	✓	✓	✓	4	85	70	3	-	2	-	-	-	-	-	-	-	-	3
CLO-5	Think practically about the industrial output of laboratory methods of synthesis	✓	✓	✓	✓	4	85	60	3	-	3	-	-	-	-	-	-	-	--	3

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Crude oil refinery	Synthesis of gases and aromatic compounds	Industrial polymers	Synthesis of natural products	Process chemistry
	12	12	12	12	12
SLO-1	Oil refinery physical processes, desalting and dehydration	Chemicals from benzene, toluene and xylene, review of electrophilic substitution reactions	Polymer – introduction, molecular weights of polymer, preparations.	Carbohydrates, lipids, oils and fats.	Process chemistry – introduction.
SLO-2	Crude distillation, primary raw materials from petroleum and natural gas	Phenol-formaldehyde resins, reduction of benzene to cyclohexane	Free radical polymerization, acid-catalyzed polymerization.	Amino acids, fine chemicals such as advanced intermediates.	Properties of a drug, cardiovascular drugs, (atorvastatin, rosuvastatin).

SLO-3	Liquid fuels – Petroleum, cracking - steam cracking: production of lower alkenes	Oxidation to adipic acid (nylon 6,6 and nylon 6), caprolactam from cyclohexanone oxime, Beckmann rearrangement	Ziegler-Natta process, copolymerization.	Pesticides, vitamins, Flavor and fragrance chemicals	Drugs affecting the nervous system, barbiturates, psychotropic drugs, stimulants
SLO-4	Tutorial : Oil refinery physical processes, desalting and dehydration	Tutorial : Chemicals from benzene, toluene and xylene, review of electrophilic substitution reactions	Tutorial : Ziegler-Natta process, copolymerization.	Tutorial : Carbohydrates, lipids, oils and fats, amino acids, fine chemicals such as advanced intermediates.	Tutorial : Properties of a drug, cardiovascular drugs, drugs affecting the nervous system, barbiturates, psychotropic drugs, stimulants
SLO-5	Advantages of catalytic cracking over thermal cracking, synthetic petrol, octane and cetane numbers	Reactions of toluene, benzyl chloride, benzoic acid and benzaldehyde, xylene to phthalic anhydride (plasticizers).	Living polymers, block polymers, stereoregular polymers.	Process Chemistry: Batch reactor design, fermentation technology-cell biomass	Antibacterial agents, sulfonamides, penicillin, cephalosporins
SLO-6	Production of gasoline, diesel, production of liquid petroleum gas (LPG), compressed natural gas (CNG).	Chemicals from acetylene, addition reactions, reactions of acetylene; trichloromethylene (degreasing), perchloroethylene (dry cleaning).	Syndiotactic, isotactic, atactic polymers, plastics, molding techniques, fabricating methods.	Bakers yeast production from sugars, triglycerides.	Tetracyclines, macrolides, steroid drugs (oral contraceptives, sex hormones)
SLO-7	MTBE and ETBE production routes, use of zeolites for shape selectivity in the oil refinery.	Synthesis of gases, ammonia (Haber process), carbon monoxide, coal-tar chemicals.	Hard tough plastics, high density polyethylene, polypropylene, polystyrene, nylon, polyvinyl chloride, phenol-formaldehyde resins.	Fat industrial extraction, saponification, fat hydrogenation.	Adrenocortical hormones, anabolic agents, anti-inflammatory agents.
SLO-8	Tutorial : Production of gasoline, diesel, LPG, CNG.	Tutorial : Synthesis of gases, ammonia (Haber process), carbon monoxide, coal-tar chemicals.	Tutorial : Hard tough plastics, high density polyethylene, polypropylene, polystyrene, nylon, polyvinyl chloride, phenol-formaldehyde resins.	Tutorial : Bakers yeast production from sugars, triglycerides	Tutorial : Antibacterial agents, sulfonamides, penicillin, cephalosporins
SLO-9	Chemicals from ethylene, propylene, addition reactions; conversion to acrolein and acrylonitrile	Fischer-Tropsch reaction	Soft weak plastics, low density polyethylene, elastomers (rubbers), discussion on polyisoprenes	Detergents and surfactants, trans esterification.	Analgesics (aspirin, acetaminophen), anti-histamines
SLO-10	Synthesis of cumene hydroperoxide; phenol and acetone, chemicals from the C4 stream.	Fats and oils, fatty acids, alcohols, carbohydrates	Natural rubber, styrene-butadiene rubber, synthetic natural rubber	Enzyme technology (biocatalysts for chemical transformations), production of 1-amino acids.	Anti-cancer agents, semisynthetic route of Taxol
SLO-11	Butadiene, Diels-Alder reaction, 1,4-additions.	Starch, cellulose, natural gums	Fiber reinforced plastics, applications, biodegradable plastics.	Production of artificial sweeteners, D-mannitol, acesulfame, saccharin.	Synthesis of antidiabetic drugs, metformin, sitagliptin, canagliflozin
SLO-12	Tutorial : Butadiene, Diels-Alder reaction, 1,4-additions.	Tutorial : Fischer-Tropsch reaction	Tutorial : Natural rubber, styrene-butadiene rubber, synthetic natural rubber	Tutorial : Detergents and surfactants, Production of artificial sweeteners, D-mannitol, acesulfame, saccharin.	Tutorial : Analgesics (aspirin, acetaminophen), anti-histamines

Resources

1	*Philip J. Chenier, Survey of industrial chemistry, 2nd Revised Edition, VCH, New York 1992.*	6	*Moulijn, J. A.; Makkee, 2.; Diepen, A. van. Chemical process technology [on line]. 2nd ed. Chichester: Wiley, 2013.*
2	*Mohammad F. Ali, Bassam 2. El Ali, James G. Speight, Handbook of Industrial Chemistry: Organic Chemicals, McGraw-Hill Education, 2005.*	7	-

3	*Harold A. Wittcoff, Industrial Organic Chemicals in Perspective, Krieger Publishing ,1992,.*	8	-
4	*3. Harry Szmant, Organic Building Blocks of the Chemical Industry, Wiley-Interscience; 1st edition,1989.*	9	-
5	*Weissermel, K.; Arpe, 3.-J. Industrial organic chemistry. 4th completely rev. ed. Weinheim [etc.]: Wiley-VCH, 2003.*	10	-

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)		✓
		CLA – 1 (10 %)		CLA – 2 (10 %)		CLA – 3 (20 %)		CLA – 4* (10%)				
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	
1	Remember	15	-	15	-	10	-	10	-	15	-	
2	Understand	15	-	15	-	10	-	10	-	15	-	
3	Apply	20	-	25	-	25	-	25	-	25	-	
4	Analyze	20	-	25	-	25	-	25	-	25	-	
5	Evaluate	15	-	10	-	15	-	15	-	10	-	
6	Create	15	-	10	-	15	-	15	-	10	-	
Total (%)		100	-	100	-	100	-	100	-	100	-	

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Baburaj Baskar, Department of Chemistry, SRMIST Email id: baskarb@srmist.edu.in Dr. Palash Sanphui, Department of Chemistry, SRMIST Email id: palashi@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	PPY25G01T	Course Title	LASER Physics	Category	G	Generic Elective Course	L	T	P	C
							3	1	0	4

Offering Department	Physics and Nanotechnology	Pre-requisite Courses	-	Co-requisite Courses	-	Progressive Courses	-	Data Book / Codes/Standards	-

Rationale (CR)	*The purpose of learning this course is to:*
CR-1	acquire the knowledge on laser beam characteristics
CR-2	acquire knowledge for solving problems in laser physics
CR-3	analyze Fabry-Perot cavity to understand laser resonator
CR-4	gain knowledge on Q-switched and mode-locked lasers
CR-5	acquire the knowledge on advanced topic of random lasers

Outcomes (CO)	*At the end of this course, learners will be able to:*	Depth				Attainment			Program Outcomes (PO)												
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
		Conceive	Design	Implement	Operate	Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethical Practices & Social	Individual & Team Work	Communication	Project Management &	Life Long Learning
CO-1	use the basic characteristics of a laser	✓	✓	-	-	5	85	75	3	-	3	-	3	-	-	-	-	-	-	-
CO-2	analyse Fabry Perot cavity to understand a laser resonator	✓	✓	-	-	4	85	75	3	-	3	-	3	-	-	-	-	-	-	-
CO-3	apply Rate equations to understand the dynamics of a laser	✓	✓	-	-	6	85	75	3	-	3	-	3	-	-	-	-	-	-	-
CO-4	implement the conditions of stable resonators	✓	✓	-	-	3	85	75	3	-	3	-	3	-	-	-	-	-	-	-
CO-5	work with the physics of various types of lasers	✓	✓	-	-	2	85	75	3	-	3	-	3	-	-	-	-	-	-	-

Title & Session Outcomes	Basic concepts on lasers	Cavity modes	Stable resonators and four level laser system	Q-switching and mode locking	Types of lasers
Duration (hour)	12	12	12	12	12
SO-1	General Introduction to lasers, Spontaneous and stimulated emission, Stimulated absorption	Cavity life time and Quality factor, Ultimate line width of a laser	Geometrical optics analysis of optical resonators, Condition for stable resonators	Introduction to Q-switching, Dynamics of the Q-switching process	Coherence properties of laser light
SO-2	The laser idea, Gain medium, pumping scheme and optical feedback,	Einstein's A and B Coefficients	Stability diagram for optical resonators	Electro-optical Q-switching	Temporal coherence, Michelson Interferometer, First-order correlation function
SO-3	Properties of laser beams, Monochromaticity, Directionality, coherence,	Introduction to resonators, Fabry-Perot cavity	Sources of resonator loss	Introduction to mode locking, Mathematical interpretation for mode locking	Spatial coherence, Young's double slit experiment to understand spatial coherence
SO - 4	Tutorial	Tutorial	Tutorial:	Tutorial:	Tutorial:

SO-5	Modes of a cavity, Black body radiation	Elementary theory of Fabry-Perot cavity, Transmission spectrum	Laser rate equations, Mathematical formulation of rate equations for four level laser system	Passive and active mode locking	He-Ne laser (CW)
SO-6	Calculation of mode density for black body	Coefficient of finesse/Quality factor Fundamental Gaussian beam	Condition for population inversion, Threshold condition for four level system	Gain saturation, Spatial hole burning	Nd:YAG laser (Pulsed)
SO-7	Comparison of black body radiation with laser radiation	Gaussian beam in homogeneous medium	Calculating threshold for He-Ne laser, Integrating cavity rate equation	Longitudinal and transverse mode selection, Single mode operation	Introduction to random laser
SO-8	Tutorial:	Tutorial:	Tutorial:	Tutorial:	Tutorial:
SO-9	Line shape functions, Line-broadening mechanisms	Gaussian beam focusing	Rate equations under steady state condition	Multi-mode lasers	Emission properties of a random laser
SO-10	Homogeneous and inhomogeneous broadening	Higher order Hermite Gaussian beams	Variation of laser power around the threshold	Gain competition	Modes of a random laser
SO-11	Natural, Doppler and Collison broadening	Analysis of higher order Hermite Gaussian beams	Optimum output coupling, Laser spiking	Optical amplifiers	Applications of random lasers
SO-12	Tutorial:	Tutorial:	Tutorial:	Tutorial:	Tutorial:

Assessment

Level of Thinking		Continuous Learning Assessment (CLA) (50 % weightage)				Final Exam (50% Weightage)
		CLA – 1 (10%)	CLA – 2 (10%)	CLA – 3 (20%)	CLA – 4* (10%)	
		Theory	Theory	Theory	Theory	Theory
1	Remember	20%	20%	20%	20%	20%
2	Understand	20%	20%	20%	20%	20%
3	Apply	30%	30%	30%	30%	30%
4	Analyze	30%	30%	30%	30%	30%
5	Evaluate	-	-	-	-	-
6	Create	-	-	-	-	-
	Total(%)	100	100	100	100	100

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	✓	Case Studies	✓	No Poverty	✓
Emulations	✓	Group Discussion	✓	Zero Hunger	-
Prototypes	-	Hands-on Practice	-	Good Health & Well Being	✓
Hands-on Practice Tools	-	Inquiry Learning	✓	Quality Education	✓
Mathematical Computing Tools	-	Interactive Lecture	✓	Gender Equality	✓
Field Visit	-	Leading Question	✓	Clean Water & Sanitation	-
		Mind Map	-	Affordable & Clean Energy	-
		Minute Paper	-		
		Peer Review	-		
		Problem Based Learning	✓		

*The evaluation can be done based on one or more parameters that include, i) Seminars, ii) Mini-project, iii) Case-studies, iv) MOOC Certifications, v) Publication of Articles, vi) Presentation of research work in Conferences, vii) Assignments.

Resources			
1	K. Thyagarajan and A.K. Ghatak, Lasers Theory and Applications, 1st Ed., Macmilan Publishers, 2010	2	O. Svelto, Principles of lasers, 4th Ed., Springer, 1998.
3	A. Yariv, Quantum Electronics, 3rd Ed., John Wiley, New York, 1989	4	Seigman, Lasers, 3rd Ed., Oxford Univ. Press, 1986
5	B.E.A. Saleh and M.C. Teich, Fundamentals of Photonics, 2nd Ed., Wiley, 2012.	6	D. Wiersema, The physics and applications of random lasers, Nature Physics, vol.4, pp 359-367, (2008)

Designers					
Professional Experts		**Higher Institution Experts**		**Internal Experts**	
1	Dr. N Vijayan, NPL, nvijayan@nplindia.org	1	Prof. Maruthi Manoj Brundavanam, IIT Kharagpur, bmmanoj@phy.iitkgp.ac.in	1	Dr. K Shadak Alee, SRMIST, shadakk@srmist.edu.in
2	Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	2	Prof. M Bala Murali Krishna, IIT Jodhpur, bmkrishna@iitj.ac.in	2	Dr. Junaid M Laskar, SRMIST, junaidmb@srmist.edu.in

Course Code	PPY25G02J	Course Title	Semiconductor Virtual Nanofabrication	Category	G	Generic Elective Course	L	T	P	C
							3	0	2	4

Offering Department	Physics and Nanotechnology	Pre-requisite Courses	-	Co-requisite Courses	-	Progressive Courses	-	Data Book / Codes/Standards	-

Rationale (CR)	*The purpose of learning this course is to:*
CR-1	Know what semiconductor process technology is and acquire special skillset for a fab engineer semiconductor industry demand
CR-2	Prepare yourself to meet with the requirement of highly trained workforce to nurture the India Semiconductor Mission
CR-3	Understand the basic physics of CMOS devices and various processes and tools involved in CMOS micro/nano fabrication
CR-4	Become familiarize with the CMOS processing through virtual training using SEMulator3D
CR-5	Study the fundamentals of Nanofabrication and Microfabrication

Outcomes (CO)	*At the end of this course, learners will be able to:*	Depth				Attainment			Program Outcomes (PO)												
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
		Conceive	Design	Implement	Operate	Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethical Practices & Social	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CO-1	Apply CMOS device physics and differentiate between design, fabrication, packaging, system manufacturing and product	✓	✓	✓	✓	4	85	75	-	-	3	-	3	-	-	-	3	-	-	-
CO-2	Develop integral skills in semiconductor microfabrication unit processes	✓	✓	✓	✓	4	85	75	-	-	3	-	3	-	-	-	3	-	-	-
CO-3	Develop module-level understanding of advanced CMOS FinFET process	✓	✓	✓	✓	4	85	75	-	-	3	-	3	-	-	-	3	-	-	-
CO-4	Demonstrate ability to use SEMulator3D to design CMOS devices and solve integration challenges	✓	✓	✓	✓	4	85	75	-	-	3	-	3	-	-	-	3	-	-	-
CO-5	Use Statistical Process Control	✓	✓	✓	✓	4	85	75	-	-	3	-	3	-	-	-	3	-	-	-

Title & Session Outcomes	Introduction To Semiconductors	Unit Processes	Module Processes	Contact Module and BEOL Processes	Statistical Process Control
Duration (hour)	15	15	15	15	15
SO-1	Semiconductor Ecosystem	Silicon – From crystal growth to wafer preparation	Isolation module – Advantages and challenges of STI verses LOCOS	Contact module – Metal/semiconductor contacts	Introduction and importance of SPC,
SO-2	Overview of semiconductor logic, memory, display, and MEMS	Wafer orientation and Doping (Diffusion and ion implantation)	Device architecture – Planar to FinFET	contact resistance issues of simple metal/silicon contact	Basic Concepts of Statistical Distribution
SO-3	MOS transistor and CMOS Logic Invertor	Wafer cleaning and oxide growth process	Use of SiGe and strain	metal silicides, silicidation process, evolution from Ti to Co to Ni	Hypothesis Testing
SO-4--5	*Practice: Demo on SEMulator3D software*	*Practice: Familiarize with SEMulator3D using basic tutorial on STI*	*Practice: LOCOS isolation verses Shallow Trench Isolation (STI)*	*Practice: Ion implantation and Silicidation*	*Practice: PlanarFET vs FinFET inverter*

SO-6	MOSFET device physics	Deposition technologies - CVD, PVD, ALD, Cu electroplating	Gate module – SiO_2 versus high-k dielectrics	Interconnect module – Need for multiple metal layers	Theory of z-test, t-test
SO-7	Moore's Law and Scaling	Optical lithography – Exposure system, resolution, light source	Polysilicon versus metal gate	RC delay	ANOVA
SO-8	CMOS fabrication Layout design rules	Photoresist materials	Gate-first versus gate last	challenge of electromigration	Sample size estimation
SO-9-10	*Practice:* Learn to use the Layout editor of SEMulator3D & *Create a layout of NMOS or PMOS using SEMulator3D*	*Practice: Visit to Process Lab*	*Practice: Gate-First versus Gate-Last*	*Practice: Damascene process*	*Practice: Module-level understanding of CMOS 14-nm process*
SO-11	Manufacturing ecosystem - difference between design, fabrication, packaging, system manufacturing and product	Advanced lithography tools and concepts (immersion lithography and multiple patterning)	Integration challenges of replacement metal gate	Evolution from Al verses Cu	Theory of DOE, Screening test, RSM
SO-12	Manufacturing ecosystem cont.	Dry and wet etching – Etch chemistry and etch tools	Well & junction module – Basics of implantation	Damascene and dual-damascene process, W plugs and via	Fractional and Full-factorial tests
SO-13	Semiconductor manufacturing process overview (FEOL verses BEOL)	Semiconductor metrology	Source-drain and well implants, other implants	Intermediate dielectric – materials and integration challenges	Paired Means
SO-14-15	*Practice: Building NMOS or PMOS using SEMulator3D*	*Practice: Simulate the spacer fabrication and multiple patterning*	*Practice: Building CMOS inverter using SEMulator3D*	*Practice: Dual-Damascene process*	*Practice: Build your own device*

Assessment

Level of Thinking		Continuous Learning Assessment (CLA) (50 % weightage)								Final Exam (50% Weightage)
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4* (10%)		
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)
1	Remember	10	10	10	10	10	10	10	10	20
2	Understand	10	10	10	10	10	10	10	10	20
3	Apply	15	15	15	15	15	15	15	15	30
4	Analyze	15	15	15	15	15	15	15	15	30
5	Evaluate	-								
6	Create	-								
Total%		100		100		100		100		100

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	✓	Case Studies	✓	No Poverty	✓
Emulations	✓	Group Discussion	✓	Zero Hunger	-
Prototypes	-	Hands-on Practice	✓	Good Health & Well Being	-
Hands-on Practice Tools	✓	Inquiry Learning	✓	Quality Education	✓
Mathematical Computing Tools	✓	Interactive Lecture	✓	Gender Equality	✓
Field Visit	-	Leading Question	✓	Clean Water & Sanitation	-
		Mind Map	-	Affordable & Clean Energy	-
		Minute Paper	-		
		Peer Review	-		
		Problem Based Learning	✓		

*The evaluation can be done based on one or more parameters that include, i) Seminars, ii) Mini-project, iii) Building device designs using SEMulator3D software, iv) MOOC Certifications, v) Publication of Articles, vi) Presentation of research work in Conferences, vii) Assignments.

Resources			
1	. S. M. Sze and M. K. Lee. "Semiconductor Devices: Physics and Technology" – John Wiley & Sons Inc., 3rd edition, 2012.	2	Stephen A. Campbell , "The Science and Engineering of Microelectronic Fabrication" – Oxford university Press, 2001
3	Yoshio Nishi and Rober Doering (Eds.), "Handbook of Semiconductor Manufacturing Technology"- CRC Press, 2nd Edition, 2007.	4	Marc J.Madou. "Fundamentals of Microfabrication and Nanotechnology – Volume II" – CRC Press, 3rd Edition, 2011.
5	Gary S. May and Costas J. Spanos "Fundamentals of Semiconductor Manufacturing and Process Control" IEEE A JOHNWILEY&S ONS, INC., Publication.	6	Gary S. May and Costas J. Spanos "Fundamentals of Semiconductor Manufacturing and Process Control" IEEE A JOHNWILEY&S ONS, INC., Publication
7	https://onlinecourses.nptel.ac.in/noc20_bt37/preview	8	https://onlinecourses.nptel.ac.in/noc20_bt17/preview

Designers					
Professional Experts		**Higher Institution Experts**		**Internal Experts**	
1	Dr. Joseph Ervin, LAM Research, Joseph.Erwin@lamresearch.com	1	Dr. Sushobhan Avasthi, Centre for Nano Science and Engineering (CENSE), Indian Institute of Science, Bangalore. savasthi@iisc.ac.in	1	Dr. S. Chandramohan, SRMIST
2	Mr. Kulanthaivelu Ramaswamy, Technical Staff Engineer-Analog Design, Micochip Technology Inc. Kulanthaivelu.Ramasamy@microchip.com	2		2	Prof. Sarin Sundar, SRMIST
				3	Dr. Shailendra K. Saxena, SRMIST

s

Course Code	PCY25G01T	Course Name	Research Skills and Learning	Course Category	G	Generic Elective Course	L	T	P	C
							3	1	0	4

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment			Program Outcomes (PO)												
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Understand the concept of research and differenttypes of research in the context of chemistry																			
CLR-2	Evaluate the different methods of scientific writingand reporting																			
CLR-3	Impart the knowledge about the statisticaldistribution and applications																			
CLR-4	Develop the skill of technical writing																			
CLR-5	Inculcate the knowledge of intellectual property andrights																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	Understand the key areas of research	✓	✓	✓	-	4	85	75	-	3	2	3	-	-	-	-	-	-	-	-
CLO-2	Develop experimental skills and documentation	✓	✓	✓	-	4	85	70	-	3	3	-	-	-	-	-	3	-	-	-
CLO-3	Develop competence on data collection andprocess of scientific documentation	✓	✓	✓	✓	4	85	70	-	3	3	3	-	-	-	-	-	-	-	-
CLO-4	Understand the research ethics	✓	✓	✓	✓	4	85	70	-	3	2	3	-	-	-	-	-	-	-	3
CLO-5	Submit proposals for funding agencies	✓	✓	✓	✓	4	85	60	-	3	3	2	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Literature review, DOI and other indices	Online data base and data analysis	Statistical Data	Scientific writing	Research ethics
	12	12	12	12	12
SLO-1	What is Research? Introduction – Motivation of Research - Objectives of research, Research methods and methodologies-Overview	Online databases, E-journals. Journal access – open access - subscription	Analysis and Presentation of Data, Descriptive statistics	Technical writing, technical writing - Activity	Ethics in research, authors Acknowledgement

SLO-2	types of research- Descriptive vs analytical types of research - applied vs fundamental	Citation index, Impact factor, H-index, E-consortium	Choosing and using statistical tests Data-Sample-purpose	Technical presentation -Activity	Group discussion on ethics in research Outcome of group discussion
SLO-3	types of research- quantitative vs qualitative types of research- conceptual vs empirical	UGC Infonet, E-book Preprint servers – advantages and risks	Sample test - Different types of T-test - problems F- test , χ^2 - test	Creativity in research Basic idea Creativity in research - Activity	Plagiarism Tools to avoid plagiarism
SLO-4	Tutorial: Activity based on Literature Survey	Tutorial: Activity based on data analysis	Tutorial: Activity based on T-test	Tutorial: Seminar presentation	Tutorial: Plagiarism check for assignment
SLO-5	Literature review vs. literature report Basic steps while conducting Literature and its Consolidation	Search engines, Scirus, Google Scholar ChemIndustry, Wiki-Databases	Chemometrics Analysis of variance(ANOVA),	Good practical Units,numbers Reproducibility	Presentations - Power-point presentation. Poster presentation
SLO-6	Sources of information Primary, secondary, and tertiary sources of literature	ChemSpider, Science Direct SciFinder, Scopus	Correlation and regression Curve fitting	Scientific writing – Abbreviations – standards rules nomenclature in chemistry and other fields	Elements of excellent presentation Communication skills
SLO-7	Journal abbreviations, abstracts, reviews, monographs, dictionaries	Internet resources for Science, Library research,	fitting of linear equations, analysis of residuals	justification for scientific contributions, description of methods	Activity based on research presentation
SLO-8	Tutorial: Activity based on Literature Survey	Tutorial: Activity based on data analysis	Tutorial: Activity based on chemometrics	Tutorial: Assignments on technical writing	Tutorial: Seminar on research topics
SLO-9	Introduction to Chemical Abstracts Author Index	field research Laboratory research	General polynomial fitting linearizing transformations	conclusions the need for illustration, style	Proposal submission for funding agencies Knowledge of funding agencies
SLO-10	Formula Index Subject Index	Data Analysis Making, and Recording Measurements	exponential function fit, r and its abuse	Writing references Research report writing	Intellectual property rights
SLO-11	Doi and other Indices with examples, Substance Index	Tabulation and generationof graphs, Maintaining a laboratory record	Basic aspects of multiple linear regressionanalysis	Activity-based on scientific writing	Patent rights, Copyrights
SLO-12	Tutorial: Activity based on Literature Survey	Tutorial: Activity based on tabulation and generation of graphs	Tutorial: Activity based on linear fit and regression analysis	Tutorial: Assignment on report writing	Tutorial: Drafting project proposal

Resources	
1	Dawson, C.. Practical research methods. UBS Publishers, New Delhi, 2002
2	Walpole R.A., Myers R.H., Myers S.L.and Ye King: Probablity and statstics for engineers and scientist, Pearson Prentice Hall, Pearson Education, Inc. 2007
3	Kothari C.K., Research Methodology-Methods and Techniques(New Age International, New Delhi), 2004

Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA) (50% weightage)				Final Assessment (50 % weightage)
		CLA – 1	CLA – 2	CLA – 3	CLA – 4*	
		(10 %)	(10 %)	(20 %)	(10%)	
		Theory (%)	Theory (%)	Theory (%)	Theory (%)	Theory (%)
1	Remember	15	15	10	10	15
2	Understand	15	15	10	10	15
3	Apply	20	25	25	25	25
4	Analyze	20	25	25	25	25
5	Evaluate	15	10	15	15	10
6	Create	15	10	15	15	10
	Total (%)	100	100	100	100	100

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts	Higher Institution Experts	Internal Experts
1 Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1 Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1 Dr. T. Pushpa Malini, Department of Chemistry SRMIST Email: pushpamt@srmist.edu.in
	2 Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2 Dr. M.R.Ganesh, SRMIST Email: ganeshm1@srmist.edu.in
		3 Prof. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25S02L	Course Title	Advanced Organic Chemistry Practical	Category	S	Skill Enhancement Course	L	T	P	C
							0	0	6	3

Course Offering Department	Chemistry	Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	Data Book / Codes/Standards	Nil

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment					Program Outcomes (PO)										
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	*Practice separation techniques used in organic synthesis*																			
CLR-2	*Know how isolate natural products*																			
CLR-3	*Learn orthogonal protection of functional groups*																			
CLR-4	*Gain practical experience about oxidation and reduction*																			
CLR-5	*Learn multi step synthesis*																			
Outcomes (CLO)	**At the end of this course, learners will be able to:**	Conceive	Design	Implement	Operate	Bloom's Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethicalpractices&SocialResponsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	*Acquire knowledge about advanced methods of organic synthesis*	✓	✓	✓	-	4	85	75	-	3	-	2	-	-	3	-	-	-	-	-
CLO-2	*Learn synthetic procedures: aqueous workup, distillation, reflux, separation, isolation, and crystallization*	✓	✓	✓	-	4	85	70	-	2	3	3	-	-	-	-	-	-	-	-
CLO-3	*Experience the procedure for natural product isolation*	✓	✓	✓	✓	4	85	70	-	3	3	-	-	-	3	-	-	-	-	-
CLO-4	*Perform multicomponent reaction and green chemistry*	✓	✓	✓	✓	4	85	70	-	3	3	-	2	-	-	-	-	-	-	-
CLO-5	*Learn about the orthogonal protection method*	✓	✓	✓	✓	4	85	60	-	3	3	2	-	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Organic synthesis - I	**Organic synthesis - II**	**Organic synthesis - III**	**Organic synthesis - IV**	**Organic synthesis - V**
	18	**18**	**18**	**18**	**18**
SLO-1 -6	Distillation at normal pressure: Single and mixture of compounds	Isolation of natural product: caffeine from tea leaves	Orthogonal protection of amine and acid functional groups	Multistep synthesis: Cyclohexanone → cyclohexanone oxime → caprolactone	Multicomponent synthesis: Mannich reaction

SLO-6-12	Distillation at reduced pressure: Single and mixture of compounds	Preparation of methyl orange from sulphanilic acid.	Oxidation of alcohol: benzyl alcohol → benzyl aldehyde	Chalcone → chalcone dibromide → -bromochalcone	Green chemistry: Direct Oxidative esterification of aldehyde
SLO-13-18	Separation using column chromatography-melting point measurement	Preparation of 4-nitrotriphenyl amine (NTPA) from *p*-fluoronitrobenzene and diphenyl amine	Reduction of carbonyl compound: 4-nitrobenzaldehyde → 4-nitrobenzyl alcohol	Benzophenone → benzopinacol → benzopinacolone	Organic synthesis in water

Resources	
1	*Vogel, A Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall.*
2	*Fieser and Fieser, Reagents in Organic Synthesis, Wiley.*
3	*Mann &Saunders, Practical Organic Chemistry, 4th Ed., Longmans.*

Assessment

Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1		CLA – 2		CLA – 3		CLA – 4*			
		(10 %)		(10 %)		(20 %)		(10%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	-	15	-	15	-	15	-	15	-	15
2	Understand	-	15	-	15	-	15	-	15	-	15
3	Apply	-	20	-	20	-	20	-	20	-	20
4	Analyze	-	20	-	20	-	20	-	20	-	20
5	Evaluate	-	15	-	15	-	15	-	15	-	15
6	Create	-	15	-	15	-	15	-	15	-	15
Total (%)		-	100	-	100	-	100	-	100	-	100

Strategies

Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	✓	Gender Equality	✓
		Debate	-		
		Interactive Lecture	-		
		Brainstorming	-		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers

Professional Experts		Higher Institution Experts		Internal Experts	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Baburaj Baskar, Department of Chemistry, SRMIST Email id:baskarb@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in

Course Code	POC25I01L	Course Name	Internship	Course Category	P	Project Work, Internship In Industry / Higher Technical Institutions	L	T	P	C
							0	0	0	2

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemistry*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLR-1:	*gain experience*																		
CLR-2:	*have a better understanding*																		
CLR-3:	*have the opportunity to learn and watch.*																		
CLR-4:	*gain the ability to put new things into practice.*																		
CLR-5:	*Build confidence*																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1:	*Improve the communication skill*	2	80	75	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CLO-2:	*recognise parallel relationship between words*	2	80	70	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CLO-3:	*Improve Professional behavior and/or knowledge*	2	75	70	3	3	3	3	3	3	3	3	2	3	2	3	3	3	3
CLO-4:	*Improve the Project-related skills*	2	80	75	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CLO-5:	*Improve employability-enhancing activities*	2	80	70	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3

	Continuous Learning Assessment (50% weightage)		Final Evaluation (50% weightage)	
	Review – 1	Review – 2	Project Report	Viva-Voce
Internship	20%	30%	30%	20%

Semester-IV

Course Code	POC25P01L	Course Name	Project Work	Course Category	P	Project Work, Internship In Industry / Higher Technical Institutions	L	T	P	C
							0	0	20	10

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemistry*	Data Book / Codes/Standards	*Nil*		

Rationale (CR)	The purpose of learning this course is to:	Depth				Attainment			Program Outcomes (PO)											
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	*Produce competent, creative and imaginative graduates with a strong scientific acumen*																			
CLR-2	*Apply of the acquired knowledge, skills, and tools pertinent to the field of Chemistry*																			
CLR-3	*Promote independent and collaborative research work in the domain of chemistry*																			
CLR-4	*Inculcate the ethical responsibility of the graduate in the scientific society*																			
CLR-5	*Identify the challenges and solutions pertinent to the field of Chemistry*																			

Outcomes (CO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethical practices &Social Responsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	*conduct thorough research on a given topic*	✓	✓	✓	✓	4	85	75	3	-	-	-	3	-	-	-	-	-	-	2
CLO-2	*critically analyze data, and draw relevant conclusions*	✓	✓	✓	✓	4	85	75	-	-	3	3	3	-	-	-	-	-	-	-
CLO-3	*identify complex problems and develop feasible solutions,*	✓	✓	✓	✓	4	85	75	-	3	-	3	3	-	-	-	-	-	-	3
CLO-4	*understand and applies problem solving skills learned, and implement them effectively in a project setting*	✓	✓	✓	✓	4	85	75	2	3	-	3	2	-	-	-	-	-	-	-
CLO-5	*inculcate professional communication through Interviews & Group Discussions*	✓	✓	✓	✓	4	85	75	-	-	-	-	-	3	-	1	2	3	-	-

	Continuous Learning Assessment (50% weightage)		Final Evaluation (50% weightage)	
	Review – 1*	Review – 2*	Project Report*	Viva-Voce
Project Work	20%	30%	30%	20%

* includes submission of project work in the form of paper for presentation/publication in a conference/journal and/or preliminary filing of a patent with proof.

GENERIC ELECTIVES OFFERED BY THE CHEMISTRY DEPARTMENT

Course Code	PCY25G02T	Course Name	Chemistry of Biomolecules	Course Category	G	Generic Elective Course	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemistry	Data Book / Codes/Standards	NIL		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning	Program Learning Outcomes (PLO)

Rationale (CLR)	The purpose of learning this course is to:	Depth				Attainment			Program Outcomes (PO)												
		1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12
CLR-1	Provide basic understanding about the biomolecules like amino acids, proteins, nucleic acids, lipids and carbohydrates																			
CLR-2	appreciate the role of these biomolecules in biology.																			
CLR-3	gain knowledge about enzymes and coenzymes																			
CLR-4	apply the information gained about enzymes and coenzymes into organic chemistry applications like molecule synthesis																			
CLR-5	gain knowledge about amino acids and proteins and their structural features																			

Outcomes (CLO)	At the end of this course, learners will be able to:	Conceive	Design	Implement	Operate	Level of Thinking	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Problem Solving	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethical practices &Social Responsibility	Individual & Team Work	Communication	Project Management & Finance	Life Long Learning
CLO-1	apply the information gained about enzymes and coenzymes into organic synthesis.	✓	✓	✓	✓	4	85	75	3	-	-	-	3	-	-	-	-	-	-	2
CLO-2	understand the importance of nucleic acid in bioorganic chemistry	✓	✓	✓	✓	4	85	75	-	-	3	3	3	-	-	-	-	-	-	-
CLO-3	understand the importance of carbohydrate chemistry	✓	✓	✓	✓	4	85	75	-	3	-	3	3	-	-	-	-	-	-	3
CLO-4	understand the significant role of amino acid, peptides and proteins in bioorganic chemistry	✓	✓	✓	✓	4	85	75	2	3	-	3	2	-	-	-	-	-	-	-
CLO-5	understand interactions between amino acids, peptides, nucleic acids and there role in biomolecule structure	✓	✓	✓	✓	4	85	75	3	-	-	2	3	-	-	-	-	-	-	-

Sessions	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5
	Properties of Amino acids, Peptides and proteins	Importance Enzymes and coenzymes	Introduction to Nucleotides and nucleosides	Fatty Acids and Lipids	Structures and properties Carbohydrates
	(12)	(12)	(12)	(12)	(12)
SLO-1	Classification and structure of amino acids	Enzymes, Classification	Nature of genetic material	Fatty acids classification	Classification of carbohydrates

SLO-2	Configuration of amino acids, acid-base properties and isoelectric point	Kinetics, inhibition	**Structure of purine and pyrimidine**	Nomenclature, structure of fatty acids	Stereo isomerism of sugars
SLO-3	Separation of amino acids	Mechanisms of enzyme action	Nucleotides and nucleosides	Properties of fatty acids	Optical isomerism of sugars
SLO-4	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session
SLO-5	Peptide bonds, disulfide linkages	Cofactors as derived from vitamins, co-enzymes	Types of nucleic acids	**Structure and function of prostaglandins, tri-acyl glycerol**	Mutarotation, occurrence,
SLO-6	Proteins classification based on solubility, shape, composition and function,	Prosthetic, prosthetic group and apoenzymes	Structure of DNA	Structure and functions of phospholipids,	Structure of mono and di saccharides
SLO-7	Structure of polysaccharides	Structure and biological functions of coenzyme-A	Properties of nucleic acids	Spingomyelin	Biological importance of mono, di and polysaccharides
SLO-8	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session
SLO-9	Structure of proteins, Determination of the primary structure of a protein, secondary, tertiary and quaternary structures	Thiamine pyrophosphate, pyridoxal phosphate	Hypo and hyperchromicity	Plasmologens	An introduction to mucopolysaccharides
SLO-10	Determination of the primary structure of a protein, secondary, tertiary and quaternary structures,	NAD+, NADP+ , FAD, lipoic acid	Transcription and translation	Structure and function of glycolipids,	Reactions of carbohydrates due to the presence of hydroxyl, aldehyde and ketone groups.
SLO-11	Protein denaturation.	Overview of reactions catalysed by the above cofactors	Determination of the base sequence of DNA	Cholesterol.	Reactions of carbohydrates due to the presence of hydroxyl, aldehyde and ketone groups.
SLO-12	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session	Tutorial: Question answer session

Learning Resources	1.D. 1. Nelson, 2. 2. Cox, Lehninger Principles of Biochemistry, 5thEd., W. 3. Freeman; New York, USA, 2005. 2. R. K. Murray, D. K. Grammer, Harper's Biochemistry, 29th Ed., McGraw Hill, Lange Medical Books, United Kingdom, 2009. 3. J.1. Jain, S. Jain, N. Jain, Fundamentals of Biochemistry, S. Chand & Company. India, 2013. 4. P. Y. Bruice, Organic Chemistry, 5th Ed., Pearson, 2014.

Assessment									
Level of Thinking		Continuous Assessment (CA) (100 % weightage)							
		CA– 1 (20%)		CA– 2 (30%)		CA– 3 (30%)		CA – 4* (20%)	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
1	Remember	20	-	15	-	15	-	20	-
2	Understand								
3	Apply	20	-	20	-	20	-	20	-
4	Analyze								
5	Evaluate	10	-	15	-	15	-	10	-
6	Create								
Total%		100		100		100		100	-

Strategies					
Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	✓	Case Studies	-	No Poverty	-
Emulations	-	Group Discussion	✓	Zero Hunger	-
Prototypes	-	Hands-on Practice	✓	Good Health & Well Being	-
Hands-on Practice Tools	✓	Inquiry Learning	✓	Quality Education	✓
Mathematical Computing Tools	✓	Interactive Lecture	✓	Gender Equality	-
Field Visit	-	Leading Question	✓	Clean Water & Sanitation	-
		Mind Map	-	Affordable & Clean Energy	-
		Minute Paper	-		
		Peer Review	-		
		Problem Based Learning	✓		

Assessment											
Bloom's Level of Thinking		Continuous Learning Assessment (CLA) (50% weightage)								Final Assessment (50 % weightage)	
		CLA – 1 (20 %)		CLA – 2 (20 %)		CLA – 3 (40 %)		CLA – 4* (20%)			
		Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)	Theory (%)	Practice (%)
1	Remember	15	-	15	-	10	-	10	-	15	-
2	Understand	15	-	15	-	10	-	10	-	15	-
3	Apply	20	-	25	-	25	-	25	-	25	-
4	Analyze	20	-	25	-	25	-	25	-	25	-
5	Evaluate	15	-	10	-	15	-	15	-	10	-
6	Create	15	-	10	-	15	-	15	-	10	-
Total (%)		100	-	100	-	100	-	100	-	100	-

Strategies					
Technology		Pedagogy / Andragogy		Sustainable Development	
Simulations	-	Clarification/Pauses	✓	Good Health & Well Being	✓
Presentation Tools	-	Group Discussion	✓	Quality Education	✓
Learning Management System	✓	Hands-on Practice	-	Gender Equality	✓
		Debate	-		
		Interactive Lecture	✓		
		Brainstorming	✓		

* The evaluation can be done on one or more parameters that include, (i) Seminars, (ii) Mini-Project, (iii) Case-Studies, (iv) MOOC Certification, (v) Publication of Article, (vi) Presentation of Research Work in Conferences, (vii) Assignments

Designers					
Professional Experts		**Higher Institution Experts**		**Internal Experts**	
1	Dr. Ravikiran Allada, Head Analytical R&D and ASAT (AVP) || Steriscience (Strides), Bengaluru, Karnataka, Email Id: Ravikiran.Allada@Steri-science.com	1	Prof. G. Sekar, Department of Chemistry, IIT Madras Email: gsekar@iitm.ac.in	1	Dr. Priyadip Das, Department of Chemistry, SRMIST Email id: priyadip@srmist.edu.in
		2	Prof. Sukhendu Mandal, Department of Chemistry, IIISER, Thiruvananthapuram Email: sukhendu@iisertvm.ac.in	2	Prof. Dr. M. Arthanareeswari, Department of Chemistry, SRMIST Email id: arthanam@srmist.edu.in