UPL -University of Sustainable Technology

SRICT Institute of Science & Research

Syllabus of 2nd Year M. Sc. Chemistry

As Per National Education Policy 2020 (NEP 2020)

UPL UNIVERSITY OF SUSTAINABLE TECHNOLOGY

UPL University of Sustainable Technology

SRICT- Institute of Science & Research

AY-2025-2026

UPL -University of Sustainable Technology

SRICT Institute of Science & Research

UPL University of Sustainable Technology, Ankleshwar				
SRICT- Institute of Science & Research (SRICT-ISR)				
2nd Year M. Sc. Chemistry				
SEM	**TYPE OF COURSE**	**COURSE CODE**	**NAME OF SUBJECT**	**Credits**
3	**MAJOR**	**CHM500-5C**	Reaction Mechanism and Stereochemistry	**4**
	MAJOR	**CHM501-5C**	Synthetic Organic Chemistry	**4**
	MAJOR	**CHM502-5C**	Chemistry of Polymers and Agrochemicals	**4**
	MAJOR	**CHM503-5C**	Practicals in Chemistry-VII	**6**
	CORE COURSE	**CHR500-5C**	Research Project-I	**4**
			Total Credits	**22**
4	**MAJOR**	**CHM504-5C**	Strategic Organic Synthesis	**4**
	MINOR	**CHE500-5C**	Research Methodology	**2**
	CORE COURSE	**CHR501-5C**	Research Project-II	**16**
			Total Credits	**22**

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Teaching/Exam Scheme

M. Sc. Sem. III

Sr. No.	Course Code	Category of course	Course title	Hour s Per week			Total con. hrs.	Credits	E	M	I	V	Total Marks
				L	T	P							
1	CHM500-5C	Major Course	Reaction Mechanism and Stereochemistry	4	0	-	4	4	50	50	-	-	100
2	CHM501-5C	Major Course	Synthetic Organic Chemistry	4	0	-	4	4	50	50	-	-	100
3	CHM502-5C	Major Course	Chemistry of Polymers and Agrochemicals	4	0	-	4	4	50	50	-	-	100
4	CHM503-5C	Major Course	Practicals in Chemistry-VII	-	-	12	12	6	75	75	-	-	150
5	CHR500-5C	Core Course	Research Project-I	-	-	8	8	4	-	-	50	50	100
			Total	12	0	20	32	22	225	225	50	50	550

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Master of Science
Course Code: CHM500-5C
Course Name: Reaction Mechanism and Stereochemistry
Semester: III

w.e.f.: July 2026

Type of course: Major Course

Prerequisite: Should have underlying knowledge of reaction mechanism and stereochemistry.

Rationale: At the end of the course, the students should be able to enhance advanced understanding of reaction mechanisms, stereochemistry, and molecular rearrangements, enabling students to predict reaction outcomes and design organic syntheses essential for postgraduate research and modern chemical applications.

Teaching and Examination Scheme:

Credits				Examination Marks		Total Marks
L	T	P	Total	CCE Marks	SSE Marks	
4	0	-	4	50	50	100

Contents:

Sr. No.	Content	Total Hours
	SECTION - A	
1	**Molecular rearrangements-I** (A) Nucleophilic rearrangement on C-atom: (i) Expansion and contraction of rings/Demajnov rearrangement, (ii) Benzil-benzilic acid rearrangement. (B) Electrophilic rearrangement on C-atom: (i) Favorskii rearrangement (ii) Sommelet-Hauser rearrangement (iii) Neber rearrangement. (C) Nucleophilic rearrangement on N-atom: (i) Schmidt rearrangement (ii) Curtius rearrangement.	**9**
2	**Molecular rearrangements-II** Aromatic rearrangements: (i) Jacobsen rearrangement (ii) Orton rearrangement (iii) Hoffmann- Martius rearrangement (iv) Fischer- Hepp rearrangement. Rearrangement involving migration from oxygen to ring: Fries rearrangement (ii) Claisen rearrangement.	**9**
3	**Name reactions**	**12**

	General nature, method, mechanism and synthetic applications of the following reactions; (i) Ugi reaction (ii) Noyori reaction (iii) Wittig reaction (iv)Peterson olefination reaction (v) Stille reaction(vi) Negeshi reaction (vii) Kumada reaction (viii) Hiyama reaction (i) Ene recation (ii) Staudinger reaction (iii) Corey- Fuchs reaction (iv)Ritter reaction (v) Mcmurry reaction (vi) Michael addition (vi) Shapiro reaction (vii) Eschenmore fragmentation (viii) Passerini reaction.	
	SECTION - B	
4	**Stereochemistry & conformational analysis** Stereo chemical principles; Enantiomeric relationships; Distereomeric relationship; Chiral-Prochiral relationships; Stereo selective and Stereo specific reactions; Resolution of racemic mixture, Optical activity in the absence of chiral carbons biphenyl, allenes, spiranes. Inter-conversion of Fischer, Newman and Sawhorse projections. Newer method of asymmetric synthesis (including enzymatic and catalytic nexus), enantio and diastereo selective synthesis. Simple acyclic and cyclic (chair and boat cyclohexanes, Decalins, Perhydrophenanthrene) systems. Effects of conformation on reactivity in acyclic compounds and substituted cyclohexanes.	**9**
5	**Application of stereochemistry** Elimination and addition reactions Elimination Reactions: mechanisms and orientation, E1, $E1_{CB}$, E2 spectrum, effects of changes in substrate, base, leaving group and medium on reactivity, hoffman and saytzef eliminations, bredt's rule, pyrolytic eliminations- cope and chugaev eliminations. addition reactions: mechanisms, orientation and reactivity, markonikoff and anti-markonikoff additions, reactions including hydro-halo, hydro-hydroxy, hydro-alkoxy, dihydro, dihydroxy, dihalo, ozonolysis, woodward-prevost hydroxylation.	**9**
6	**Pericyclic reaction** Molecular orbital symmetry, Frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allylsystem. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions-conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloaddition antrafacial and suprafacial addition, 4n, 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangement- suprafacial and antra facial shifts of H sigmatropic	**12**

	shifts involving carbon moieties, 3,3 and 5,5- sigmatropic rearrangements. Claisen, cope and azacope rearrangement. Fluxional tautomerism. Ene reaction.	

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**10**	**20**	**15**	**15**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

1. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, Wiley publisher, ISBN-0470213612, 1990.
2. Jerry March, Advance Organic Chemistry, Reaction Mechanism and Structure, ISBN-0471601802, 4th Edition, John Wiley & Sons, 1992
3. Morrison & Boyd, Organic Chemistry, 5th Edition, ISBN: 978-0205084531, Masood Books UP, 2009.

Reference Books:

1. Christian M. Rojas, Molecular rearrangements in organic synthesis, wiley publisher, ISBN 978-1-118-34796-6, 1st Edition, 2015.
2. Bradford P. Mundy, Michael G. Ellerd, Frank G. Favaloro, Jr., Name Reactions and Reagents in Organic Synthesis, John Wiley & Sons, ISBN- 9780471228547, 2015.
3. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry by 3rd Edition, ISBN- 9780387448978, 1977.
4. Vinay Sharma, Rakesh kumar, Pericyclic reaction in organic photochemistry, 1st Edition, ISBN No- 978-81-8398-632-8, Pragati Prakashan, 2008.

Course Outcomes:

After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand stereochemical principles and conformational analysis.	20%
CO-2	Explain mechanisms of elimination and addition reactions.	15%
CO-3	Interpret orbital symmetry and pericyclic reaction mechanisms.	15%

CO-4	Analyze nucleophilic and electrophilic rearrangements.	15%
CO-5	Explain aromatic and oxygen-migration rearrangements.	15%
CO-6	Apply name reactions in organic synthesis with sustainability focus..	20%

List of Open Source Software/learning website:

1. NPTEL - Pericyclic Reactions and Organic Photochemistry
2. https://assets.vmou.ac.in/MSCCH06.pdf
3. https://womengovtcollegevisakha.ac.in/departments/Pericyclic%20Reactions.pdf
4. https://download.e-bookshelf.de/download/0003/9427/24/L-G-0003942724-0008202834.pdf
5. https://nzdr.ru/data/media/biblio/kolxoz/Ch/Li%20J.J.%20Name%20Reactions%20(4ed.,%20Springer,%202009)(ISBN%203642010520)(O)(639s)_Ch_.pdf
6. https://books.google.co.in/books/about/Name_Reactions_and_Reagents_in_Organic_S.html?id=wwWtEAAAQBAJ&redir_esc=y

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Master of Science

Course Code: CHM501-5C
Course Name: Synthetic Organic Chemistry
Semester: III

w.e.f.: July 2026

Type of course: Major Course

Prerequisite: Should have the fundamental concepts in organic reaction mechanisms, photochemistry, reaction kinetics, and basic spectroscopic characterization techniques.

Rationale: By the end of the course, students will be able to develop advanced understanding of aromaticity, photochemistry, heterocyclic chemistry, organometallics, and catalysis to support modern organic synthesis, sustainable chemistry, and postgraduate research applications.

Teaching and Examination Scheme:

Credits				Examination Marks		Total Marks
L	T	P	Total	CCE Marks	SSE Marks	
4	0	-	4	50	50	100

Contents:

Sr. No.	Content	Total Hours
	SECTION - A	
1	**Aromaticity and aromatic character** Structure and stability of benzene, Frost circle diagram, Concept of aromaticity; Resonance and Chemical stabilization; Criteria to check aromatic character-IR, NMR, heat of hydrogenation; Huckel's rule; HMO method, Antiaromaticity, Homoaromaticity, Nonaromaticity; Aromaticity in benzenoid compounds: naphthalene, pyrene, Aromaticity in non-benzenoid compounds: Azulene, Tropolones, charged rings annulenes.	**9**
2	**Heterocyclic chemistry-I** Nomenclature of Heterocycles: Hantzsch-Widman nomenclature systems for monocyclic and fusedheterocycles and bridged heterocycles, Five and six membered heterocycles with two hetero atoms: Synthesis, reactivity, aromatic character and importance of following heterocyclic rings: Oxazole, Thiazole,	**9**

	Pyrazole, Imidazole, Pyridazine, Pyrimidine, Pyrazine Condensed five membered heterocycles: Synthesis, reactivity, aromatic character and importance of following heterocyclic Rings: Benzoxazole, Benzthiazole, Benzopyrazole, Benzimidazole.	
3	**Heterocyclic chemistry-II** Five and six membered heterocycles with more than two hetero atoms: Synthesis, reactivity, aromatic character and importance of following heterocycles:1,2,3-triazole, 1,2,4-triazole, 1,2,4-oxadiazole, 1,3,4-oxadiazole, 1,2,5-oxadiazole, Condensed six membered heterocycles: Synthesis, reactivity, aromatic character and importance of followingheterocyclic Rings: Quinoline, Isoquinoline, Cinnoline, Quinoxaline, Phthalazine, Naphthyridine, Phenoxazine.	**12**
SECTION - B		
4	**Catalysis in organic synthesis** Fundamental Concepts: Acid-base catalysis (Brønsted and Lewis), mechanism determination, enzyme catalysis, and phase transfer catalysis, Heterogeneous Catalysis, Homogeneous catalysis involving organometallic compounds, hydrogenation, hydroformylation, C-H activation, and coupling reactions (Heck, Suzuki, Negishi).	**9**
5	**Organometallic compounds and their applications** Carbon-metal bonds in organometallic compounds, Synthesis and applications of Try carbonyl nickle ferrocene, Titanium hexacarbonyl, Iron pentacarbonyl, Chromium hexacarbonyl, Organolithium, Organozincand Lithium diorganocuprate, Dibenzene chromium, Monseto catalyst, Vaska's complex, gilman reagent, Basic concept of organoboranes, Preparation of organoboranes, Stereochemistry of hydroboration, Mechanism of hydroboration – oxidation, Synthetic applications.	**9**
6	**Photochemistry** Photochemical reactions, Principle of energy transfer, electronic excitation (Janlonskidiagrame), Photosensitization, Photochemistry of carbonyl compounds, Norrish type-I and II, reaction of cyclic ketones, Peterno-Buchi reaction, Di-π methane rearrangement, Dinone photochemistry, Cis-trans Isomerisation, Photochemistry of conjugated dienes, photo rearrangement. Barton reaction. Fluorescence chemistry and its application.	**12**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
25	**30**	**10**	**15**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

1. G. R. Chatwal, Reaction Mechanism and Reagents in Organic Chemistry, Himalaya Publishing House, Bombay, ISSN- 978-9352025282, 1st Edition, 1987.
2. P. Sykes, A Guide Book to Mechanism in Organic Chemistry, , Longman., ISBN- 978-0582446953, 6th Edition, 1961.
3. G. E. Coates , M. L. H. Green , P. Powell , K. Wade, Principles of Organometallic Chemistry, 1st Edition, ISBN- 978-0-412-15350-1, Springer Nature, 1968.

Reference Books:

1. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry by 3rd Edition, ISBN- 9780387448978, 1977.
2. Jerry March, John Wiley, Advanced Organic Chemistry-Reactions, Mechanism and Structure, ISBN- ISBN 978-1119371809, 8th Edition, 2020.
3. W. Carruthers, Modern methods of organic synthesis, (Cambridge University Press, ISBN- 978-0-511-22948-0, 1st Edition, 2004.
4. Laszlo Kurti and Barbara Czako, Strategic Applications of named reactions in organic synthesis, ISBN- 9780123694829, Elsevier Academic Press, 2005.
5. P. L. Pauson, Organometallic Chemistry, London, Edward Arnold, 1967.
6. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, McMillan India Ltd., 1984.
7. Jagdamba Singh & L.D.S. Yadav, Organic Synthesis, , 6th Edition, ISSN- 978-93-89961-43-0, Pragati Prakashan, 2019.
8. Morrison & Boyd, Organic Chemistry, 5th Edition, ISBN: 978-0205084531, Masood Books UP, 2009.

Course Outcomes:

After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Explain aromaticity and stability of benzenoid and non-benzenoid systems.	20%
CO-2	Interpret principles and mechanisms of photochemical reactions.	15%
CO-3	Describe nomenclature, synthesis, and reactivity of heterocyclic compounds.	15%
CO-4	Analyze chemistry of condensed and polyheteroatom heterocycles.	15%
CO-5	Explain bonding and applications of organometallic and hydroboration reactions.	15%
CO-6	Apply catalytic methods in organic synthesis with sustainability focus.	20%

List of Open Source Software/learning website:

1. MIT OpenCourseWare - Electronic Spectroscopy and Photochemistry
2. NPTEL - Contents, Basic Concepts, Aromaticity, Catalysis in Organic Synthesis
3. Royal Society of Chemistry -Heterocyclic Chemistry
4. American Chemical Society- Synthesis of heterocyclic compound
5. PubChem - organometallic compounds
6. https://nptel.ac.in/courses/104103067
7. https://ocw.mit.edu/courses/5-61-physical-chemistry-fall-2017/resources/electronic-spectroscopy-and-photochemistry/
8. https://nptel.ac.in/courses/122106029
9. https://gt2.sgp1.digitaloceanspaces.com/original/3X/4/5/45ca6c686d1ba3dac74e3aeca4236123a607a23e.pdf
10. https://faculty.ksu.edu.sa/sites/default/files/Organometallic%20chemistry421%20chem%20%281%29%20%281%29.pdf

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Master of Science

Course Code: CHM502-5C

Course Name: Chemistry of Polymers and Agrochemicals

Semester: III

w.e.f.: July 2026

Type of course: Major Course

Prerequisite: Should have underlying knowledge of polymers and agrochemicals.

Rationale: At the end of the course, the students should be able to describe the understanding of polymer synthesis, polymerization mechanisms, characterization techniques, and agrochemicals, enabling students to apply chemical principles in material science, agriculture, and sustainable industrial applications.

Teaching and Examination Scheme:

Credits				Examination Marks		Total Marks
L	T	P	Total	CCE Marks	SSE Marks	
4	0	-	4	50	50	100

Contents:

Sr. No.	Content	Total Hours
	SECTION - A	
1	**Basics of polymers & Its characterization** Introduction of polymers, monomers, Oligomers, Various polymerization techniques, heating and solubility behavior of polymers, Classification of polymers. Methods used for molecular weight determination, tensile strength, viscosity. Chemistry of dendrimers and hyperbranched polymers, non-linear optical and photonic polymers, liquid crystalline polymers and conducting polymers. Polymer supported reagent and catalysts, Solid phase peptide synthesis.	9
2	**Mechanisms of addition polymerization** Free radical addition polymerization - mechanism and kinetics of free radical addition, polymerization, Chain transfer, Mayo equation, Thermodynamics of addition polymerization, effect of temperature, pressure, enthalpies, entropies,	9

	free energies and activation energies on polymerization, Inhibition and retardation. Ionic polymerization: common features of the two types of ionic polymerizationmechanism and kinetics of cationic polymerization, expression for the overall rate of polymerization and the number average degree of polymerization, mechanism and kinetics of anionic polymerization, expression for the overall rate of polymerization and the average degree of polymerization, living polymers. Ziegler-Natta polymerization: Ziegler-Natta catalysts, mechanism of coordination polymerization-monometallic and bimetallic mechanisms.	
3	**Step-growth polymerization** Kinetics of catalyzed and non-catalyzed polyesterification, ring-opening polymerization (mechanism of polymerization of cyclic ethers, cyclic amides and cyclosiloxanes), atom transfer polymerization, ion containing polymers polymerization in homogeneous and heterogeneous systems: homogeneous system, heterogeneous system, suspension polymerization, emulsion polymerization, interfacial condensation, solid and gas phase polymerization, salient features of different polymerization techniques miscellaneous polymerization: group transfer polymerization, metathetical polymerization, electrochemical polymerization, sustainable polymerization. Polymer processing techniques: injection molding, extrusion, blow molding, thermoforming, and rotational molding.	**12**
SECTION - B		
4	**Agrochemicals** Introduction and classification based on their actions. **Insecticides:** Introduction, nomenclature, chemistry, mode of action, synthesis and applications of:lindane, aldrin, dieldrin endosulfan, carbamate carbofuran, carbaryl, aldicarb, propaxur, chlorpyrifos and parathion.	**9**
5	**Fungicides, bactericides, herbicides and plant growth regulators** Fungicides and bactericides: Introduction, nomenclature, chemistry, mode of action, synthesis and applications of copper/sulfur fungicides, dithiocarbamates, benzimidazoles, triazoles, Kitazine, Thiophanates and antibiotic compounds. Herbicides and Plant Growth Regulators: Mode of action, urea derivatives, amide herbicides (synthesis of the following: trifluralin, butachlor, dimethoate,	**9**

	isoproturon) and plant growth regulators (hormones). synthesis of the following plant growth regulators: auxin, gibberellic acid, cytokinin, ethylene.	
6	**Pesticides and Acaricides** Pesticides: Chemistry, mode of action, and synthesis & application of Fumigants, Rodenticides, Repellents: DEET, Diethylphthalate, Pyrethrins: Pyrethrin-I and II, Alkaloid family: Nicotine. Antifeedants, Sex attractants, Acaricides: Structure, synthesis, metabolism, and mode of action of organophosphates, carbamates, pyrethroids, and neonicotinoids. sustainable agrochemicals: use of natural pesticides. Sustainable and smart agriculture: use of Bio-pesticides and biocontrol agents, bio-fertilizers, nano-fertilizers.	**12**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**10**	**20**	**15**	**15**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

1. Billmeyer, Jr, Textbook of Polymer Science, Wiley-lnterscience Publication, 1st Edition, ISBN-13- 978-0471031963, New York, 1984.
2. Rudolph D. Deanin, Polymer Structure, Properties, and Applications, 1st Edition, ISBN-9780843612028, Cahners Books publisher, 1972.
3. Fungicides. In: Westcott's Plant Disease Handbook, ISBN- 978-94-007-2141-8, Springer, Dordrecht, 2013.
4. S. Selvaraj, Textbook on Agrochemicals, ISBN- 9393405352, Agri-Biovet Press, 2024,

Reference Books:

1. Carraher Jr C.E. Seymour-Carraher, Polymer Chemistry, ISBN:978-1-4200-5102-5, 7th Edition, CRC press, 2006.
2. Robert O. Ebewele, Polymer Science and Technology, ISBN- 9780429127922, 1st Edition, CRC press, 2000.

3. Qipeng Guo, Thermosets: Structure, Properties, and Applications, ISBN: 9780081010211, 2nd Edition, 2017.
4. G.W.A. Milne, Ashghate Handbook of Pesticides and Agrochemicals, Taylor & Francis, Ashgate Publishing, ISBN 13: 978-1-138-71775-6, 1st Edition, 2000.
5. Prabhat Kumar Shrivastava, Pesticides in Crop Production: Physiological and Biochemical Action, ISBN- 9781119432197, 2020 John Wiley & Sons Ltd, 2020.
6. Hans-Georg Elias, Macromolecules: Structure and Properties, 1st Edition, ISBN-978-1-4615-7369-2, Springer Nature, 1984.
7. Andrew H. Cobb, Herbicides and Plant Physiology, ISBN: 978-1-119-15769-4, 3rd Edition, Wiley-Blackwell, 2022.

Course Outcomes:

After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Explain basic concepts, properties, and characterization of polymers.	20%
CO-2	Describe mechanisms and kinetics of addition polymerization processes.	15%
CO-3	Analyze step-growth and advanced polymerization including sustainability approaches.	15%
CO-4	Explain classification and applications of agrochemicals and insecticides.	15%
CO-5	Describe synthesis and applications of fungicides, herbicides, and plant growth regulators.	15%
CO-6	Evaluate chemistry and applications of pesticides and acaricides.	20%

List of Open Source Software/learning website:

1. NPTEL - Polymer Science, Macromolecular Chemistry video lectures
2. Royal Society of Chemistry -Educational resources on polymer reactions and mechanisms
3. American Chemical Society- Polymer chemistry articles, webinars, and learning modules
4. https://www.nzdr.ru/data/media/biblio/kolxoz/Ch/Carraher%20Jr%20C.E.%20Seymour-Carraher's%20Polymer%20Chemistry%20(7ed.,%20CRC,%202007)(ISBN%201420051024)(O)(729s)_Ch_.pdf
5. https://api.pageplace.de/preview/DT0400.9781351766449_A32307290/preview-9781351766449_A32307290.pdf
6. https://content.e-bookshelf.de/media/reading/L-13678703-5757176b7e.pdf

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Master of Science
Course Code: CHM503-5C
Course Name: Practicals in Chemistry-VII
Semester: III

w.e.f.: July 2026

Type of Course: Major course

Prerequisite: Should have fundamental knowledge of organic chemistry, polymer chemistry concepts, and skills in synthesis, purification, chromatography, and safe handling of chemicals.

Rationale: At the end of the course students will have exposure to an advanced laboratory training in multi-step organic synthesis, reaction mechanisms, polymer chemistry, and separation techniques, thereby bridging theoretical organic and polymer chemistry with real research and industrial practices.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks		Total Marks
L	T	P	C	CCE Marks	SEE Marks	
	-	12	6	75	75	150

Contents:

Sr. No.	Content	Total Hrs. 120
	Multi-Step Organic Synthesis	
	1. Preparation of p- amino benzoic acid (PABA). 2. Preparation of Benzanilide. 3. Preparation of 2, 3 Diphenyl thiozolidinone. 4. Preparation of Benzilic acid. 5. Preparation of 2-Phenyl indole. 6. Preparation of Dihydro pyridine derivative. 7. Preparation of acridone. 8. Preparation of p- amino benzene sulfonamide (Sulfanilamide). 9. Preparation of 7-hydroxy, 4-methyl, 8-(piperidine methyl, 2H-crominone). 10. Synthesis of sulpha drug from aniline 11. Synthesis of m-Chloro-nitrobenzene from nitrobenzene 12. Synthesis of paracetomol from benzene	**60**

	Polymer & Resin Synthesis	
	1. To prepare Polystyrene by suspension polymerization. 2. To prepare Polystyrene by solution polymerization. 3. To prepare Polystyrene by emulsion polymerization. 4. To prepare Poly acrylonitrile by solution polymerization. 5. To prepare Polymethamethacrylate by bulk polymerization. 6. To prepare Polysulfide rubber. (Thiokol). 7. To prepare Urea-formaldehyde 8. To prepare Glyptal resin: glycerine phthalic acid 9. To prepare Polyacryonitril 10. To prepare Polymethylomethacrylate 11. To prepare Nylon-66 12. To separate the given mixture of amino acid by ascending chromatography and measure Rf value. 13. To separate the given mixture of amino acid by radial chromatography and measure the Rf value. 14. To separate the given mixture of amino acid by ascending chromatography and measure Rf value.	**60**

Reference Books:

1. Laboratory Manual of Department of Chemistry, UPL University of Sustainable Technology, Ankleshwar.
2. Braun, Polymer Synthesis- Theory and Practice, Fifth Edition, ISBN 978-3-642-28979-8, 2013.
3. Nicolas B.and Roba M. ,Multi-Step Organic Synthesis A Guide Through Experiments, ISBN: 978-3-527-34065-1, Wiley-VCH Verlag GmbH & Co. KGaA, 2017.
4. Bogliotti, Nicolas, Moumné, Roba, Multi-Step Organic Synthesis-A Guide Through Experiments, 978-3-527-34065-1, 1st Edition, Wiley-VCH, Weinheim, 2017.
5. Sandhya P.K., Sreekala M. Sadasi, Sabu T., Phenolic Resins: Synthesis, Modifications, Properties, and Applications, ISBN : 9780323956611, Elsevier publisher, 2025.
6. Tibor C., Multivariate Methods in Chromatography: A Practical Guide, A John Wiley and Sons, Ltd, Publication, ISBN 978-0-470-05820-6, 2008.

Course Outcomes:

After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Apply organic reaction mechanisms for multistep synthesis.	10%
CO-2	Perform purification, isolation, and characterization of organic compounds.	20%
CO-3	Execute various polymerization techniques for polymer preparation.	20%
CO-4	Analyze structure–property relationships of polymers and resins.	20%
CO-5	Conduct chromatographic separation and qualitative analysis of amino acids.	10%
CO-6	Follow safe laboratory practices incorporating sustainability principles.	20%

Distribution of Practical Marks

A Level	B Level	C Level	D Level
10	**15**	**15**	**10**

Legends:

A= Conduction of Practical

B= Regular Record Writing

C= Viva -Voce

D= Understanding of Experiments

UPL University of Sustainable Technology

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Master of Science
Course Code: CHR500-5C
Course Name: Research Project-I
Semester: III

w.e.f.: July 2026

Type of Course: Core course

Prerequisite: Basic knowledge of postgraduate chemistry concepts, research methodology, and laboratory skills.

Rationale: The research project is designed to enhance the employability skills of students by providing hands-on experience in a specialized area of Chemistry. It enables students to integrate and apply theoretical knowledge acquired from various courses to address real-life scientific and industrial challenges. The project also exposes students to recent developments, advanced techniques, and research methodologies, fostering innovation, entrepreneurship, self-employment opportunities, and potential employment generation through the extension and application of project outcomes.

Teaching and Examination Scheme:

					Examination Marks				Total Marks
L	T	P	Total	Credits	Theory Marks		Practical Marks		
-	-	8	8	4	CCE (M)	SEE (E)	CCE (I)	SEE (V)	
					-	-	50	50	100

Content:

Sr. No.	Content	Total Hrs.
1	The 3rd semester of M.Sc. is required to undertake Research Project-I. There are two categories offered for Research Project-I, ss listed below: *1. University Defined Project (UDP)* *2. Industry Defined Project (IDP)* From the above two categories students have to select either of the one.	**120**

Note:*Assessment & evaluation of the research project-I in Semester-III will be carried out purely based on the literarure survey and proposal of the work. However, in semester-IV, assessment & evaluation of the research project-II will be carried out based on guideline and policy of the department.*

Course Outcomes:

After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Identify and formulate research problems through literature review.	10%
CO-2	Design and perform experiments using appropriate techniques.	20%
CO-3	Analyze and interpret experimental data scientifically.	10%
CO-4	Demonstrate independent research and critical thinking skills.	20%
CO-5	Communicate research outcomes through reports and presentations.	20%
CO-6	Follow ethical practices, safety norms, and sustainability principles in research.	20%

Reference:

1. https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf
2. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

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Teaching/Exam

Scheme M.Sc. Sem. IV

Sr. No.	Course Code	Category of course	Course title	Hour s Per week			Total con. hrs.	Credits	E	M	I	V	Total Marks
				L	T	P							
1	CHM504-5C	Major Course	Strategic Organic Synthesis	4	0	-	4	4	50	50	-	-	100
2	CHE500-5C	Minor Course	Research Methodology	2	0	-	2	2	-	-	25	25	50
3	CHR501-5C	Core Course	Research Project-II	-	-	32	32	16	-	-	200	200	400
			Total	6	0	32	38	22	50	50	225	225	550

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Master of Science
Course Code: CHM504-5C
Course Name: Strategic Organic Synthesis
Semester: IV

w.e.f.: July 2026

Type of course: Major Course

Prerequisite: Should have Fundamental understanding of asymmetric synthesis, functional group transformations, basic spectroscopic techniques and scale up.

Rationale: At the end of the course, the students should be able to develop advanced skills in asymmetric synthesis, retrosynthetic analysis, protecting group strategies, and spectroscopic structure elucidation. It enables students to design efficient multi-step organic syntheses, interpret spectral data, and understand scale-up and industrial applications, thereby preparing them for research, pharmaceutical development, and modern sustainable chemical manufacturing.

Teaching and Examination Scheme:

Credits				Examination Marks		Total Marks
L	T	P	Total	CCE Marks	SSE Marks	
4	0	-	4	50	50	100

Contents:

Sr. No.	Content	Total Hours
	SECTION - A	
1	**Asymmetric synthesis** Principles and applications of asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions stereoselectivity in cyclic compounds, enantio- selectivity, diastereo-selectivity, Methods of determination of enantiomer purity, polarimeterenatiomeric and diastereomeric excess, stereoselectivealdol reactions. Cram's rule, FelkinAnh rule, Cram's chelate model, asymmetric epoxidation and asymmetric dihydroxylation.	**9**
2	**Spectroscopic methods for structure elucidation**	**9**

	Problems based on: UV- Visible Spectroscopy, IR Spectroscopy, NMR Spectroscopy, Mass Spectrometry, Combined Spectral Interpretation.	
3	**Integrated problem solving & scale up** Multi-step synthesis with spectral analysis, Heterocycle- based drug molecules, Case studies from recent literarure. Scale up, optimization, impurity profile, industry simulation (Multi-step synthesis, polymer sysnthesis). The use of AI in bridging lab-to-production gaps through predictive modeling.	**12**
SECTION - B		
4	**Protecting groups** Need of protecting groups – Protection of alcohols, Carbonyl, Carboxylic acid and amino groups, Synthetic equivalent groups and examples on transformations.	**9**
5	**Disconnection approach-I** Introduction to disconnection, Concept of synthon, Synthetic equivalent, Functional group interconversion. One group disconnection: Disconnection and synthesis of alcohols, olefins, simple ketones, acids and its derivatives.	**9**
6	**Disconnection approach-II** Two groups disconnection: Disconnections in 1,3-dioxygenated skeletons, preparation of β-hydroxy carbonyl compounds, α,β- unsaturated carbonyl compounds, 1,3-dicarbonyls, 1,5- dicarbonyls, Pericyclic reactions: Disconnections based on Diels-Alder reaction and electrocyclic reaction: Its use in organic synthesis.	**12**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**10**	**20**	**15**	**15**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

1. Jerry March, John Wiley, Advanced Organic Chemistry-Reactions, Mechanism and Structure, ISBN- ISBN 978-1119371809, 8th Edition, 2020.

2. Morrison & Boyd, Organic Chemistry, 5th Edition, ISBN: 978-0205084531, Masood Books UP, 2009.
3. G. R. Chatwal, Reaction Mechanism and Reagents In Organic Chemistry, 5th Edition, ISBN- 978-93-5202-089-8, Himalaya Publication, 2026.
4. B. S Bahl, Arun Bahl, A Textbook of Organic Chemistry, S. Chand and Company Limited, ISBN- 978-93-525-3196-7, Edition-2005, 2019.
5. Robert M. Silverstein , Francis X. Webster , David J. Kiemle , David L. Bryce, Spectrometric Identification of Organic Compounds, 8th Edition (An Indian Adaptation, ISBN: 9789354642296, Wiley publication, 2022.

Reference Books:

1. W. Carruthers, Modern methods of organic synthesis, (Cambridge University Press, ISBN- 978-0-511-22948-0, 1st Edition, 2004.
2. Jagdamba Singh, Advanced Organic Chemistry, Pragati Prakashan, ISBN : 978-93-89961-41-6, 13th Edition, 2021.
3. Stuart Warren, Paul Wyatt, Organic Synthesis: The Disconnection Approach, A John Wiley and Sons, Ltd., Publication, 1st Edition, 2008.
4. Maria-Magdalena Cid, Jorge Bravo, Structure Elucidation in Organic Chemistry, John Wiley & Sons, ISBN- 9783527333363, 1st Edition, 2015.
5. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, , Longman., ISBN-978-0582446953, 6th Edition, 1961.
6. Jonathan clayden, Nick Greeves, Stuart Warren, Organic chemistry 2nd Edition, ISBN-9780199270293, 2012.
7. Michael Levin, Pharmaceutical Process Scale-Up, Marcel Dekker, Inc, ISBN: 0-8247-0625-0, 2002.
8. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry by 3rd Edition, ISBN- 9780387448978, 1977.

Course Outcomes:

After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Apply principles of asymmetric synthesis and stereoselectivity in organic reactions.	20%
CO-2	Explain use of protecting groups and synthetic equivalents in multistep synthesis.	15%
CO-3	Apply retrosynthetic analysis using synthon concepts and functional group interconversion.	15%
CO-4	Design synthetic routes using disconnections and pericyclic reactions with sustainability focus.	15%
CO-5	Interpret UV–Vis, IR, NMR, and Mass spectra for structure elucidation.	15%
CO-6	Develop strategies for multistep synthesis, scale-up, impurity analysis, and AI-assisted production.	20%

List of Open Source Software/learning website:

1. NPTEL - A Study Guide In Organic Retrosynthesis: Problem Solving Approach, IIT Kharagpur
2. https://rushim.ru/books/mechanizms/march6ed.pdf
3. https://recnotes.com/wp-content/uploads/2020/11/Morrison-and-Boyd-Organic-Chemistry-7th-Ed-1.pdf
4. https://gt2.sgp1.digitaloceanspaces.com/original/3X/4/5/45ca6c686d1ba3dac74e3aeca4236123a607a23e.pdf
5. https://theswissbay.ch/pdf/Books/STEM/Organic_Chemistry_J_Clayden_N_Greeves_S_Warren.pdf
6. https://mlsu.ac.in/econtents/3956_CarruthersModern%20Methods%20of%20Organic%20Synthesis-Cambridge%20University%20Press(2004).pdf
7. http://pharmainfo.in/jpsr/Documents/Volumes/vol6issue07/jpsr06071401.pdf

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Master of Science
Course Code: CHE500-5C
Course Name: Research Methodology
Semester: IV

w.e.f.: July 2026

Type of course: Minor Course

Prerequisite: Should have familiarity with scientific literature and research concepts.

Rationale: At the end of the course, tt provides students with a clear understanding of research concepts, scientific methods, problem identification, hypothesis formulation, research design, sampling techniques, and data analysis using appropriate statistical and software tools. The course also emphasizes interpretation of results, scientific writing, publication ethics, and responsible research practices, thereby preparing students to conduct independent research, critically evaluate scientific literature, and effectively communicate research findings in academic and professional environments.

Teaching and Examination Scheme:

					Examination Marks				Total Marks
L	T	P	Total	Credits	Theory Marks		Practical Marks		
2	-	-	2	2	CCE (M)	SEE (E)	CCE (I)	SEE (V)	
					-	-	25	25	50

Contents:

Sr. No.	Content	Total Hours
	SECTION - A	
1	**Foundations of research** Meaning, objectives, motivation, utility. concept of theory, empiricism, deductive and inductive theory. characteristics of scientific method- understanding the language of research- concept, construct, definition, variable. research process.	**8**
2	**Problem identification and formulation & research design** Research question, investigation question, measurement issues, hypothesis, qualities of a good hypothesis, null hypothesis & alternative hypothesis. hypothesis testing- logic & importance. Research design- Concept and	**7**

	importance in research- features of a good research design- exploratory research design- concept, types and uses, descriptive research designs – concept, types and uses. experimental design: concept of independent & dependent variables.	
SECTION - B		
3	**Sampling & data analysis** Concepts of statistical population, sample, sampling frame, sampling error, sample size, non response. characteristics of a good sample. probability sample – simple random sample, systematic sample, stratified random sample & multi-stage sampling. determining size of the sample- practical considerations in sampling and sample size. Data analysis**:** Data preparation - univariate analysis (frequency tables, bar charts, pie charts, percentages), bivariate analysis - cross tabulations and chi-square test including testing hypothesis of association. uses of various software tools for chemistry.	**7**
4	**Interpretation of data and paper writing** Layout of a research paper, journals in chemistry, impact factor of journals, when and where to publish? ethical issues related to publishing, plagiarism and self-plagiarism. Misuse of Artificial Intelligence (AI), Research ethics and merits & demerits including limitations of AI.	**8**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**10**	**20**	**15**	**15**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

1. Donald Cooper & Pamela Schindler, Research Methods, 9th edition, Tata McGraw-Hill (TMGH), ISBN: 978-0073214870, 2006.
2. Alan Bryman & Emma Bell, Business Research Methods , Oxford University Press, 5th Edition, ISBN: 979-0-19-254590-9, 2019.

3. Kothari.C.R. Research Methodology - Methods & Technology, New Age International Publisher, New Delhi, 4th Edition, ISBN- 978-81-224-2488-1, 2019.

Reference Books:

1. Young, P.V., Scientific Social Survey and Research, Prentice-Hall sociology series, 2nd Edition, ISBN: 9788120300859, 1949.
2. Gupta, S.P. Statistical Methods, Sultan Chand and sons, 9788125916543, 9351611760, ISSN: 9351611760, 1999.
3. C. B. Gupta & Vijay Gupta, An introduction to Statistics Methods, Vikas Publishing House, ISBN: 9788125916543, 1998.
4. P.L. Bhandarkar, T.S. Wilkinson. Methodology and Techniques of Social Research, Himalaya Publishing House, Mumbai, ISBN-978-9350974728, 2016.
5. Panneerselvam. R. Research Methodology, Prentice Hall of India, New Delhi, 2nd Edition, ISBN: 9788120349469, 2004.
6. Green, P.E., Research for Marketing Decisions, Prentice-Hall of India, New Delhi, 3rd Edition, ISBN: 978-8120307575, 1994.

Course Outcomes:

After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand research fundamentals, scientific methods, and hypothesis formulation.	15%
CO-2	Design research methodologies using appropriate designs and sampling techniques.	20%
CO-3	Apply statistical tools and software for data analysis and interpretation.	20%
CO-4	Communicate research findings effectively through scientific writing and publications.	15%
CO-5	Practice research ethics, plagiarism awareness, and responsible research conduct.	15%
CO-6	Apply ethical research practices supporting sustainability principles.	15%

List of Open Source Software/learning website:

1. NPTEL - https://onlinecourses.nptel.ac.in/noc26_ge43/preview
2. https://www.library.qmul.ac.uk/subject-guides/chemistry/useful-websites/
3. https://blog.feedspot.com/chemistry_websites/
4. https://egyankosh.ac.in/bitstream/123456789/85257/3/Unit-2.pdf
5. https://egyankosh.ac.in/bitstream/123456789/73586/3/Unit-7.pdf
6. https://egyankosh.ac.in/bitstream/123456789/118467/1/Unit-1.pdf
7. https://egyankosh.ac.in/bitstream/123456789/8380/1/Unit-10.pdf

Master of Science
Course Code: CHR501-5C
Course Name: Research Project-II
Semester: IV

w.e.f.: July 2026

Type of Course: Core course

Prerequisite: Basic knowledge of postgraduate chemistry concepts, research methodology, and laboratory skills.

Rationale: The research project is designed to enhance the employability skills of students by providing hands-on experience in a specialized area of Chemistry. It enables students to integrate and apply theoretical knowledge acquired from various courses to address real-life scientific and industrial challenges. The project also exposes students to recent developments, advanced techniques, and research methodologies, fostering innovation, entrepreneurship, self-employment opportunities, and potential employment generation through the extension and application of project outcomes.

Teaching and Examination Scheme:

					Examination Marks				Total Marks
L	T	P	Total	Credits	Theory Marks		Practical Marks		
-	-	32	32	16	CCE (M)	SEE (E)	CCE (I)	SEE (V)	
					-	-	200	200	400

Content:

Sr. No.	Content	Total Hrs.
1	The 4th semester of M.Sc. is required to undertake Research Project-II. There are two categories offered for Research Project-II, ss listed below: *1. University Defined Project (UDP)*	**480**

	2. Industry Defined Project (IDP) From the above two categories students have to select either of the one.	

Note:*_Assessment & evaluation of the research project-II in Semester-IV will be carried out based Review-I, II and III presentations of the research conducted, submission of 02 copies of embossed bound project thesis and open viva-voce examination._

Course Outcomes:

After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Identify and formulate research problems through literature review.	10%
CO-2	Design and perform experiments using appropriate techniques.	20%
CO-3	Analyze and interpret experimental data scientifically.	10%
CO-4	Demonstrate independent research and critical thinking skills.	20%
CO-5	Communicate research outcomes through reports and presentations.	20%
CO-6	Follow ethical practices, safety norms, and sustainability principles in research.	20%

Reference:

1. https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf
2. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf