

University of Mumbai



No. AAMS_UGS/ICC/2024-25/148

CIRCULAR:-

Attention of all the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments is invited to this office Circular No. AAMS_UGS/ICC/2023-24/23 dated 08th September, 2023 relating to the NEP UG & PG Syllabus.

They are hereby informed that the recommendations made by the Board of Deans at its meeting held on 3rd September, 2024 vide item No. 6.6 (N) have been accepted by the Hon'ble Vice Chancellor as per the power confirmed upon him under section 12(7) of the Maharashtra Public Universities Act, 2016 and that in accordance therewith syllabus for **M.Sc. (Organic Chemistry) (Sem – III & IV) for University Department of Chemistry (Autonomous)** as per appendix (NEP 2020) with effect from the academic year 2024-25.

(The Circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
21st September, 2024


(Dr. Prasad Karande)
REGISTRAR

To

All the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments.

BOD 6.6(N) 03/09/2024

Copy forwarded with Compliments for information to:-

- 1) The Chairman, Board of Deans,
- 2) The Dean, Faculty of Science,
- 3) The Chairman, **Board of Studies in Chemistry**
- 4) The Director, Board of Examinations and Evaluation,
- 5) The Director, Department of Students Development,
- 6) The Director, Department of Information & Communication Technology,
- 7) The Director, Centre for Distance and Online Education (CDOE) Vidyasagar,
- 8) The Deputy Registrar, Admission, Enrolment, Eligibility & Migration Department (AEM),

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentar@gmail.com
17	The Director, Centre for Distance and Online Education (CDOE), Vidyanagari, director@idol.mu.ac.in
18	Director, Innovation, Incubation and Linkages, Dr. Sachin Laddha pinkumanno@gmail.com
19	Director, Department of Lifelong Learning and Extension (DLLE), dlleuniversityofmumbai@gmail.com

Copy for information :-	
1	P.A to Hon'ble Vice-Chancellor, vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor pvc@fort.mu.ac.in
3	P.A to Registrar, registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O), camu@accounts.mu.ac.in

To,

1	The Chairman, Board of Deans pvc@fort.mu.ac.in
2	Faculty of Humanities, Dean 1. Prof.Anil Singh Dranilsingh129@gmail.com Associate Dean 2. Dr.Suchitra Naik Naiksuchitra27@gmail.com 3.Prof.Manisha Karne mkarne@economics.mu.ac.in
	Faculty of Commerce & Management, Dean 1. Dr.Kavita Laghate kavitalaghate@jbims.mu.ac.in Associate Dean 2. Dr.Ravikant Balkrishna Sangurde Ravikant.s.@somaiya.edu 3. Prin.Kishori Bhagat kishoribhagat@rediffmail.com

	Faculty of Science & Technology Dean 1. Prof. Shivram Garje ssgarje@chem.mu.ac.in Associate Dean 2. Dr. Madhav R. Rajwade Madhavr64@gmail.com 3. Prin. Deven Shah sir.deven@gmail.com
	Faculty of Inter-Disciplinary Studies, Dean 1. Dr. Anil K. Singh aksingh@trcl.org.in Associate Dean 2. Prin. Chadrashekhhar Ashok Chakradeo cachakradeo@gmail.com
3	Chairman, Board of Studies,
4	The Director, Board of Examinations and Evaluation, dboee@exam.mu.ac.in
5	The Director, Board of Students Development, dsd@mu.ac.in DSW directr@dsw.mu.ac.in
6	The Director, Department of Information & Communication Technology, director.dict@mu.ac.in

BOD – 3/9/2024

12(7) of M.P.U.A. 2016

Item No. 6.6 (N)

As Per NEP 2020

University of Mumbai



**Title of the P.G. Program
M.Sc. (Organic Chemistry)**

Syllabus for

Semester – Sem.- III & IV

Department of Chemistry (Autonomous)

**Ref: GR dated 16th May, 2023 for Credit
Structure of PG**

(With effect from the academic year 2024-25)



(As per NEP 2020)

Sr. No.	Heading	Particulars
1	Title of program O: _____	M.Sc. (Organic Chemistry)
2	Scheme of Examination R: _____	NEP 50% Internal 50% External, Semester End Examination Individual Passing in Internal and External Examination
3	Standards of Passing R: _____	40%
4	Credit Structure R: <u>SPA – 30B</u>	Attached herewith
5	Semesters	Sem. III & IV
6	Program Academic Level	6.5
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic Year	2024-25

Sign of the
Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science &
Technology

Sign of the
Offg. Dean
Prof. Shivram S. Garje
Faculty of Science &
Technology

Preamble

1) Introduction

This program is designed to provide a comprehensive and in-depth understanding of the fascinating world of Organic chemistry. Through a rigorous academic curriculum and hands-on research experience, we aim to nurture the intellectual curiosity and scientific acumen of our students, preparing them for successful careers in various sectors of the chemical sciences. The M.Sc. (Organic Chemistry) course is structured to equip students with a strong theoretical foundation, practical skills, and critical thinking abilities necessary to address the challenges and opportunities in the diverse fields of chemistry. Our esteemed faculty members are experts in their respective fields, with a passion for both teaching and research. They are committed to providing a nurturing learning environment, encouraging open discussions, and fostering collaborative research endeavors. Through their mentorship, students will have the opportunity to engage in cutting-edge research projects, pushing the boundaries of scientific knowledge and contributing to the advancement of the chemical sciences.

We envision our M.Sc. (Organic Chemistry) postgraduate's act as catalysts for positive change, equipped to drive innovation, shape industries, and address societal challenges through their expertise in chemistry. Whether your passion lays in research, industry, education, or beyond, our program aims to provide the knowledge and skills necessary to excel in your chosen path.

2) Aims and Objectives

The aims and objectives of M.Sc. (Organic Chemistry) course are designed to provide students with a well-rounded and advanced education in the field of Organic chemistry. These goals focus on equipping students with a deep understanding of chemical principles, fostering research and analytical skills, and preparing them for successful careers in various sectors of the chemical sciences.

The M.Sc. (Organic Chemistry) course aims to produce skilled and knowledgeable professionals who can contribute to scientific research, industrial innovation, and the betterment of society through their expertise in Organic chemistry.

3) Learning Outcomes

The learning outcomes of the M.Sc. (Organic Chemistry) course are designed to equip students with a comprehensive and advanced understanding of the field of chemistry. These learning outcomes reflect the knowledge, skills, and competencies that students are expected to gain upon successful completion of the program.

- 4) **Any other point (if any):** The skills and knowledge acquired during this master's program will make the students well-equipped for diverse roles in academia and industry.

- 5) **Credit Structure of the M.Sc. (Organic Chemistry) (Sem I, II, III & IV) (Table as per पपपपपपपपप -1 with sign of HOD and Dean)**

Post Graduate Program: M.Sc. (Organic Chemistry)

पपपपपपपपप -1

Year	Level	Sem	Major				RM	OJT/FP	RP	Cum. Cr.	Degree	
			Mandatory			Electives						
1	6.0	Sem I	3*4+ 2=14			4		4		-	22	PG Diploma (after 3 Years Degree)
			Physical Chemistry-I (55711)	TH	4	Analytical Chemistry-I (55751) (OR) Applied Industrial Chemistry-I (55752)	Research Methodology (55791)					
			Inorganic Chemistry-I (55721)	TH	4							
			Organic Chemistry-I (55731)	TH	4							
			Chemistry Practical-I (55792)	PR	2							
		Sem II	3*4+ 2=14			4		-	4	-	22	
			Physical Chemistry-II (55712)	T H	4	Analytical Chemistry-II (55771) (OR) Applied Industrial Chemistry-II (55772)	(55793)					
			Inorganic Chemistry-II (55722)	T H	4							
			Organic Chemistry-II (55732)	T H	4							
			Chemistry Practical-II (55794)	P R	2							
Cum. Cr. For PG Diploma			28			8	4	4		44		
Exit Option: PG Diploma (44 credits) after Three Year UG Degree												

R: SPA – 30B

Year	Level	Sem (2yr)	Major				RM	OJT/FP	RP	Cum. Cr.	Degree
2	6.5	Sem III	3*4+ 2=14			4	-	-	(CHEM 646)	22	PG Degree after 3-yr UG or PG Degree after 4-yr UG
			Photochemistry, Stereochemistry, Physical Organic Chemistry and Pericyclic Reactions (CHEM 641)	TH	4	Medicinal, Green & Bioorganic Chemistry (CHEM 64511)					
			Ylides, α -C-H activation and Reactions, Radicals and Organometallic Chemistry (CHEM 642)	TH	4	OR Computer Aided Drug Design, Medicinal Chemistry and Forensic analysis (CHEM 64512)					
			Heterocyclic Chemistry And Advanced Spectroscopic Techniques (CHEM 643)	TH	4						
			Organic Chemistry Practical (CHEM 644)	PR	2						
		Sem IV	3*4=12			4	-	-	(CHEM 671)	22	
			Stereochemistry, Asymmetric Synthesis, Theoretically Fascinating Molecules, Organic Electronic and Photonic materials (CHEM 647)	TH	4	Intellectual Property right and Chemoinformatics (CHEM 67011)					
			Advanced Synthetic Organic chemistry (CHEM 648)	TH	4	(OR) Enzymes, coenzymes and biogenesis (CHEM 67012)					
			Natural Products Chemistry (CHEM 649)	TH	4						
		Cum. Cr. For 1 Yr PG Degree			26			8			
Cum. Cr. For 2 Yr PG Degree			54			16	4	4	10	88	

PG Degree after 3-yr UG or PG Degree after 4-yr UG

Sign of HOD

Prof. Shivram S. Garje
Head of Department,
Department of Chemistry,
University of Mumbai

Sign of Dean,

Prof. Shivram S. Garje
Dean, Science and Technology
University of Mumbai

Department of Chemistry(Autonomous)
UNIVERSITY OF MUMBAI
Syllabus for M.Sc. (Organic Chemistry)
Semester III and IV

Choice-Based Credit System
Under New Education Policy (NEP) 2020
(To be implemented from the academic year, 2024-2025)
PROGRAM OUTLINE 2023-2024

YEAR		COURSE CODE	COURSE TITLE	CREDITS
M.Sc. Sem-III	Mandatory Course-I	641	Photochemistry, Stereochemistry, Physical Organic Chemistry and Pericyclic Reactions	04
	Mandatory Course-II	642	Ylides, α -C-H activation and Reactions, Radicals and Organometallic Chemistry	04
	Mandatory Course-III	643	Heterocyclic Chemistry And Advanced Spectroscopic Techniques	04
	Mandatory Course Practical	644	Organic Chemistry Practical	02
	Elective 1	64511	Medicinal, Green & Bioorganic Chemistry	04
	Elective 2	64512	Computer Aided Drug Design, Medicinal Chemistry and Forensic analysis	04
	Research Project	646	Research Project	04
M.Sc. Sem-IV	Mandatory Course-I	647	Stereochemistry, Asymmetric Synthesis, Theoretically Fascinating Molecules, Organic Electronic and Photonic materials	04
	Mandatory Course-II	648	Advanced Synthetic Organic chemistry	04
	Mandatory Course-III	649	Natural Products Chemistry	04
	Elective 1	67011	Intellectual Property Right and Chemoinformatics	04
	Elective 2	67012	Enzymes, coenzymes and biogenesis	04
	Research Project	671	Research Project	06

PROGRAMME SPECIFIC OUTCOME (PSOs)

- 1.** Gain knowledge of the advanced concepts in the branch of chemistry, identify and accomplish a solution to problems encountered in the field of research and analysis.
- 2.** Apply the basic knowledge of chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the global standards.
- 3.** Deduce qualitative and quantitative information of chemical compounds using advanced spectroscopic methods which can further be analyzed using practical skills inculcated in them during the course.
- 4.** Imbibe the attitude as well as aptitude of a scientific approach along with analytical reasoning with respect to the novel techniques implemented in the industry.
- 5.** Use the subject knowledge, communication, and ICT skills to become an effective team leader/team member in the interdisciplinary fields.
- 6.** Understand, Manage, and contribute to solve basic societal issues and environmental concerns ethically based on principles of scientific knowledge gained.
- 7.** Exhibit professional work ethics and norms of scientific development.

Syllabus for
M.Sc. (Organic Chemistry)
(Sem. III & IV)
Semester – III

PROGRAM(s): M.Sc.-II		SEMESTER: III		
Course: Paper-I		Course Code: CHEM 641 Course Title: PHOTOCHEMISTRY, STEREOCHEMISTRY, PHYSICAL ORGANIC CHEMISTRY, AND PERICYCLIC REACTIONS		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 50)	Semester End Examination (Marks- 50)
04		04	50	50
Learning Objectives: 1. To gain knowledge about the different types of photochemical aspects for various Organic compounds. 2. To understand the various methods of synthesis of Organic compounds based on its stereochemistry, 3. To know the in-depth knowledge of various organic intermediates based on its physical approach for organic compounds. 4. To get information about the various types of pericyclic reactions.				
Course Outcomes: 1. Learners will be able to study the approaches of photochemistry and reaction based on photochemistry of various organic compounds. 2. Learners will be able to understand various synthetic approaches for synthesizing Organic compounds based on different stereochemistry involved. 3. Learners will be able to understand the different types and different physical aspects for organic compounds. 4. Learners will be able to study various types and different photochemical approaches for organic compounds.				

Paper-I

CHEM 641: PHOTOCHEMISTRY, STEREOCHEMISTRY, PHYSICAL ORGANIC CHEMISTRY, AND PERICYCLIC REACTIONS

Unit-I	<u>PHOTOCHEMISTRY</u>	[15L]
1.1	General Principles -Importance and applications of photochemical processes, Mechanism of absorption of photochemically relevant radiation, Excitation and deactivation of molecules, Electronic transitions and states, Selection rules, notations, types and characteristics, Electron energy transfer, Photosensitization and quenching processes.	[3L]
1.2	Photochemistry of carbonyl compounds, $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions, Norrish type-I and Norrish type-II cleavages, Paterno-Buchi reactions, photoreductions, photochemistry of enones, cyclohexadienones, rearrangements of α , β -unsaturated ketones.	[5L]
1.3	Photochemistry of unsaturated system-olefins, cis-trans isomerizations and, Di- π methane rearrangement.	[3L]
1.4	Photochemistry of arenes, 1, 2; 1, 3 and 1, 4 additions.	[1L]
1.5	Singlet oxygen and photooxygenation reactions.	[1L]
1.6	Intramolecular Rearrangements: Rearrangements with trimesityl compound to enolether, o-nitrobenzaldehyde to o-nitrosobenzoic acid. Determination of photochemical mechanisms:	[2L]
Unit-II	<u>STEREOCHEMISTRY</u>	[15L]
2.1	Stereochemistry of decalins, hydrindanes, steroids and Bridged ring compounds, Bredt's rule, discussion on non-classical carbocation.	[4L]
2.2	Transannular effects, Addition reactions, elimination reactions.	[2L]
2.3	Classification of point groups based on symmetry elements with appropriate examples[non-mathematical treatment]	[2L]
2.4	Molecular dissymmetry and chiroptical properties: Linearly and circularly polarized light, Circular birefringence and Circular dichroism, ORD and CD curves and their applications, The Octant rule and its applications, Applications of CD in conformational studies of biopolymers.	[4L]
2.5	Structures, symmetry and synthesis of 3-prismane and cubane: Reactions of cubane and its derivatives, Structures and symmetry of 4/5/6 prismanes and general methods of synthesis of Helicenes and their chiral applications.	[3L]
Unit-III	<u>REACTIVE INTERMEDIATES & PHYSICAL ORGANIC CHEMISTRY</u>	[15L]
3.1	Organic reactive intermediates: Methods of generation, Structure, Stability and important reactions of Carbocations [including NGP and non-classical carbocations], Carbenes, Arynes, Nitrenes, ketenes.	[8L]
3.2	Acid-base catalysis-General and specific acid and base catalysed reactions, Acidity functions and acidity strength, Reaction rates and acidity scales, Mechanism of acid-base catalysis.	[3L]

3.3	Potential Energy surfaces, Bell-Evans Polanyi principle, Marcus theory, Curtin-Hammett principle	[2L]
3.4	Kinetic methods: Determination of reaction order and rate constants, Empirical rate equations for parallel reactions, Sequential reactions.	[2L]
Unit-IV	PERICYCLIC REACTIONS	[15L]
4.1	Role of FMOs in organic reactivity: Hard and Soft electrophiles and nucleophiles, Ambident nucleophiles, ambident electrophiles, the α effect.	[3L]
4.2	Classification of pericyclic reactions: Thermal and photochemical reactions	[1L]
4.3	Three approaches: (1) Conservation of orbital symmetry/Correlation Diagram (2) Frontier Molecular Orbital approach [FMO] and (3) Aromatic [Huckel and Mobius] Transition state approach.	[2L]
4.4	Cycloaddition reactions: $4n$ and $(4n+2)$ π electron systems. Diels-Alder reactions, 1,3-Dipolar cycloadditions and Cheletropic reactions, retro-Diels-Alder reaction. Rates of Diels-Alder reaction based on FMOs; regioselectivity, periselectivity and site selectivity in Diels-Alder reactions.	[3L]
4.5	Electrocyclic reactions: Conrotatory and disrotatory motions, $4n$ and $(4n+2)$ π electron systems and other systems.	[2L]
4.6	Sigmatropic rearrangements: H-Shifts and C-shifts, supra and antarafacial migrations. Retention and inversion of configurations. Cope and Claisen rearrangements	[3L]
4.7	Diimide reduction reactions, *Group transfer reactions	[1L]

Paper-II

PROGRAM(s): M.Sc.-II		SEMESTER: III		
Course: Paper-II		Course Code: CHEM 622 Course Title:-YLIDES, α-C-H ACTIVATION AND REACTIONS, RADICALS AND ORGANOMETALLIC CHEMISTRY		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 50)	Semester End Examination (Marks- 50)
04	—	04	50	50
Learning Objectives: 1. To gain knowledge about the different types of ylides its different preparation methods, reactions in organic synthesis. 2. To understand various types or metal and nonmetal based reagents used in organic reactions. 3. To understand the radical initiated reactions of transition and rare earth metal reactions 4. To understand the role of organometallic compounds in the course of different types of organic synthesis				
Course Outcomes: 1. Learners will be able to study the different types of ylides and their use in different organic reactions 2. Learners will be able to understand the metal and non-metal based reaction and their applications in various organic synthesis. 3. Learners will be able to understand how different transition and rare earth metals are used in organic compounds. 4. Learners will be able to study the role of various organometallic compounds and its applications in synthetic strategy.				

Paper-II
CHEM 642: YLIDES, α -C-H ACTIVATION AND REACTIONS, RADICALS AND ORGANOMETALLIC CHEMISTRY

<u>Unit-I</u>	<u>YLIDES, α-C-H ACTIVATION & REACTIONS</u>	[15L]
1.1	Methods of preparations, structures and reactivity comparison of phosphorus, sulfur and nitrogen ylides, Reactions of P-, S- and N-ylides with carbonyl compounds and other substrates, including mechanism, stereochemistry and applications in natural product synthesis of Wittig reaction.	
1.2	α -C-H activation by nitro, sulfoxide, sulfone and phosphonate groups: generation of carbanions by strong bases (LDA/n-BuLi) and applications in C-C bond formations. Vicarious nucleophilic substitutions.	
1.3	Bamford-Stevens Reaction, Julia-Kocienski Olefination, Ramberg-Bäcklund Reaction, Staudinger Reaction, Bestmann-Ohira Reagent, Barton-Kellogg olefination, Steven's rearrangement, Pummerer sulfoxide rearrangement. Determination of photochemical mechanisms:	
<u>Unit-II</u>	<u>RADICALS IN ORGANIC SYNTHESIS</u>	[15L]
2.1	General aspects: Electrophilic and nucleophilic radicals and their reactivities with π -rich/deficient olefins.	
2.2	Inter- and intramolecular aliphatic C-C bond formation via mercury hydride, tin hydride, carbon hydride, thio donor (Barton's radical decarboxylation reaction).	
2.3	Cleavage of C-X, C-Sn, C-Co and C-S bonds in the generation of radicals.	
2.4	Trapping by electron transfer reactions using Mn(OAc) ₃ .	
2.5	Radical-Radical processes: oxidative couplings, single electron oxidation of Carbanions to generate radicals, dehydrodimerization and Reductive couplings.	
2.6	C-C bond formation in aromatics: Introduction, radical reactions on aromatics, electrophilic radical reactions, nucleophilic radicals, Radical reactions on heteroaromatics-alkylations and acylations.	
2.7	Hunsdiecker halodecarboxylation, Barton-McCombie alcohol deoxygenation, Kuivila-Beckwith and Stork radical dehalogenation/cyclization, Bergman and Myers-Saito Cycloaromatization.	
<u>Unit-III</u>	<u>METALS/NON-METALS IN ORGANIC SYNTHESIS</u>	[15L]
3.1	Organolithium reagents, Preparation and synthetic applications, including directed metallation. Organocuprate reagents.	
3.2	Applications of boron: generation of diborane, hydroboration/oxidation of alkenes, alkynes mechanism, regiochemistry and stereochemistry. Asymmetric hydroboration using	

- chiral borane reagents, functional groups reduction by diborane.
- 3.3** Mercury in organic synthesis: Oxymercuration-demercuration of alkenes, mechanism and regiochemistry, solvomercuration and intramolecular mercuration. Mercuration of aromatics and transformation of aryl-mercurels to aryl halides.
- 3.4** Organosilicons: Important features of silicon governing the reactivity of C-Si compounds: Preparation and important C-C bond forming reactions of alkyl silanes, alkenyl silanes, aryl silanes and allyl silanes. Silyl enol ethers as enolate precursors. Iodo trialkyl silane and trialkylsilylcyanide in organic synthesis.
- 3.5** Organotin compounds: Preparation of alkenyl/aryl and allyl tin compounds and their acylation and Michael reactions.
- 3.6** Selenium in organic synthesis: preparation of selenols/selenoxide, selenoxide elimination to create unsaturation, selenoxide and seleno-acetals as α -C-H activating groups.
- Unit-IV** **TRANSITION & RARE-EARTH METALS IN ORGANIC SYNTHESIS** [15L]
- 4.1** Basic concepts, 18 electron rule, oxidative addition, reductive elimination, substitution.
- 4.2** **Pd and Rh in organic synthesis:**
 π -bonding of Pd and Rh with olefins, applications in C-C bond formations including Wacker process, Heck reaction, Negishi coupling reactions, Carbonylation, hydroformylation, decarbonylation, olefin isomerism, aryl amination using Pd reagents. Olefin metathesis(RCM) using catalysis.
- 4.3** Applications of nickel, cobalt, iron and chromium carbonyls in organic synthesis
- 4.4** Selected applications of Samarium iodide, and Cerium (IV), in organic synthesis.
- 4.5** Eu(OTf)₃ and Sc(OTf)₃ as efficient, water tolerant Lewis acid catalysts in aldol condensation, Michael reactions, Diels-Alder and aza-Diels-Alder reactions, acylation reactions.

Paper-III

PROGRAM(s): M.Sc.-II		SEMESTER: III		
Course: Paper-III		Course Code: CHEM 643 Course Title:- HETEROCYCLIC CHEMISTRY AND ADVANCED SPECTROSCOPIC TECHNIQUES		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 50)	Semester End Examination (Marks- 50)
04	–	04	50	50
Learning Objectives: 1. To understand the different heterocyclic compounds, its nomenclature system for monocyclic and bicyclic compounds. 2. To study the reactivity, general methods of preparations and applications of various heterocycles in organic compounds 3. To know the in-depth theory behind IR, NMR spectroscopy and interpretation of various organic compounds 4. To get information about FT-NMR, ESR, fluorescence spectroscopy.				
Course Outcomes: 1. Learners will be able to study IUPAC nomenclatures of fused heterocyclic compounds. 2. Learners will be able to understand the reactivity different methods of preparations. 3. Learners will be able to understand the principle of IR, NMR spectroscopy for Organic compounds 4. Learners will be able to study various information in depth about FT-NMR, ESR and fluorescence spectroscopy				

Paper-III

CHEM 643: HETEROCYCLIC CHEMISTRY AND ADVANCED SPECTROSCOPIC TECHNIQUES

<u>Unit-I</u>	<u>HETEROCYCLIC CHEMISTRY-I</u>	[15L]
1.1	Introduction, Classification, IUPAC and common names of mono- and bicyclic fused Heteroaromatic compounds.	[5L]
1.2	Reactivity, important general methods of synthesis and selected applications of the following heterocycles: Pyrazole, imidazole, oxazole, isoxazole, thiazole, benzimidazole, benzoxazole, benzthiazole, pyridine and pyridine N-oxide.	[10L]
<u>Unit-II</u>	<u>HETEROCYCLIC CHEMISTRY-II</u>	[15L]
2.1	Reactivity, important general methods of synthesis and selected applications of the following Heterocycles: Pyridazine, pyrimidine, pyrazine, oxazine, quinoline, isoquinoline, coumarin, indole, purine, s-triazine, benzodiazepine, piperidine, morpholine.	
<u>Unit-III</u>	<u>ADVANCED SPECTROSCOPIC TECHNIQUES-I</u>	[15L]
3.1	FT-IR Spectroscopy: Principle and applications	[2L]
3.2	NMR Spectroscopy: Relaxation phenomenon and relaxation time, First order, higher order spectra and their simplifications, Double resonance, NOE, NOE difference spectroscopy and chemical shift reagents.	[3L]
3.3	Second order spectra: Spin system notation, AB, AX, AB ₂ -AX ₂ , ABX, AMX and A ₂ B ₂ -A ₂ X ₂ spin system with suitable examples, Coupling in aromatic and heteroaromatic systems, long range coupling.	[2L]
3.4	Spectra of diastereotopic systems.	[1L]
3.5	ESR: Fundamentals and applications.	[2L]
3.6	Fluorescence Spectroscopy: Principles and applications	[2L]
3.7	Problems	[3L]
<u>Unit-IV</u>	<u>ADVANCED SPECTROSCOPIC TECHNIQUES-II</u>	[15L]
4.1	FT-NMR: Pulse sequences, pulse widths, spins and magnetisation vectors.	[1L]
4.2	¹³ C-NMR: ¹³ C nucleus, ¹³ C-chemical shifts, Calculation of ¹³ C-chemical shifts, proton coupled ¹³ C-spectra, ¹³ C-spectra Integration, proton decoupled ¹³ C-spectra. Off-resonance decoupling, DEPT-technique, heteronuclear coupling of carbon to ¹⁹ F and ³¹ P.	[3L]
4.3	¹⁹ F-NMR: Principles and applications.	[2L]
4.4	³¹ P-NMR: Principles and applications	[2L]
4.5	Two dimensional NMR: Introduction, COSY technique and overview of COSY experiment, how to read COSY spectra, HETCOR technique and overview of the HETCOR experiment, how to read HETCOR spectra.	[2L]
4.6	NOESY, ROESY, HMBC, INADEQUATE techniques.	[2L]
4.7	Problems	[2L]
4.8	Applications of NMR in medicine.	[1L]

PROGRAM(s): M.Sc.-II		SEMESTER: III		
Course: Practical		Course Code: CHEM 644 Course Title:- ORGANIC CHEMISTRY PRACTICAL		
Teaching Scheme				Evaluation Scheme
Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 25)	Semester End Examination (Marks- 25)
04	NA	02	25	25
Learning Objectives: 1. To gain knowledge of the in separations of ternary mixtures based on their chemical nature 2. To gain ability to perform identifications of different solid-solid combinations based on their chemical nature of compounds. 3. The learners will learn the Qualitative Analysis of different types of Organic compounds. 4. The learner will gain knowledge and hands on experience of different characterization techniques. 5. The learners will gain ability to prepare different derivatives of organic compounds.				
Course Outcomes: 1. The learner will be able to carry out the separations of ternary mixtures based on their chemical nature. 2. Apply the knowledge of qualitative analysis for the identification of organic compounds 3. The learner will be able to understand the characterization techniques to identify different class of compounds. 4. The learners will be able to separate three different compounds based on their reactivity and able to prepare different derivatives.				

CHEM 644: ORGANIC CHEMISTRY PRACTICAL

One step preparations with column chromatography (minimum 3) and Separation and analysis of ternary mixture: (minimum 5)

Preparations

1. P-Nitrophenol from phenol (Purification by column chromatography)
2. Acetyl ferrocene from ferrocene (Purification by column chromatography)
3. m-nitroaniline from m-dinitrobenzene (Purification by column chromatography)
4. Flourenone from flourene (Purification by column chromatography)
5. Preparation of anthrone via anthraquinone from Anthracene.

Seprations

A three component mixture of solid and liquids and belonging to same or different chemical classes. Detection and separation of ternary mixture of same or different physical states (solid and liquids) and same or different chemical classes. [Mixtures with same chemical classes separable by physical methods can be given. Identification of all three components is expected

ELECTIVE COURSE-I

PROGRAM(s): M.Sc.-II		SEMESTER: III		
Course: Elective 1		Course Code: CHEM 64511 Course Title:- MEDICINAL, GREEN AND BIOORGANIC CHEMISTRY		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks-50)	Semester End Examination (Marks-50)
04	–	04	50	50
Learning Objectives: 1. To understand the general introduction to discovery of new drugs their lead modifications and drug design and developments. 2. To get knowledge about Synthesis and application of various drugs and its steric effect. 3. To know about the green chemistry approaches, different examples of green synthesis/reactios and enzyme catalyzed organic reactions. 4. To get information about nucleic acids and its recombinant DNA synthesis.				
Course Outcomes: 1. Learners will be able to study the introduction to discovery of new drugs, their lead modifications and various developments in drug design. 2. Learners will be able to study synthesis and applications of various drugs. 3. Learners will be able to understand the green chemistry approaches, different green synthesis and enzyme catalyzed organic reactions. 4. Learners will be able to study about nucleic acids and its recombinant DNA synthesis.				

ELECTIVE COURSE-I
CHEM 64511: MEDICINAL, GREEN AND BIOORGANIC CHEMISTRY

<u>Unit-I</u>	<u>DRUG DISCOVERY/DESIGN & DEVELOPMENT & SYNTHESIS-I</u>	[15L]
1.1	General introduction to discovery of new drugs: Drug discovery without a Lead: Penicillin and Librium. Lead discovery: Random screening, non-random (or Targeted) screening. Drug metabolism studies, clinical observations, Rational approach to lead discovery.	[6L]
1.2	Lead Modification: Drug design and Development Identification of pharmacophore, functional group modification, structure activity relationship, privileged structures and drug like molecules. Structural modification to increase potency and therapeutic index: Homologation. Chain branching, ring chain transformation, bioisosterism.	[6L]
1.3	Combinatorial Chemistry: General concepts, split synthesis, peptide libraries, encoding combinatorial libraries.	[3L]
<u>Unit-II</u>	<u>DRUG DISCOVERY/DESIGN & DEVELOPMENT & SYNTHESIS-II</u>	[15L]
2.1	Synthesis and application of following drugs: Atorvastatin, Linezolid, Nateglinide, S-omeprazole, Ramipril, Zidovudine (AZT).	[10L]
2.2	Steric effect:	
2.3	The Taft and other equations, methods used to correct regression parameters with biological activity. Hansch analysis: A linear multiple regression analysis.	[5L]
<u>Unit-III</u>	<u>GREEN CHEMISTRY & ENZYMATIC PROCESSES</u>	[15L]
3.1	Green Chemistry: Introduction, Basic principles of green chemistry with applications.	[3L]
3.2	Examples of green synthesis/reaction: Green Starting materials Green Reagents Green Solvents and reaction conditions (Solvent replacement table, Supercritical fluids) Green Catalysis (Traditional processes and green one) Synthesis of Ibuprofen, Adipic Acid.	[7L]
3.3	Enzyme catalyzed Organic Reactions: Hydrolysis, Hydroxylation, Oxidation and Reductions.	[5L]
<u>Unit-IV</u>	<u>BIOORGANIC CHEMISTRY</u>	[15L]
4.1	Nucleic acids: Structure and function of DNA and RNA, genetic code, protein biosynthesis, mutation.	[10L]
4.2	Recombinant DNA Synthesis: Phosphodiester, Phosphotriester, Phosphoramidate and H-phosphate approach including solid phase approach.	[5L]

ELECTIVE COURSE-II

PROGRAM(s): M.Sc.-II		SEMESTER: III		
Course: Elective 2		Course Code: CHEM 64512 Course Title: COMPUTER AIDED DRUG DESIGN, MEDICINAL CHEMISTRY & FORENSIC ANALYSIS		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 50)	Semester End Examination (Marks- 50)
04	–	04	50	50
Learning Objectives: 1. To study the introduction to computer aided drug design 2. To study the history, different techniques and applications of computer aided drug design. 3. To learn the quantitative structure activity relationships: Basics Physicochemical parameters and methods to calculate them. 4. To understand about the lipophilicity effects and parameters (log P, π -substituent constant), steric effects (Taft steric and molar refractivity), Biological parameters.				
Course Outcomes: 1. Students will be able to understand the introduction to computer aided drug design. 2. Students will get the knowledge about the history, different techniques and applications of computer aided drug design. 3. Students will get knowledge about the quantitative structure activity relationships: Basics Physicochemical parameters and methods to calculate them 4. Students will able to know about lipophilicity effects and parameters (log P, π -substituent constant), steric effects (Taft steric and molar refractivity), Biological parameters				

ELECTIVE COURSE-II
CHEM 64512: COMPUTER AIDED DRUG DESIGN, MEDICINAL CHEMISTRY & FORENSIC ANALYSIS

<u>Unit-I</u>	<u>COMPUTER AIDED DRUG DESIGN</u>	[15L]
1.1	Introduction to computer aided drug design (CADD): History, different techniques and applications.	
1.2	Quantitative structure activity relationships: Basics Physicochemical parameters and methods to calculate them: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, π -substituent constant), steric effects (Taft steric and molar refractivity), Biological parameters.	
<u>Unit-II</u>	<u>MOLECULAR DOCKING, PROPERTIES AND DRUG DESIGN</u>	[15L]
2.1	Molecular docking and receptor interactions: Rigid docking, flexible docking, Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AChE & BuChE)	
2.2	Prediction and analysis of ADMET properties of new molecules and its importance in drug design.	
2.3	<i>De novo</i> drug design: Receptor/enzyme-interaction and its analysis, receptor/enzyme cavity size prediction, predicting the functional components of cavities.	
2.4	Introduction to homology modeling and generation of 3D-structure of protein.	
<u>Unit-III</u>	<u>MEDICINAL CHEMISTRY</u>	[15L]
3.1	Structure and activity: Relationship between chemical structure and biological activity (SAR). Receptor Site Theory. Approaches to drug design. Introduction to combinatorial synthesis in drug discovery.	
3.2	Drugs based on substituted benzene ring: Chloramphenicol, salmetrol, tolazamide, diclophenac, tiapamil, intryptyline.	
3.3	Drugs based on five-membered heterocycles: Tolmetin, spiralpril, oxaprozine, sulconazole, nizatidine, imolamine, isobuzole.	
3.4	Drugs based on six-membered heterocycles: Warfarin, quinine, norfloxacin and ciprofloxacin, methyclothiazide, citrine, terfenadine.	[2L]
<u>Unit-IV</u>	<u>FORENSIC ANALYSIS</u>	[15L]
4.1	Introduction: Profile of a Forensic laboratory, Forensic Scientist's role and quality control, crime-scene investigation, collection and preserving physical evidences and evidentiary documentation, future prospects of forensic analysis.	
4.2	Forensic Toxicology: Analysis of various types of poisons (corrosive, irritant, analgesic, hypnotic, tranquillizer, narcotic, stimulants, paralytic, anti-histamine, domestic and industrial (gaseous and volatile) poisoning and food poisoning), Explosive and explosion residue analysis, lethal drug analysis (sampling, sealing, packing, laboratory methods of testing, reporting the analysis results, court evidence and medico-legal aspects for the consideration of chemical data as a proof for crime), Importance of physiological tests in forensic toxicology.	

Reference Books:

- 1 Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, OxfordUniversity Press.
- 2 Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, PlenumPress.
- 3 Stereochemistry: Conformation and mechanism, P.S. Kalsi, New Age International,New Delhi.
- 4 Stereochemistry of carbon compounds, E.L Eliel, S.H Wilen and L.N Manden, Wiley.
- 5 Stereochemistry of Organic Compounds- Principles and Applications, D. Nasipuri. New International Publishers Ltd.
- 6 March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley.
- 7 Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad,Pearson Education.
- 8 Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.
- 9 Understanding Organic Reaction Mechanisms, Adams Jacobs, Cambridge UniversityPress.
- 10 Writing Reaction Mechanism in organic chemistry, A. Miller, P.H. Solomons, Academic Press.
- 11 Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Nelson Thornes.
- 12 Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya Shankar Singh, Pearson Education.
- 13 Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, Thomson Brooks.
- 14 Spectrometric Identification of Organic Compounds, R. Silverstein, G.C Bassler and T.C. Morrill, John Wiley and Sons.
- 15 Organic Spectroscopy, William Kemp, W.H. Freeman & Company.
- 16 Organic Spectroscopy-Principles and Applications-Jagmohan, Narosa Publication.
- 17 Organic Spectroscopy, V.R. Dani, Tata McGraw Hill Publishing Co.
- 18 Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International Ltd.
- 19 Mechanism in Organic Chemistry, Peter sykes, 6th edition onwards.
- 20 Physical Organic Chemistry, Neil Isaacs
- 21 Modern Physical Organic Chemistry, Eric V. Anslyn and Dennis A. Dougherty
- 22 Stereochemistry: A Three-Dimensional Insight by Anil V. Karnik and MohammedHasan.

PROGRAM(s): M.Sc.-II		SEMESTER: III		
Course: Research Project		Course Code: CHEM 646 Course Title:-RESEARCH PROJECT		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 50)	Semester End Examination (Marks- 50)
	–	04	50	50
Learning Objectives: 1. To understand and discuss the new research topics in the field of chemistry. 2. To understand the importance, relevance, and procedure to gather back ground literature information from various scientific database. 2. To display, organize and represent correlation between different types of data. 3. To summarize and provide a concise summary of research projects carried out. 4. Demonstrate a capacity to communicate research results clearly and comprehensively. Course outcomes: - 1. Students will define a research question, design objectives and appropriate hypothesis for their project. 2. Students will find and evaluate relevant literature and back ground information related to their project. 3. Students will learn and use the techniques needed to do their experiments. 4. Students will learn and follow appropriate protocols for documenting their research as well to analyse the experimental data. 5. Students will be able to use logic and evidence to draw conclusions and future scope of the research work done.				

Semester – IV

PROGRAM(s): M.Sc.-II		SEMESTER: IV		
Course: Paper-I		Course Code: CHEM 647 Course Title:- STEREOCHEMISTRY, ASYMMETRIC SYNTHESIS, THEORETICALLY FASCINATING MOLECULES, ORGANIC ELECTRONIC AND PHOTONIC MATERIALS		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks-50)	Semester End Examination (Marks- 50)
04	–	04	50	50
Learning Objectives: 5. To gain knowledge about the different types of stereochemical aspects of Organic compounds. 6. To understand the various methods of synthesis of Organic compounds based on its stereochemistry, 7. To know the in-depth knowledge of various Asymmetric Synthesis. 8. To get information about the various types of organic electronic and photonic materials.				
Course Outcomes: 5. Learners will be able to study the approaches of stereochemistry of various organic compounds. 6. Learners will be able to understand various Asymmetric synthetic approaches for synthesizing Organic compounds based on different stereochemistry involved. 7. Learners will be able to understand the different types and different aspects of fascinating molecules. 8. Learners will be able to study various types and different synthetic approaches for organic and photonic materials.				

Paper-I

CHEM 647: STEREOCHEMISTRY, ASYMMETRIC SYNTHESIS, THEORETICALLY FASCINATING MOLECULES, ORGANIC ELECTRONIC AND PHOTONIC MATERIALS

<u>Unit-I</u>	<u>STEREOCHEMISTRY</u>	[15L]
1.1	Racemates and methods of resolution of racemates.	[3L]
1.2	Chemical and Instrumental methods of determining configurations.	[4L]
1.3	Conformation and reactivity in cyclic compounds with more emphasis on cyclohexane derivatives, Reactions involving steric factors and stereoelectronic factors, Addition reactions, substitution reactions, elimination reactions, rearrangement reactions, I-strain concept.	[4L]
1.4	Determination of enantiomer and diastereomer composition. (a) Chiroptical methods and their limitations [Horeau effect] (b) Methods based NMR: Use of Chiral Derivatizing Agents, CDA, Chiral Solvating Agents, CSA, and Chiral Shift Reagents, CSR.; (c) Chromatographic methods, use of chiral stationary phase (chiral columns)	[4L]
<u>Unit-II</u>	<u>ASYMMETRIC SYNTHESIS</u> Principles of asymmetric synthesis, Cram's rule, Sharpless epoxidation, asymmetric dehydroxylation, asymmetric aminohydroxylations, asymmetric Diels-Alder reactions, chiral borane reagents, asymmetric reductions of prochiral carbonyl compounds and olefins. Use of chiral auxiliaries in Diastereoselective reductions. Synthesis of alpha amino acids (Corey's Diastereoselective hydrogenation of cyclic hydrazones); Synthesis of L- DOPA [Knowles's Mosanto process], asymmetric aldol and related reactions. Use of Chiral BINOLs, BINAPs, and chiral oxazolines and oxazolidines in asymmetric transformations.	[15L]
<u>Unit-III</u>	<u>THEORETICALLY FASCINATING MOLECULES</u>	[15L]
3.1	Structures, synthesis and properties of cyclophanes, calixarenes, C-60, rotaxanes.	[5L]
3.2	Design, operating photophysical principles, synthesis of selected chemo-and fluorescence based metal ion sensors derived from crown ethers and macrocyclic systems, and chemo- and fluorophore chelators.	[8L]
3.3	The Host Guest binding phenomena: Assessment by UV/VIS or Fluorescence methods; NMR methods. The Benesi-Hildebrand Equation, Stern Volmer relationships	[2L]
<u>Unit-IV</u>	<u>ORGANIC, ELCTERONIC & PHOTONIC MOLECULES</u> Organic nonlinear chromophores, Conducting polymers, Dye sensitized organic photovoltaic materials, Organic Magnetic materials, Organic light emitting diodes. General examples of organic conjugated chromophores and polymers, synthesis and various applications.	[15L]

PROGRAM(s): M.Sc.-II		SEMESTER: IV		
Course: Paper-II		Course Code: CHEM 648 Course Title:- ADVANCED SYNTHETIC ORGANIC CHEMISTRY		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 50)	Semester End Examination (Marks- 50)
04	–	04	50	50
Learning Objectives: 1. To get basic knowledge about domino reaction & click chemistry 2. To know about the Polymer supported reagents for acid base catalysis, electrode potential, anodic oxidation and cathodic reduction reactions. 3. To get in-depth knowledge retrosynthetic approach.				
Course Outcomes: 1. Learners will be able to study the domino, tandem and click chemistry reactions. 2. Learners will be able to study polymer supported reagents and application in organic synthesis. 3. Learners will be able to study anodic oxidation and cathodic reduction based reactions. 4. Learners will be able to study the use of retrosynthetic approach for organic synthesis.				

Paper-II

CHEM 648: ADVANCED SYNTHETIC ORGANIC CHEMISTRY

<u>Unit-I</u>	<u>DOMINO REACTION & CLICK CHEMISTRY</u>	[15L]
1.1	Multi-component reactions: i) Strecker reaction ii) Hantzsch dihydropyridine synthesis iii) Biginelli condensation iv) Passerini 3-component condensation v) Ugi 4-component condensation iv) Domino Knoevenagel-hetero-Diels-Alder reaction.	
1.2	Domino Reactions/Tandem Reaction/Cascade Reactions: Definition and Classification Cascade processes: concept, examples of cationic, anionic and radical initiated cascade reactions.	
1.3	Click Chemistry reactions	
<u>Unit-II</u>	<u>POLYMER SUPPORTED REAGENTS & ELECTROORGANIC SYNTHESIS</u>	[15L]
2.1	Polymer supported reagents for acid base catalysis,	
2.2	Introduction: Electrode potential, cell parameters, electrolyte, working electrode, choice of solvents, supporting electrolytes.	
2.3	Cathodic reductions: alkyl halides, aldehydes/ketones, nitro compounds, olefin, arenes, Electrodimerizations.	
2.4	Anodic oxidations: Kolbe type reactions, oxidation of arylalkanes.	
<u>Unit-III</u>	<u>NON-CLASSICAL METHODS OF ORGANIC SYNTHESIS</u> Principles and applications of the following:	[15L]
3.1	1) Phase transfer catalysis, crown ethers and cryptands, concepts, synthesis and applications 2) Micelles, structures, properties and reactions 3) Ionic liquids 4) cyclodextrin, structure and functions 5) ultrasound in organic synthesis 6) Zeolites, structures, properties and catalysis and 7) Organocatalysis 7) Microwave in organic synthesis 8) Solid phase synthesis	
<u>Unit-IV</u>	<u>DESIGNING ORGANIC SYNTHESIS</u>	[15L]
4.1	Umpolung: Concept of umpolung, generation of acyl anion equivalent-1, 3-dithiane from carbonyl compounds, use of methylthio-methylsulfoxide, via cyanide ion and cyanohydrin ethers, nitro compounds and metallated vinyl ethers.	
4.2	Methodology in organic synthesis: Functional group interconversions, general methods of 4 - 7 membered ring formation, Disconnection approach and Retrosynthetic analysis, ideas of synthones and retrones, Examples of acyclic saturated and unsaturated systems, monocyclic and bicyclic compounds.	
4.3	Target oriented and methods oriented synthesis: Strategies and tactics.	
4.4	Protection-deprotection of functional groups: carbonyl, hydroxyl, amino, carboxyl, with examples illustrating the applications of each.	

PROGRAM(s): M.Sc.-II	SEMESTER: IV			
Course: Paper-III	Course Code: CHEM 649 Course Title:- NATURAL PRODUCTS CHEMISTRY			
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 50)	Semester End Examination (Marks- 50)
04	–	04	50	50
Learning Objectives: 1. To understand the occurrence, structures, classification biological role, important structural and stereochemical features of the different class of steroids. 2. To study the various insect pheromones, insect growth regulators, plant growth regulators and antibiotics. 3. To know the in-depth about carbohydrates, natural pigments, prostaglandins and lipids. 4. To introduce different vitamins and synthetic approaches to prepare vitamins.				
Course Outcomes: 1. Learners will be able to structures, classification biological role, important structural and stereochemical features of the different class of steroids 2. Learners will be able study the various insect pheromones, insect growth regulators, plant growth regulators and antibiotics. 3. Learners will be able to understand the different carbohydrates, natural pigments, prostaglandins and lipids. 4. Learners will be able to learn the different vitamins and synthetic approaches to prepare vitamins.				

Paper-III

CHEM 649: NATURAL PRODUCTS CHEMISTRY

Unit-I	<u>NATURAL PRODUCTS CHEMISTRY-I</u>	[15L]
1.1	Steroids: Occurrence, structures, classification biological role, important structural and stereochemical features of the following types of steroids-Estrogens, gestrogens, androgens, corticosteroids, sterols, bile acids, calciferol, sapogenins and steroidal alkaloids.	[5L]
1.2	Synthesis of 16-DPA from cholesterol and plant sapogenin.	[3L]
1.3	Synthesis of commercially important steroids from 16-DPA.	[4L]
1.4	Synthesis of cinerolone, Jasmolone, allethrolone, pyrethrolone, exaltone and muscone.	[3L]
Unit-II	<u>NATURAL PRODUCTS CHEMISTRY-II</u>	[15L]
2.1	Insect pheromones: Structural features and importance. Synthesis of bombycol, gossyplure, disparlure, brevicomin and grandisol.	[5L]
2.2	Insect growth regulators: General idea, constitution of JH, structures of JH ₂ and JH ₃ .	[2L]
2.3	Plant growth regulators: Structural features and applications of aryl acetic acids, gibberelic acids, brassinolides and triacontanol, Synthesis of triacontanol.	[2L]
2.4	Antibiotics: Classification on the basis of activity and structure determination of penicillin-G, Cephalosporin-C and terramycin, Synthesis of penicillin-G, phenoxymethyl penicillin and Semi-synthetic cephalosporins.	[6L]
Unit-III	<u>NATURAL PRODUCTS CHEMISTRY-III</u>	[15L]
3.1	Carbohydrates	
3.2	Types of naturally occurring sugars: Deoxysugars, amino sugars, branched sugars. Structure determination of lactose, inositol and amino sugars, Constitution and applications of chitin.	[6L]
3.3	Natural pigments: General structural features, occurrence, isolation, biological importance and applications of: carotenoids, anthocyanins, flavones, xanthenes, quinones, pterins and porphyrins. Structure determination and synthesis of β -carotene and ubiquinone.	[4L]
3.4	Prostaglandins: Classification, General structure and biological importance. Structure determination and synthesis of PGE ₁ and PGF _{1α}	[3L]
3.5	Lipids: Structure and role of carbolipids, phospholipids and sphingolipids.	[2L]
Unit-IV	<u>NATURAL PRODUCTS CHEMISTRY-IV</u>	[15L]
4.1	Vitamins: Classification, sources and biological importance, Synthesis of B ₁ , B ₂ , B ₆ , D, E, K and compounds with vitamin-K activity. Multi-step synthesis of natural products:	[5L]

Synthesis of the following natural products with special reference to [10L]
 reagents used, stereochemistry and functional group transformations:
 Reserpine, Longifoline, Griseofulvin, Estrone, β -Vetivone, 4-Demethoxy daunomycin, caryophyllin etc.

PROGRAM(s): M.Sc.-II		SEMESTER: IV		
Course: Elective 1		Course Code: CHEM 67011 Course Title:-INTELLECTUAL PROPERTY RIGHTS AND CHEMOINFORMATICS		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours perweek)	Credit	Continuous Assessment (CA) (Marks- 50)	Semester End Examination (Marks- 50)
04	–	04	50	50
Learning Objectives: 1. To understand the Ethics and concepts of intellectual property rights in research. 2. To the fundamentals of patent laws and drafting procedure. 3. To understand the copyright laws and related subject matters in research. 4. To understand the basic concepts of chemoinformatics. 5. To design and develop solutions to analyze pharmaceutical problems using computers. Course outcomes: 1. Correlate the knowledge of IPR with its utilization in designing strategy for chemical product development for various purposes. 2. Acquire comprehensive knowledge on Patents including filing of patents. 3. Gain ability to bridge the gap between chemistry and data science, creating innovative solutions and driving advancements in pharma and chemical industries. 4. The learnings can help the budding researchers in accelerating drug discovery by efficiently screening large compound libraries and predicting molecular properties of novel compounds.				

Elective –1

Course Code: CHEM 63011

Course Title:-Intellectual Property Rights and Chemoinformatics

Unit-I

[15L]

Introduction to Intellectual Property:

Historical Perspective, Different types of IP, Importance of protecting IP.

Patents:

Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Health care-balancing promoting innovation with public health, Software patents and their importance for India.

Industrial Designs:

Definition, How to obtain, features, International design registration.

Layout design of integrated circuits:

Circuit boards, Integrated Chips Importance for electronic industry.

Copyrights:

Introduction, How to obtain, Differences from Patents.

Trade Marks:

Introduction, How to obtain, Different types of marks-Collective marks, certification marks, service marks, Trade names, etc.

Unit-II

[15L]

Geographical Indications:

Definition, rules for registration, prevention of illegal exploitation, importance to India.

Trade Secrets:

Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

IP Infringement issue and enforcement:

Role of Judiciary, Role of law enforcement agencies-Police, Customs, etc.

Economic Value of Intellectual Property:

Intangible assets and their valuation, Intellectual Property in the Indian Context- Various Laws in India Licensing and technology transfer.

Different International agreements:

(a) World Trade Organization (WTO):

- (i) General Agreement on Tariffs & Trade (GATT) , Trade Related Intellectual Property Rights (TRIPS) agreement
- (ii) General Agreement on Trade related Services (GATS)
Madrid Protocol
- (iii) Berne Convention
- (iv) Budapest Treaty

(b) Paris Convention

WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity

Unit-III

[15L]

Introduction to Cheminformatics:

History and evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure elucidation.

Representation of molecules and chemical reactions:

Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.

Searching chemical structures:

Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.

Unit-IV

[15L]

Applications: Prediction of Properties of Compound, Linear Free Energy Relations, Quantitative Structure-Property Relations, Descriptor Analysis, Model Building, Modeling Toxicity, Structure-Spectra correlations, Prediction of NMR, IR and Mass spectra, Computer Assisted Structure elucidations, Computer assisted Synthesis Design, Introduction to drug design, Target Identification and Validation, Lead Finding and Optimization, Analysis of HTS data, Virtual Screening, Design of Combinatorial Libraries, Ligand-Based and Structure Based Drug Design, Application of Cheminformatics in Drug Design.

Reference books:

1. Andrew R. Leach & Valerie, J. Gillet (2007) *An introduction to Cheminformatics*. Springer: The Netherlands.
2. Gasteiger, J. & Engel, T. (2003) *Cheminformatics: a text-book*. Wiley-VCH.
3. Gupta, S.P. *QSAR and Molecular Modeling*, Springer-Anamaya Pub.: New Delhi.

PROGRAM(s): M.Sc.-II		SEMESTER: IV		
Course: Elective -2		Course Code: CHEM 63012 Course Title:- APPLIED INORGANIC CHEMISTRY-II		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 50)	Semester End Examination (Marks- 50)
04	–	04	50	50
Learning Objectives: 1. To introduce enzymes its properties, kinetics and use of enzymes as catalyst. 2. To get knowledge of mechanism of enzyme action and Synthetic approach of enzyme. 3. To understand the chemistry of coenzymes its structures, mechanism of action and bio-modeling studies of the following coenzymes. 4. To get information about biogenesis and biosynthesis of selected natural products.				
Course Outcomes: 1. Learners will be able to study the enzymes its properties, kinetics and use of enzymes as catalyst 2. Learners will be able to study mechanism of enzyme action and Synthetic approach of enzyme 3. Learners will be able to understand the chemistry of coenzymes its structures, mechanism of action and bio-modeling studies of the following coenzymes. 4. Learners will gain information about biogenesis and biosynthesis of selected natural products.				

Elective -2

CHEM 67011: ENZYMES, COENZYMES AND BIOGENESIS

<u>Unit-I</u>	<u>ENZYMES-I</u>	[15L]
1.1	Introduction and classification of enzymes.	[5L]
	Properties of enzymes: i) Enzyme efficiency ii) Enzyme specificity.	
1.2	Enzyme Kinetics: i) Effect of substrate ii) Other factors affecting enzyme kinetics such as temperature, pH etc.	[5L]
1.3	Enzymes as Catalyst: Specificity of Enzyme Catalyzed Reactions, Rate accelerators.	[5L]
<u>Unit-II</u>	<u>ENZYMES-II</u>	[15L]
2.1	(i) Mechanism of enzyme action and Synthetic approach of enzyme, Mechanism of alcoholic fermentation. (ii) Role of main enzymes involved in the synthesis and breakdown of glycogen. (iii) Glycogen storage diseases caused by enzyme deficiency.	[7L]
2.2	Chemical nature of selected enzymes: Co-carboxylase, Coenzyme A, Riboflavin phosphate, UDPG, Glucose-1, 6-diphosphate.	[6L]
2.3	Bradford assay for enzyme characterization	[2L]
<u>Unit-III</u>	<u>COENZYMES</u>	[15L]
3.1	Chemistry of Coenzymes: structures, mechanism of action and bio-modeling studies of the following coenzymes-thiamine pyrophosphate, lipoic acid, nicotinamide adenine dinucleotide, flavin adenine dinucleotide, pyridoxal phosphate, Vitamin B ₁₂ .	[12L]
3.2	Oxygen activation in biological systems with reference to Cytochromes.	[3L]
<u>Unit-IV</u>	<u>BIOGENESIS & BIOSYNTHESIS OF NATURAL PRODUCTS</u>	[15L]
4.1	Biogenesis: Precursors, Primary and secondary metabolites, Acetate hypothesis. Mevalonate and Shikimic acid pathways.	[5L]
4.2	Biosynthesis: amino acids, alkaloids, steroids and terpenoids.	[5L]
4.3	Biosynthesis of selected natural products: L-Tryptophan, Cephaline, Cholesterol, Ephedrine, Citranellal.	[5L]

Reference Books:

- 1 Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford University Press.
- 2 Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.
- 3 Stereochemistry: Conformation and mechanism, P.S. Kalsi, New Age International, New Delhi.
- 4 Stereochemistry of carbon compounds, E.L. Eliel, S.H. Wilen and L.N. Manden, Wiley.
- 5 Stereochemistry of Organic Compounds- Principles and Applications, D. Nasipuri, New International Publishers Ltd.
- 6 March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley.
- 7 Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad, Pearson Education.
- 8 Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.
- 9 Understanding Organic Reaction Mechanisms, Adams Jacobs, Cambridge University Press.
- 10 Writing Reaction Mechanism in organic chemistry, A. Miller, P.H. Solomons, Academic Press.
- 11 Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Nelson Thornes.
- 12 Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya Shankar Singh, Pearson Education.
- 13 Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, Thomson Brooks.
- 14 Spectrometric Identification of Organic Compounds, R. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley and Sons.
- 15 Organic Spectroscopy, William Kemp, W.H. Freeman & Company.
- 16 Organic Spectroscopy-Principles and Applications-Jagmohan, Narosa Publication.
- 17 Organic Spectroscopy, V.R. Dani, Tata McGraw Hill Publishing Co.
- 18 Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International Ltd.
- 19 Mechanism in Organic Chemistry, Peter sykes, 6th edition onwards.
- 20 Physical Organic Chemistry, Neil Isaacs
- 21 Modern Physical Organic Chemistry, Eric V. Anslyn and Dennis A. Dougherty
- 22 Stereochemistry: A Three-Dimensional Insight by Anil V. Karnik and Mohammed Hasan.

PROGRAM(s): M.Sc.-II		SEMESTER: IV		
Course: Research Project		Course Code: CHEM 611		
		Course Title:-RESEARCH PROJECT		
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks- 75)	Semester End Examination (Marks- 75)
	–	06	75	75
Learning Objectives: 1. To understand and discuss the new research topics in the field of chemistry. 2. To understand the importance, relevance, and procedure to gather back ground literature information from various scientific database. 3. To display, organize and represent correlation between different types of data. 4. To summarize and provide a concise summary of research projects carried out. 5. Demonstrate a capacity to communicate research results clearly and comprehensively. Course outcomes: - 1. Students will define a research question, design objectives and appropriate hypothesis for their project. 2. Students will find and evaluate relevant literature and back ground information related to their project. 3. Students will learn and use the techniques needed to do their experiments. 4. Students will learn and follow appropriate protocols for documenting their research as well to analyse the experimental data. 5. Students will be able to use logic and evidence to draw conclusions and future scope of the research work done.				

Semester III
Course title: Research Project

Guidelines for the conducting the research project.

1. Each student will perform project separately.
2. **Students should devote enough time to their project work (08 hours each week).**
3. Select a topic that is relevant to your interests and social relevance considering the constraints of available resources and time.
4. Consult with faculty members or mentors to select a relevant research topic that has the potential to contribute to the discipline of chemistry.
5. Literature survey for the research project is suggested to be from Journals indexed in globally recognised databases including recently published research papers.
6. Participation in national and international conferences and other project competitions is encouraged.
7. Project report must be written systematically and presented in bound form.
8. Continuous evaluation of the research project will be done by the internal examiner or mentor.
9. Student must do presentation of the research work in external exam.

Evaluation of Research Project Semester – III

A) CONTINUOUS ASSESSMENT - 50%

Sr. No	Criteria for evaluation	Marks
	Attendance (DPR to be maintained)	10
2.	Literature Survey	25
3.	Scheme/ Outline of project / Methodology	15
Total		50

B) SEMESTER END EXAMINATION - 50%

Sr. No	Criteria for evaluation	Marks
1.	Presentation	15
2.	Dissertation	20
3.	Viva	15
Total		50

SEMESTER IV
Course: Research Project

Guidelines:

1. Students are to work on research project individually and should be the continuity of the research project selected in the semester.
2. Research Project is of 6 credits which equals to project working hours of 180.
3. The title of the research project should be descriptive, appropriate and concise as possible.
4. A detailed description of Chemicals, equipment, experimental procedures should be mentioned in the project report.
5. The project report should be well-structured, should present an accurate and complete account of the research performed with data, discussion and conclusions.
6. The publications of earlier work should be cited.
7. Record of attendance and continuous performance of the student is monitored by the mentor.
8. At the end of the semester, the student has to present the project report in a bound form for external evaluation.
9. Participation in national and international conferences and other project competitions is encouraged.

Evaluation of Research Project Semester - IV

A) CONTINUOUS ASSESSMENT - 50%

Sr. No.	Evaluation Type	Marks
1	Attendance (DPR* to be maintained)	20
2	Experimental/ Interpretation	35
3	Conclusion/ output	20
Total		75

DPR: Daily Progress Report

B) SEMESTER END EXAMINATION - 50%

Sr. No	Evaluation Type	Marks
1	Presentation	20
2	Dissertation	30
3	Viva	25
Total		75

Letter Grades and Grade Points

Semester GPA/ Program CGPA/Semester	% Marks	Letter Grade Result
9.00-10.00	90.0-100.0	O (Outstanding)
8.00<9.00	80.0<90.0	A+ (Excellent)
7.00<8.00	70.0<80.0	A (Very Good)
6.00<7.00	60.0<70.0	B+ (Good)
5.50<6.00	55.0<60.0	B (Above Average)
5.00<5.50	50.0<55.0	C (Average)
4.00<5.00	40.0<50.0	P (Pass)
Below 4.00		F (Fail)
Ab (Absent)		Absent

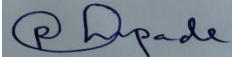
Sign of HOD

Prof. Shivram S. Garje
Head of Department,
Department of Chemistry,
University of Mumbai

Sign of Dean,

Prof. Shivram S. Garje
Dean, Science and Technology
University of Mumbai

Team for Creation of Syllabus

Name	Department/College Name	Sign
Dr. Ramchandra Govind Thorat	Department of Chemistry, University of Mumbai	
Dr. Vikas V.Borge	Department of Chemistry, University of Mumbai	
Dr. Satish B.Manjare	Department of Chemistry, University of Mumbai	
Dr. Anil V.Karnik	Department of Chemistry, University of Mumbai BSR Fellow	
Dr. Mahendra Patil	Department of Atomic Energy. CEBS, University Of Mumbai	
Dr. Prashant Ghorpade	Department of Chemistry, Kirti College College	

Sign of HOD

Prof. Shivram S. Garje
Head of Department,
Department of Chemistry,
University of Mumbai

Sign of Dean,

Prof. Shivram S. Garje
Dean, Science and Technology
University of Mumbai

Justification for M.Sc. (Organic Chemistry)

1.	The necessity for starting the course:	M.Sc. (Organic Chemistry) course is necessary for those who seek to deepen their knowledge, specialize in a particular area, and pursue advanced careers in research, industry, academia, or other chemistry-related fields. It offers numerous opportunities for personal and professional growth, enabling you to make a positive impact on the world through scientific exploration and discovery.
2.	Whether the UGC has recommended the course:	Yes
3.	Whether all the courses have commenced from the academic year 2023-24	The course has already commenced from the academic year from 1967 and in the academic year 2022-23 it is restructured under NEP 2020
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?:	This course is not self-financed. Currently, twelve permanent faculty members are working in the department out of 26 sanctioned faculty positions.
5.	To give details regarding the duration of the Course and is it possible to compress the course?:	The duration of the program is two years (4 semesters). It is not possible to compress the course. Under NEP 2020 students have option of exit at the end of first year with PG Diploma in Organic Chemistry.
6.	The intake capacity of each course and no. of admissions given in the current academic year:	The intake capacity of the program is 20. Number of admission for the academic year 2022-23 is 20.
7.	Opportunities of Employability / Employment available after undertaking these courses:	M.Sc. (Organic Chemistry) students have a wide range of employment opportunities across various sectors. The skills and knowledge acquired during their master's program make them well-equipped for diverse roles. Some of the common areas where M.Sc. (Inorganic Chemistry) students can find employment include; Research and Development (R&D), Pharmaceutical Industry, Chemical Manufacturing, Environmental and Analytical Chemistry, Quality Assurance and Control, Materials

		Science and Nanotechnology, Teaching and Academia, Healthcare and Clinical Research etc. The key to employability for M.Sc. (Organic Chemistry) students are to build a strong resume through internships, research projects, and networking. Additionally, staying updated with the latest advancements in the field and continuously improving their skills can enhance their competitiveness in the job market.
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Sign of HOD

Sign of Dean,

Prof. Shivram S. Garje
Head of Department,
Department of Chemistry,
University of Mumbai

Prof. Shivram S. Garje
Dean, Science and Technology
University of Mumbai