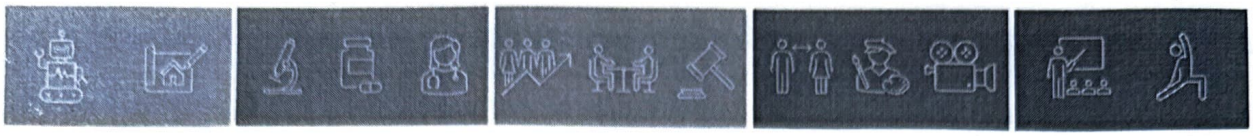

FACULTY OF SCIENCE

COURSE STRUCTURE

(Choice Based Credit System)

MASTER OF SCIENCE (ORGANIC CHEMISTRY)

Effective from Academic Year: 2022-23

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Faculty Name: SCIENCE

Programme Name: Master of Science (Organic Chemistry)

Programme Structure Summary

SEMESTER I											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
Core	Electron spectroscopy and Magneto chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Organic Chemistry-I	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Physical Chemistry-I	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Lab Synthesis-I (201330101, 201330102 and 201330103)	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Lab Analysis-I (201330101, 201330102 and 201330103)	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Comprehensive Viva – Voce	1	-	-	-	-	-	50/20	-	-	50/20
Elective	Biophysical Chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40
Elective	Polymer Chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40

SEMESTER II											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
Core	Quantum Chemistry & Organometallic Chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Organic Chemistry-II	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Topics in Physical Chemistry-II	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Lab Synthesis-II (201330201, 201330202 and 201330203)	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Lab Analysis-II (201330201, 201330202 and 201330203)	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Comprehensive Viva - Voce	1	-	-	-	-	-	50/20	-	-	50/20
Elective	Introduction to Biochemistry	4	4	-	-	4	50/20	50/20	-	-	100/40
Elective	Analytical Chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40

Faculty Name: SCIENCE

Programme Name: Master of Science (Organic Chemistry)

SEMESTER III											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
Core	Organic Spectroscopy	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Disconnection Approach	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Heterocyclic Chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Spectral Exercise and Organic Separation Lab OR	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Project Work	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Synthesis and Application of Dyes and Intermediates Lab OR	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Project Work	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Comprehensive Viva – Voce	1	-	-	-	-	-	50/20	-	-	50/20
Elective	Selected Topics in Organic Chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40
Elective	Occupational Practices	4	4	-	-	4	50/20	50/20	-	-	100/40

SEMESTER IV											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
Core	Natural Products	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Medicinal Chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Stereochemistry of Organic Compounds	4	4	-	-	4	50/20	50/20	-	-	100/40
Core	Multistep Synthesis of Heterocyclic Compounds Lab OR	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Project Work	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Spectral Analysis & Synthesis of Drugs, Intermediates and Esters Lab OR	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Project Work	4	-	8	-	8	-	-	50/20	50/20	100/40
Core	Comprehensive Viva – Voce	1	-	-	-	-	-	50/20	-	-	50/20
Elective	Topics in Organic Chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40
Elective	Applied Organic Chemistry	4	4	-	-	4	50/20	50/20	-	-	100/40

Faculty Name: SCIENCE

Programme Name: Master of Science (Organic Chemistry)

Programme Outcomes

PO-1	After completing Masters in Organic Chemistry, students have in-depth knowledge about organic-chemical reactions with a focus on principles for effective synthesis strategies, stereo selectivity, catalysis, as well as organometallic chemistry
PO-2	Students will become familiar with the different branches of chemistry like analytical, organic, inorganic, physical and polymer chemistry. They will also learn to apply appropriate techniques for the qualitative and quantitative analysis of chemicals.
PO-3	Students will have skill enhancement in the core chemistry with practical hands which will make students employable in academia and industries
PO-4	Getting good jobs at various industries like Pharma, Chemical, Dyes/Pigments, Petroleum, Fertilizers, and many more in the R&D, ADL, QC & QA departments of industries as well as in production department

Programme Specific Outcomes

PSO-1	The course itself cultivates the students as per the market requirement and can sustainably consider themselves as an Organic chemist.
PSO-2	Students will become sharpens their career by pursuing M.Phil. and Ph.D. programs.

Faculty Name: Science

Programme Name: Master of Science (Organic Chemistry)

Semester: I

Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Core	Faculty of Science	201330101	Electron spectroscopy and Magneto chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Faculty of Science	201330102	Organic Chemistry-I	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Faculty of Science	201330103	Physical Chemistry-I	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Faculty of Science	201330104	Lab Synthesis-I (201330101, 201330102 and 201330103)	4	-	8	-	8	-	P	-	3.5	-	-	50/20	50/20	100/40
Core	Faculty of Science	201330105	Lab Analysis-I (201330101, 201330102 and 201330103)	4	-	8	-	8	-	P	-	3.5	-	-	50/20	50/20	100/40
Core	Faculty of Science	201330106	Comprehensive Viva	1	-	-	-	-	T	-	-	-	-	50/20	-	-	50/20
Elective	Faculty of Science	201330107	Biophysical Chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Elective	Faculty of Science	201330108	Polymer Chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40

 # T = Theory, P = Practical, Tu = Tutorial

Name & Sign [Chairman - Board of Studies]:

Name & Sign [Dean / Director]:

Dean
Faculty of Science
The CVM University

Faculty Name: Science

Programme Name: Master of Science (Organic Chemistry)

Semester: II

Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Core	Faculty of Science	201330201	Quantum Chemistry & Organometallic Chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Faculty of Science	201330202	Organic Chemistry-II	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Faculty of Science	201330203	Topics in Physical Chemistry-II	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Faculty of Science	201330204	Lab Synthesis-II (201330201, 201330202 and 201330203)	4	-	8	-	8	-	P	-	3.5	-	-	50/20	50/20	100/40
Core	Faculty of Science	201330205	Lab Analysis-II (201330201, 201330202 and 201330203)	4	-	8	-	8	-	P	-	3.5	-	-	50/20	50/20	100/40
Core	Faculty of Science	201330206	Comprehensive Viva	1	-	-	-	-	T	-	-	-	-	50/20	-	-	50/20
Elective	Faculty of Science	201330207	Introduction to Biochemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Elective	Faculty of Science	201330208	Analytical Chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40

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Faculty Name: Science

Programme Name: Master of Science (Organic Chemistry)

Semester: III

Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Core	Science	201330301	Organic Spectroscopy	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Science	201330302	Disconnection Approach	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Science	201330303	Heterocyclic Chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Science	201330304	Spectral Exercise and Organic Separation Lab OR	4	-	8	-	8	-	P	-	4	-	-	50/20	50/20	100/40
Core	Science	201330305	Project Work	4	-	8	-	8	-	P	-	-	-	-	50/20	50/20	100/40
Core	Science	201330306	Synthesis and Application of Dyes and Intermediates Lab OR	4	-	8	-	8	-	P	-	4	-	-	50/20	50/20	100/40
Core	Science	201330307	Project Work	4	-	8	-	8	-	P	-	-	-	-	50/20	50/20	100/40
Core	Science	201330308	Comprehensive Viva – Voce	1	-	-	-	-	T	-	-	-	-	-	-	50/20	50/20
Elective	Science	201330309	Selected Topics in Organic Chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Elective	Science	201330310	Occupational Practices	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40

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Faculty Name: Science

Programme Name: Master of Science (Organic Chemistry)

Semester: IV

Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Core	Science	201330401	Natural Products	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Science	201330402	Medicinal Chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Science	201330403	Stereochemistry of Organic Compounds	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Core	Science	201330404	Multistep Synthesis of Heterocyclic Compounds Lab OR	4	-	8	-	8	-	P	-	4	-	-	50/20	50/20	100/40
Core	Science	201330405	Project Work	4	-	8	-	8	-	P	-	-	-	-	50/20	50/20	100/40
Core	Science	201330406	Spectral Analysis & Synthesis of Drugs, Intermediates and Esters Lab OR	4	-	8	-	8	-	P	-	4	-	-	50/20	50/20	100/40
Core	Science	201330407	Project Work	4	-	8	-	8	-	P	-	-	-	-	50/20	50/20	100/40
Core	Science	201330408	Comprehensive Viva – Voce	1	-	-	-	-	T	-	-	-	-	-	-	50/20	50/20
Elective	Science	201330409	Topics in Organic Chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40
Elective	Science	201330410	Applied Organic Chemistry	4	4	-	-	4	T	-	2	-	50/20	50/20	-	-	100/40

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **I**

Course Code: **201330101**

Course Title: **Electron spectroscopy and Magneto chemistry**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) To be able to use Crystal Field Theory to understand the magnetic properties of coordination compounds.
b) To be able to describe the stability of metal complexes by the use of Nephelauxetic series and electronic parameters from them.
c) To review the basic concepts of electronic states of transition metal complexes.
d) The learners should be able to apply theories of chemical bonding, electronic structure and magnetic properties of coordination complexes to identify the occurrence, active site structure and functions of some transition metal ions.
e) To develop an understanding of calculation of Dq, B and ß parameters.
f) To clarify the concept of magnetic properties like magnetic susceptibility and magnetic moments.
g) To understand the effect of an external magnetic field when any transition metal complex comes under its influence.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Unit	Description in details	Weightage (%)
I	**Electron spectroscopy of transition metal complexes: I** Concept of crystal field theory(CFT), ligand field theory (LFT) and molecular orbital theory (MOT); splitting of d-orbitals in various stereochemistry; tetragonal distortion in octahedral complexes;	25%

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	spectrochemical series; nephelauxetic series; Electronic states and term symbols; microstates; derivation of terms for closed subshell; derivation of terms for p^2, d^2 & f^2 configuration.	
II	**Electron spectroscopy of transition metal complexes: II** Correlation diagrams; Orgel diagram; Tanabe- Sugano diagram; selection rule; determination of Dq and electronic parameters; interpretation of spectra.	**25%**
III	**Magnetochemistry: I** Magnetic susceptibility; sources of paramagnetism; diamagnetic susceptibility; Pascal constants and constitutive corrections; Langevin equation; Van Vleck's formula; antiferromagnetism; Types of antiferromagnetism; antiferromagnetism exchange pathway; Ferromagnetism and magnetic domains; molecular field theory of ferromagnetism; magnetic sublattice, ferrimagnetism and canting.	**25%**
IV	**Magnetochemistry: II** Spin-orbit coupling; Lande interval rule; quenching of orbital magnetic moment by crystal field; spin-orbit coupling on A and E terms; spin-orbit coupling on T term; Spin paring: Spin paring in octahedral complexes; in non-octahedral complexes; some aspects of spin pairing and cross over region. **Chemistry of lanthanides and actinides:** Term symbols, spectral and magnetic properties of the compounds of lanthanides and actinides; use of lanthanide compounds as shift reagents.	**25%**

Reference Books/Audio-visual Course:

1	Molecular Spectroscopy, Theory and Applications, By: Raman Patel and Raman Patel
2	Electronic absorption spectroscopy and related techniques, By: D.N. Sathyanarayana

Supplementary learning Material:	
1	http://chemistry.du.ac.in/study_material/201B/Tanabe%20Sugano%20Diagrams.pdf
2	https://www.youtube.com/watch?v=SqxcALnh4zg
3	https://www.youtube.com/watch?v=uZxmg5s17xM
4	https://www.mdpi.com/journal/magnetochemistry
5	https://www.youtube.com/watch?v=3HSVkQQKI7E

Pedagogy:

- To motivate students and deepen their understanding of chemistry, instructors need to plan thoughtful lessons in advance and establish clear learning goals. Allowing students to reflect on their knowledge complemented by effective questioning from the instructor helps them solidify concepts.
- Other effective lesson formats appropriate for some topics in chemistry include role playing, manipulation of concepts via simulations, and differentiated instruction. Cognitive science discourages "teaching as telling," therefore careful planning is necessary to avoid this pitfall. If

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a lecture format is decided to be the most effective way to teach a concept, allow students to preview the information and provide them in advance with organizers to maximize participation and promote student understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After the completion of this course, student will be able To understand the concept of Crystal field theory (CFT) and Ligand field theory (LFT) and the splitting of d-orbitals in various stereochemistry. To determine the term symbols and derivation of terms for f2 configurations.	**25**
CO-2	To explain correlation diagrams for octahedral and tetrahedral stereochemistry and Tanabe Sugano diagram for octahedral and tetrahedral stereochemistry. To understand the Charge Transfer transition and understand the concept of Molecular orbital theory for the octahedral and tetrahedral complexes. To calculate the electronic parameters and Interpret of electronic spectra of coordination compounds	**25**
CO-3	To develop an understanding of calculation of Dq, B and ß Parameters To clarify the concept of magnetic properties like magnetic susceptibility and magnetic moments.	**25**
CO-4	To understand the spin-orbit coupling on T, A and E terms and Spin paring and also explain Term symbols, spectral and magnetic properties of the compounds of lanthanides and actinides.	**25**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	April 2022
Last Reviewed on (Month-Year):	-
Next Review on (Month-Year):	March 2025

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **I**

Course Code: **201330102**

Course Title: **Organic Chemistry-I**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) To understand the structure, stereochemistry and reaction pathways of organic molecules.

b) This subject gives basic idea about the nature of bonding in organic molecules and the role of structures in interpreting organic reactions.

Unit	Description in details	Weightage (%)
I	**Stereochemistry:** Concept of Chirality, Chirality and Symmetry, Sawhorse, Newman and Fischer Projections, Interconversion of Projection formula, Elements of Chirality including Chiral centre, Chiral axis, Chiral plane and Helicity, CIP Nomenclature, Molecules with more than one Chiral centre, Total number of Stereoisomer in such molecules, Enantiomeric and Diastereomeric Relationship, Chirogenicity and Stereogenecity, Pseudochirality, Topicity and Prostereoisomerism, Determination of Topic relationship between Homomorphic ligands in Intact Molecules, Concept of stereoselective and stereospecific reactions, Optical Purity.	**25%**
II	**Name Reaction Mechanism and their Application:** Molecular Rearrangement involving Non-classical Carbocation, Wagner- Meerwein and Related Rearrangements, Wolff, Curtius, Schmidt, Lossen, Beckmann, Benzil-Benzilic acid, Favorskii, Stevensen, Sommelet-Hauser Rearrangements, Fries reaction, aldol and related reactions, Knoevenagel, Dieckman, Darzen, Claisen reaction. [Emphasizing on Various Techniques for Determination of Mechanism]	**25%**
III	**Elimination and Addition React ions :** Mechanisms and Orientation, E_1, E_1cb, E_2 spectrum, Effects of Changes in Substrate, Base, Leaving Group and Medium on Reactivity, Hoffman and Saytzef eliminations, Bredt's Rule,	**25%**

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	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 [Emphasizing on Various Techniques for Determination of Mechanism]	
IV	**Aromatic substitution reactions (Electrophilic and Nucleophilic):** Mono-substituted benzenes - Reactivity and Orientations, Orientation in Benzene Rings with more than One Substituent, ipso substitution, Orientation in Other Ring Systems, Mechanisms of Fridel- Craft reactions, Nitration, Sulphonation, Halogenation, Diazocoupling and Formylation. Benzyne Mechanisms for Aromatic Nucleophilic substitution reactions.	**25%**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Organic Reactions, Stereochemistry and Mechanism: P.S. Kalsi (New Age.)
2	Principles of Organic Synthesis: R.O.C Norman & J.M. Coxon (ELBS)
3	Mechanism in Organic Chemistry: Peter Sykes (Orient Longman)
4	Modern Methods of Organic Synthesis: W. Carruthers (Cambridge)
5	Organic Reaction Mechanism: V.K.Ahluwalia and R.K.Parashar (Narosa)
6	Organic Chemistry: Clayden, Greeves and Warren (Oxford)

Supplementary learning Material:	
1	https://nptel.ac.in/courses/104105086
2	https://nptel.ac.in/courses/104101115
3	https://nptel.ac.in/courses/104103110

Pedagogy:

- For teaching the organic chemistry PG level, initially teaching must be in very simple way and gradually drag them to the in-depth knowledge of the subject using different interesting methodology such as use of scientific models, correlation with live examples etc.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	

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20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To understand various aspects of stereochemistry of organic molecules, and how to identify the configuration of different organic compounds along with topicity and symmetry of chiral compounds.	**25**
CO-2	To gain the knowledge of important reagents used in synthesis and understand the reaction mechanism of various name reactions.	**25**
CO-3	To understand the various addition and elimination reactions and their stereo chemical aspects.	**25**
CO-4	To understand the various electrophilic and nucleophilic reactions.	**25**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	April 2022
Last Reviewed on (Month-Year):	-
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **I**

Course Code: **201330103**

Course Title: **Physical Chemistry-I**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) To learn chemical thermodynamics (laws) and chemical kinetics of reactions and mechanism by which they occurs.
b) Concept of fugacity and methods for determination of fugacity.
c) Reaction rate and order. Understand the fundamentals of surfactants and how its behavior for Micellization.
d) Ionic liquids synthesis properties and applications in various fields.
e) Importance of electronics/potential in chemistry including charge density, current density, overvoltage factors affecting etc.

Unit	Description in details	Weightage (%)
I	**Chemical Thermodynamics :** Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties: partial molar free energy, partial molar volume and partial molar heat content and their significances. Determinations of these quantities. Concept of fugacity and determination of fugacity. Non-ideal systems: Excess functions for non-ideal solutions, Activity, activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength.	**25 %**
II	**Chemical Kinetics – I :** Chemical kinetics and its scope, rate of reaction, factors influencing the rate of a reaction, measurements of reaction rates, differential and integral rate laws, rate laws and equilibrium constants for elementary reactions, temperature dependence of rate constants, Arrhenius equation, concept of activation energy, reaction mechanisms and examples ;- uni-molecular reactions, bi-molecular reactions, trimolecular reactions.	**25 %**

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III	**Electrochemistry :** Ion solvent interactions. Structure of electrified interfaces, Bockris, Devanathan models, Over potentials/voltage and factors affecting on it and applications, exchange current density, electrode polarization and factors affecting on it, Kohlrausch's law, Indicator electrode or Ion selective electrode (Glass electrode), Thermodynamics of a reversible cell (Nernst equation for electrode potential), Role of Salt bridge for electrolytic cells and electrochemical cells.	**25 %**
IV	**Surface Chemistry :** Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Surface films on liquids (Electro-kinetic phenomenon), catalytic activity at surface. Micelles: Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micelle concentration (CMC), factors affecting the CMC of surfactants, Ionic Liquids, synthesis, properties and applications.	**25 %**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	An Introduction to Chemical Thermodynamics, R. P. Rastogi and P. R. Misra, (Vikas Publishing House Pvt.Ltd.
2	Thermodynamics, P. C. Rakshit, (The New Book Stall, Calcutta).
3	Fundamentals of Chemical Thermodynamics, M. L. Lakhanpal, (Tata McGraw-Hill Publishing Company, New Delhi).
4	Elements of Physical Chemistry, Peter Atkins, Julio De Paula, David Smith,(Oxford University Press, 6th Edition)
5	Physical Chemistry, Ira N Levine (Tata McGraw-Hill Publishing Company, New Delhi, Fifth Edition).
6	Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum Press
7	Modern Electrochemistry, Vol. I and Vol. II, J. O. M. Bockris and A. K. N. Reddy, Plenum press
8	Chemical Kinetics, K. J.Laidler, Mc-Graw Hill Publisher
9	Thermodynamics for Chemists, S. Glasstone, (East-West Edition, Third Edition)
10	Surfactants and Interfacial Phenomena, Milton J. Rosen, (Willey Interscience, Third Edition).
11	Colloid and Interface Science, Pallab Ghosh (PHI Learning Private Limited)

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Supplementary learning Material:	
1	http://ndl.iitkgp.ac.in/document/dXU1U0hFMlkrUnlMNU96a21CR0s3RGZwUjl4VmVHdFVlNzlST3IyejFIRXZ5QzhNUkxDcVM0ZExMQmhlVlhEN1c3eCtYTDBRNXRiWjdNMnVUMUFYcnc9PQ
2	http://ndl.iitkgp.ac.in/document/OEYweXpIRmlkYURkM3JkbUdtKy9UZjdaNnJVQ294VnNpOHo5bzRZWHk2d095MnhsSEtpRUltbkF1QkhQZXpXQldKWHFVZGhRLzU0Zm14WTZydWkvSFE9PQ
3	http://ndl.iitkgp.ac.in/document/TzNlQmFaaUc4dGYyMTZRbFIremJQS2ZmQjlTeGY5bVk0S2dDUDZCUDBiWEl1WnY1ZU0yRmgraTBIMVk4RmYwUA
4	https://www.youtube.com/watch?v=TnDCxw0y6YM
5	https://www.youtube.com/watch?v=7I0Xg92_eA4
6	https://www.youtube.com/watch?v=jX4dEOFwaLQ
7	https://www.youtube.com/watch?v=5tNt_-fCR_0
8	https://www.youtube.com/watch?v=sGtO_GGBVvM

Pedagogy:

- For student – teacher learning pedagogy: Currently, we are engaging with the five major approaches, which are constructivist, collaborative, integrative, reflective and inquiry based learning. In this learning process students can achieved their goal by improving results, understanding. For better understanding of theory in classroom, we have some models, from which theoretical fundaments can be easily cleared.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of these course students should be able to realize the terms ionic strength, activity coefficient, DHO equation and also able to explain Laws of thermodynamics to chemical processes.	**25**
CO-2	Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in physical chemistry.	**25**
CO-3	Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.	**25**
CO-4	To study the energy of activation and second order reaction.	**25**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **I**

Course Code: **201330104**

Course Title: **Lab Synthesis-I (201330101, 201330102 and 201330103)**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) Develop advanced laboratory skills used in the synthesis of inorganic and organic molecules.
b) To impart the basic analytical and technical skills to work effectively in the various fields of chemistry.
c) To motivate for the critical thinking and analysis skills to solve chemical problems.
d) To learn instrumental based practical including pH-metery, conductometery, potentiometry, polarimetry and spectrophotometry.

INORGANIC CHEMISTRY **(Weightage 33.33%)**

Total Credit : 4

❖ **Synthesis of metal complexes, double salts and estimation by gravimetry.**

1. Hexa ammine nickel(II) chloride.
2. Ferrous ammonium sulphate.
3. Mercury tetrathiocyanatocobaltate.
4. Tris-acetylacetonato Manganese(II) chloride.
5. Pottasiumtrioxalatoferrate
6. Prussian blue
7. Hexaure chromic chloride.
8. Tetra ammine copper sulphate
9. Cis – trans- bis oxalate, diaquo chromate(III)

ORGANIC CHEMISTRY **(Weightage 33.33%)**

Total Credit : 4

❖ **List of Synthesis**

1. Claisen-Schmidt Reaction:
   Benzal-acetophenone from acetophenone/ Dibenzalacetone from Benzaldehyde
2. Pechmann Condensation:
   7-Hydroxy-4-methyl Coumarin
3. Diels-Alder reaction:

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9,10-dihydroanthracene-α, β-succinic anhydride from anthracene

4. Sandmeyer reaction:
   Aniline to chlorobenzene, p-nitroaniline to p-nitrochlorobenzene, Anthranilic acid to *o*-chlorobenzoic acid, *o*-toluidine to *o*-chlorotoluene, *p*-iodonitrobenzene from *p*-nitroaniline, *m*-nitrophenol from *m*-nitroaniline etc.
5. Fisher indole synthesis:
   1,2,3,4-Tetrahydrocarbazole from Cyclohexanone
6. Lieben haloform reaction:
   Iodoform from Acetone
7. Knorr-Quinoline synthesis:
   2-hydroxy-4-methylquinoline from Acetoacetanilide
8. Dye Synthesis: [DIAZOTIZATION & COUPLING]
   1-Phenyl azo-2-naphthol
9. Cannizarro reaction:
   Benzyl alcohol and Benzoic acid from Benzaldehyde
10. Aspirin from salicylic acid [Acetylation]

Boiling point determination of unknown liquid sample

PHYSICAL CHEMISTRY **(Weightage 33.33%)**

Total Credit : 4

(Physical –I)

Sr. No. Description in detail

1. To determine the heat of solution of the given acid by solubility method
2. Determination of hydrolysis constant of aniline hydrochloride by distribution method
3. Determination of the critical solution temperature (CST) of the phenol/water system and to study the effect of additive on CST
4. To determine the surface tension of methyl acetate, ethyl acetate, hexane and chloroform and hence calculate the atomic parachors of C, H. Cl etc
5. To determine partial molar volume of sodium chloride in aqueous solution at room temperature

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/16	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Advanced Practical Inorganic Chemistry – Gurdeep Raj Goel Publishing House, Meerut.
2	Qualitative Inorganic Analysis. – A. I. Vogel, 6th Edition revised by G. Svehla ELBS– London
3	Textbook of Chemistry Analysis – A. I. Vogel
4	Qualitative Chemistry semi micro analysis – edited by P. K. Agasyan CBS Publisher-Delhi.

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5	Chemistry: Inorganic Qualitative Analysis in the Laboratory, Clyde Metz, Elsevier, 2012, ISBN: 978032316104
6	Elementary Practical Organic Chemistry (part-1 to 3) By A. I. Vogel (CBS publication)
7	Experimental Physical Chemistry by R. C. Das & B. Behera, (Tata McGraw hill Publishing Company Ltd., New Delhi)
8	A Laboratory Manual of Experiments in Physical Chemistry by D. Brennan and C. F. H. Tipper,(McGraw hill Publishing Company Ltd., London)
9	Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T. K. Chondhekar, (Anjali Publication, Aurangabad)
10	Advanced Practical Physical Chemistry by J. B. Yadav, (Goel Publishing House, Meerut)
11	Experimental Physical Chemistry by G. Peter Matthews, (Clarendon Press, Oxford, London)
12	Experimental Physical Chemistry by V. D. Athawale and ParulMathur, (New Age International Publishers, New Delhi)
13	Advanced Physical Chemistry Experiments by Gurtu and Gurtu, (Pragati Prakashan, Meerut)
14	Advanced Physico-Chemical Experiments by J. Rose, (Sir Isaac Pitman & Sons Ltd., London)
15	Experiments in Physical Chemistry by D. P. Shoemaker, C. W. Garland and J. W. Nibler, (McGrawHill International Edition, London).

Supplementary learning Material:	
1	https://www.youtube.com/watch?v=DkS5rzGGpEc
2	https://www.youtube.com/watch?v=x_QR_tJgDCU
3	https://www.youtube.com/watch?v=dy2rsAL9sD8
4	https://www.youtube.com/watch?v=Y4NmpO1xI8U
5	https://www.youtube.com/watch?v=DkS5rzGGpEc
6	https://www.youtube.com/watch?v=x_QR_tJgDCU
7	https://www.youtube.com/watch?v=dy2rsAL9sD8
8	https://www.youtube.com/watch?v=Y4NmpO1xI8U

Pedagogy:

- Practical knowledge starts with introduction to equipment and chemicals by giving them the enough idea about the effectiveness and harmfulness of chemicals especially hazardous chemicals which are new to them. Explain the theory behind the reaction and appropriate reason for the formation of the product and also explain about the precaution required for the particular practical.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Students will able: To learn formation of inorganic complex and find the % of purity of complexes.	**33.33**

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CO-2	To demonstrate and apply the fundamental knowledge of the basic principles in various fields of Chemistry. To inculcate logical thinking to address a problem and become result oriented with a positive attitude.	**33.33**
CO-3	To determine specific rotations and percentage of optically active substances by polorimetrically. To find out the acidity, basicity and PKa value on pH meter. To make aware and handle the sophisticated instruments/equipments.	**33.33**

Curriculum Revision:	
Version:	2
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **I**

Course Code: **201330105**

Course Title: **Lab Analysis-I (201330101, 201330102 and 201330103)**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) Develop advanced laboratory skills used in the synthesis of inorganic and organic molecules.
b) To impart the basic analytical and technical skills to work effectively in the various fields of chemistry.
c) To motivate for the critical thinking and analysis skills to solve chemical problems.
d) To learn kinetics based practicals and determination of critical solution temperature, critical micelle concentration, rate of acid catalyzed reaction and transition temperature.

INORGANIC CHEMISTRY **(Weightage 33.33%)**
Total Credit : 4

- **Qualitative Analysis (6 + 1 Radicals)**
  6 – Cation, Anion variable
  1 – Rare earth element form the following:
  Th, Ce, Li, Mo, Se, Te, V, Ti and Zr etc.

ORGANIC CHEMISTRY **(Weightage 33.33%)**
Total Credit : 4

- **Estimations**

1. Hydroxyl Group Estimation
2. Unsaturation Estimation
3. Phenol/ Aniline Estimation
4. Ascorbic Acid (Vitamin-C) Estimation
5. Acid + Amide / Acid + Ester Estimation

PHYSICAL CHEMISTRY **(Weightage 33.33%)**
Total Credit : 4

Sr. No.	Description in detail
1.	To determine the dissociation constants (k1 and k2) of a dibasic acid pH metrically
2.	To find out the (a) cell constant of given conductivity cell, (b) to determine the critical micelle concentration (CMC) of an ionic surfactant

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3. Determination of DG, DH and DS for a reaction using an electrochemical cell
4. To verify law of additivity of absorbance for a mixture of colored substances in solution using potassium permanganate and potassium dichromate solutions
5. To determine the concentration of a given solution of an optically active substance by polarimetric measurements

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Advanced Practical Inorganic Chemistry – Gurdeep Raj Goel Publishing House, Meerut.
2	Qualitative Inorganic Analysis. – A. I. Vogel, 6th Edition revised by G. Svehla ELBS– London
3	Textbook of Chemistry Analysis – A. I. Vogel
4	Qualitative Chemistry semi micro analysis – edited by P. K. Agasyan CBS Publisher-Delhi.
5	Chemistry: Inorganic Qualitative Analysis in the Laboratory, Clyde Metz, Elsevier, 2012, ISBN: 978032316104
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8	A Laboratory Manual of Experiments in Physical Chemistry by D. Brennan and C. F. H. Tipper,(McGraw hill Publishing Company Ltd., London)
9	Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T. K. Chondhekar, (Anjali Publication, Aurangabad)
10	Advanced Practical Physical Chemistry by J. B. Yadav, (Goel Publishing House, Meerut)
11	Experimental Physical Chemistry by G. Peter Matthews, (Clarendon Press, Oxford, London)
12	Experimental Physical Chemistry by V. D. Athawale and ParulMathur, (New Age International Publishers, New Delhi)
13	Advanced Physical Chemistry Experiments by Gurtu and Gurtu, (Pragati Prakashan, Meerut)
14	Advanced Physico-Chemical Experiments by J. Rose, (Sir Isaac Pitman & Sons Ltd., London)
15	Experiments in Physical Chemistry by D. P. Shoemaker, C. W. Garland and J. W. Nibler, (McGrawHill International Edition, London).

Supplementary learning Material:	
1	https://www.youtube.com/watch?v=DkS5rzGGpEc
2	https://www.youtube.com/watch?v=x_QR_tJgDCU
3	https://www.youtube.com/watch?v=dy2rsAL9sD8
4	https://www.youtube.com/watch?v=C1tG69O0fXc
5	https://www.youtube.com/watch?v=9ZVuwyx6ipU
6	https://www.youtube.com/watch?v=kS-mXZ44Rl4

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Pedagogy:

- Practical knowledge starts with introduction to equipment and chemicals by giving them the enough idea about the effectiveness and harmfulness of chemicals especially hazardous chemicals which are new to them. Explain the different types of analysis and its importance in the field of chemistry. Analysis required accuracy and for accuracy we are concern with absolute discipline which in turn important for the accurate analysis and learning of analysis based practicals.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will able: To develop practical skills in identification of metal salt in the unknown inorganic mixture via performing various qualitative analyses	**33.33**
CO-2	To understand the methods used for estimations of various organic compounds quantitatively	**33.33**
CO-3	To get hand on training for the determination of critical solution temperature, critical micelle concentration, rate of acid catalyzed reaction and transition temperature.	**33.33**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **I**

Course Code: **201330106**

Course Title: **Comprehensive Viva – Voce**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) Actually, this is not a theory or practical subject; this is just a viva-voce of compilation of all theory subjects including inorganic chemistry, organic chemistry, physical chemistry and polymer chemistry.

b) The main objective of this subject is to improve knowledge of chemistry (All four theory subjects), this might be useful to face interview after M.Sc. To improve communication skill of students.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	-	1	-	50/20	-	-	50/20

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**The syllabus for this subject is already covered in all four theory subjects.**	-

Pedagogy:

For student – teacher learning pedagogy: Currently, we are engaging with the five major approaches, which are constructivist, collaborative, integrative, reflective and inquiry based learning. In this learning process students can achieved their goal by improving results and understanding.

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**30**	**10**	**10**	**15**	**15**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Viva voce examination is as important as the written mode of examination. Using this method, it is easy to test the flexibility and potential of the students for their higher order cognitive skills. It also provides direct contact with the students to assess their way of communication, presentation skills and in-depth knowledge of various theory subjects. It helps students to improve their own perception for their future career endeavour.	**100**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **I**

Course Code: **201330107**

Course Title: **Biophysical Chemistry**

Course Group: **Elective**

Course Objectives:

The objectives of this course are to enable students to…

a) Historical development in biophysical materials including, cell structure and Functions, Nucleic Acids, Thermodynamics of Biopolymer solutions, Overview of metabolic processes – catabolism and anabolism, ATP, etc.

b) To learn about structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cell.

c) To gain knowledge of building blocks, amino acids, peptides and proteins, structure and functions of proteins, enzymes – mechanism.

d) To understand and gain the knowledge of structure of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA), double helix model of DNA and forces responsible for holding it.

e) To acquire the knowledge of thermodynamics of biopolymer solutions. Overview of metabolic processes.

f) To learn and understand the biological energy, properties of ADP, ATP and AMP, synthesis of ATP from ADP, hydrolysis of ATP. Understand the biochemical reactions, such as exergonic reactions, endogonic reactions, coupled reactions and energy conservation. Finally, working numerical based on energetic of biochemical reactions.

Unit	Description in details	Weightage (%)
I	**Cell Structure and Functions :** Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells, biomolecules : introduction and building blocks, amino acids, peptides and proteins, structure and functions of proteins, enzymes – mechanism, Carbohydrates :structure and functions, lipids and biological membranes	**25 %**
II	**Nucleic Acids :** Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA), double helix model of DNA and	**25 %**

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	forces responsible for holding it. Properties of DNA in solution, Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code, Chemical synthesis of mono and trinucleoside. Denaturation of DNA, RNA –types, hydrolysis, analysis and nucleic acid – protein complexes, helix coil transition	
III	**Thermodynamics of Biopolymer solutions :** Osmotic pressure, membrane equilibrium, muscular contraction and energy generation, mechano-chemical system, chain configuration of biopolymers, statistical distribution of end – to – end and average dimensions, Cell membrane and transport of ions : Structure and functions of cell membrane, ion transport across cell membrane, passive mediate transport, active transport.	**25 %**
IV	**Bioenergetics :**Overview of metabolic processes – catabolism and anabolism, ATP – the biological energy currency, Principles and ATP cycles – properties of ADP, ATP and AMP, synthesis of ATP from ADP, hydrolysis of ATP, Standard free energy change in biochemical reactions, exergonic reactions, endegonic reactions, coupled reactions and energy conservation. Working numerical based on energetic of biochemical reactions.	**25 %**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Lehninger Principles of Biochemistry, M. M. Cox and D. L. Nelson (W. H. Freeman and Co., New York, Firth Edition)
2	Biochemistry, J. M. Berg, J. L. Tymoszko and L. Stryer (W. H. Freeman and Co., New York, Fifth Edition)
3	Fundamentals of Biochemistry, D. Voet and C. W. Pratt (John Wiley & Sons, Inc., Second Edition)
4	Biochemical calculations, Irwin H. Segel (John Wiley & Sons, New York, Second Edition)
5	Biophysical Chemistry, M. Satake, Y. Hayashi, M. S. Sethi and S. A. Iqbal (Discovery Publishing House, New Delhi)
6	Physical Chemistry : Principles and Applications in Biological Sciences, I. Tinoco Jr., K. Sauer, J. C. Wang, J. D. Puglisi (PEARSON publisher, Fourth Edition).
7	Fundamentals of Biochemistry, A. C. Deb (New Central Book Agency,Kolkata)

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Supplementary learning Material:	
1	https://catalogue.library.cern/series/y1qt4-tgf29
2	https://www.youtube.com/watch?v=WcEYI6KAVWc
3	http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.378.9452
4	https://www.youtube.com/watch?v=1LtU8jwhK7o

Pedagogy:

- For student – teacher learning pedagogy: Currently, we are engaging with the five major approaches, which are constructivist, collaborative, integrative, reflective and inquiry based learning. In this learning process students can achieved their goal by improving results and understanding. By learning and understanding this course student can aware and charged with knowledge of nucleic acid, DNA, RNA, Cell Structure and Functions.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course students should be able to; To learn about the cell Structure and its functions: To learn the structure of cells and their functions, comparison of plant and animal cells, learn to understand the knowledge of amino acids, peptides and proteins, structure and functions of proteins, enzymes – mechanism. To understand the structure of carbohydrates and its functions, lipids and biological membranes	**20**
CO-2	Fulfill with Knowledge about Nucleic Acids: including, ribonucleic acids (RNA) and deoxyribonucleic acids (DNA), double helix model of DNA. Students can gain the knowledge of chemical and enzymatic hydrolysis of nucleic acids. Acquired knowledge of chemical synthesis of mono and trinucleoside. Learn about denaturation of DNA, RNA	**20**
CO-3	Describes of fundamental concepts of thermodynamics of Biopolymer solutions. Learn to understand the osmotic pressure, membrane equilibrium, muscular contraction and energy generation, mechano-chemical system, chain configuration of biopolymers. The statistical distribution of end – to – end and average dimensions, Cell membrane and transport of ions: Structure and functions of cell membrane, ion transport across cell membrane, passive mediate transport, active transport.	**20**

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CO-4	To understand the bioenergetics materials. Learn to understand the metabolic processes – catabolism and anabolism. To understand the principles and ATP cycles – properties of ADP, ATP and AMP, synthesis of ATP from ADP, hydrolysis of ATP. Standard free energy change in biochemical reactions, exergonic reactions, endegonic reactions, coupled reactions and energy conservation. Working numerical based on energetic of biochemical reactions.	**20**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	April 2022
Last Reviewed on (Month-Year):	-
Next Review on (Month-Year):	March 2025

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **I**

Course Code: **201330108**

Course Title: **Polymer Chemistry**

Course Group: **Elective**

Course Objectives:

The objectives of this course are to enable students to…

a) Historical development in polymeric materials. To learn various techniques for polymer synthesis.
b) Role of various additives in polymer. Synthesis of polymers by chain growth and step growth.
c) Copolymerization behavior in solution.
d) Type, properties and applications of polymers Average Molecular Weight Concepts and Measurement of Molecular Weights. To learn various methods for mol. Wt. determination. Monomer – Repeating Unit – Polymers structuration etc.

Unit	Description in details	Weightage (%)
I	**Introduction**: Historical development in polymeric materials, Basic concepts: Oligomer, Monomer, Polymer, Polymerization and Functionality, Repeating Unit, Degree of Polymerization, Bonding in Polymers, Notation and Nomenclature of Polymers, Classification of Polymers depending on- (i) Origin (Natural, Semi-Synthetic, Synthetic); (ii) Chemical Structure (Organic Inorganic, Homochain and Heterochain); (iii) Thermal Response or the behaviour of heat or pressure (Thermoplasticsand Thermosetting); (iv) Line Structure (Linear, Branched, Cross-linked, hyper branched and dendrimer); (v) Ultimate forms and Applications (Plastics, Elastomers, Fibers and Liquid Resins); (vi) Tacticity or the Stereochemistry of the Polymers (Optical Isomerism in Polymers: Isotactic, Syndiotactic, Atactic and Geometrical isomerism in Polymers); (vii) Crystallinity (Crystalline, Semi-crystalline and Amorphous) and (viii) Mode of Synthesis (Homopolymers, Copolymers, Addition, Condensation),Glass Transition Temperature (Tg) and Factors Influencing the Glass Transition Temperature **Average Molecular Weight Concepts and Measurement of**	**25 %**

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	Molecular Weights (Mn ,Mw and Mz **):**Number Average and Weight Average Molecular Weights, Molar Mass & Molar Mass Distribution, Polydispersity, Method of Working out Weight Average Molecular Weight and Number Average Molecular Weight, Molecular Weight and Degree of Polymerization, Polydispersity and Molecular Weight Distribution in Polymers, Practical Significance of Polymer Molecular Weight, End Group Analysis, Freezing Point Depression (Cryoscopy), Boiling Point Elevation (Ebullioscopy), Membrane Osmometry, Vapour Phase Osmometry, Dilute Solution Viscosity, Light Scattering, Ultracentrifugation and GPC	
II	**Chain-Growth Polymerization**: **(i) Chain Radical (Addition) Polymerization:** Free radical addition polymerization mechanism of vinyl polymerization(Generation of free radicals, initiation, propagation, termination, chain transfer inhibition of retardation, configuration of monomer units in vinyl polymer chains), Methods of Initiating Free Radical Polymerization, Kinetics of free radical addition polymerization (experimental determination of rate constants, derivations for rate expressions and expressions for kinetic chain length, degree of polymerization and average life time of a kinetic chain),Control of molecular weight by transfer, The Mayo Equation and Evaluation of the Chain Transfer Constant, Factors (Temperature, Initiator Concentration, Monomer Concentration and Pressure) determining radical polymerization and the properties of the resulting polymer, Equilibrium of Radical Polymerization (ii) Ionic (Catalytic) Polymerization - common features of two types of ionic polymerization, Mechanism of cationic polymerization, expressions for overall rate of polymerization and the number average degree of polymerization. Mechanism of anionic, polymerization, expressions for overall rate of polymerization and the average degree of polymerization, Living polymers. (iii) Coordination (Insertion) Polymerization *:* Ziegler – Natta Catalysis	**25 %**
III	**Step-growth Polymerization**: Ring – opening Polymerization (Mechanism of polymerization of cyclic ethers, cyclic amides and cyclosiloxanes), Atom transfer Polymerization, Kinetics of catalyzed and non – catalysed polyesterification. **Copolymerization:** Free Radical Copolymerization, Determination of Reactivity Ratio, Reactivity Ratios and Copolymerization Behaviour, Copolymer Composition at Higher Conversations, Structure and Reactivity of Monomers and Radicals, The Q-e scheme of Alfrey and Price.	**25 %**
IV	**Techniques of Polymerization:** Bulk – Solution – Suspension and Emulsion polymerization, Melt Polycondensation, Solution Polycondensation, Interfacial Condensation, Solid and Gas Phase	**25 %**

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	Polymerization, Salient features of different polymerization techniques, Kinetics of emulsion polymerization. **Polymer solubility and solutions:** Introduction, General rules for polymer solubility, Thermodynamic basis of Polymer Solubility, Prediction of Solubility. Organometallic Polymers, Ion-containing Polymers, Additives for Polymers	

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Polymer Chemistry – An Introduction by Malcom P. Stevens, AddisonWesley Publishing Co. Inc. Massachusetts.
2	Polymer Chemistry by C. Carraher,Marcel Dekker Inc., New York-Basel.
3	Textbook of Polymer Science by F. W. Billmeyer, Wiley – Interscience, New York
4	Introduction to Polymer Chemistry by R. B. Seymour,Mc – Graw – Hill, New York
5	Polymer Science by V. R.Gowariker, N. V. Viswanathan and JayadevSreedhar, New Age International Publishers
6	Introduction to Polymer Chemistry by R. J. Young and P. A. Lovell
7	Principles of Polymer Chemistry (IInd Edition) by A. Ravve
8	Principles of Polymers Systems, F. Rodriguez, Hemisphere, Publishing Corporation, Washington, DC.
9	Principles of Polymer Science (Second Edition) by P. Bahadur and N. V. Sastry, Narosa Publishing House, New Delhi

Supplementary learning Material:	
1	https://link.springer.com/book/10.1007/978-94-017-2504-0
2	http://ndl.iitkgp.ac.in/document/bWE1aGp5enNHZzh1MlhwRVoxT0dmRWxiWnlsajdYdlloenVCWmkwaEVmeFlDNHFrVkZYWnNFTUF0bW8ra3A1MDNrdkFSa00rYnlCNlBQRERLZ2djNVE9PQ
3	https://www.youtube.com/watch?v=Zsyt9RfMAhk
4	https://www.youtube.com/watch?v=BC1nk4x5BlQ
5	https://www.youtube.com/watch?v=4lKVZpJI0Oo
6	https://www.youtube.com/watch?v=newNCml5DN0
7	https://www.youtube.com/watch?v=d8hWZJMIz4Q

Pedagogy:

- For student – teacher learning pedagogy: Currently, we are engaging with the five major approaches, which are constructivist, collaborative, integrative, reflective and inquiry based learning. In this learning process students can achieved their goal by improving results and understanding.

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of these course students should be able; To learn the thermodynamic basis polymer solubility To explain the utility of polymeric materials in day today life. To describe the different types of polymers. To explain the different methods of polymerization reaction. To explain natural and synthetic polymers	**20**
CO-2	To know the qualitative properties of solution, the depression in freezing point, elevation in boiling point and osmotic pressure.	**20**
CO-3	To describe of fundamental concepts of macromolecules. To explain the preparation of high polymers, polymerization steps. To describe fundamental of conducting polymers and their various application.	**20**
CO-4	To explain the kinetics of polymerization process To understand the utility of conducting polymers To describe the process involved in the polymerization reaction.	**20**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **II**

Course Code: **201330201**

Course Title: **Quantum Chemistry & Organometallic Chemistry**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) The objective of this course is to introduce the students to Quantum Chemistry uses high-level mathematics as a tool to understand atomic and molecular structure and properties, as well as chemical reactivity

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Unit	Description in details	Weightage (%)
I	**Commutation relations** Commutative property; momentum operator; Hamiltonian operator; angular momentum operator; angular momentum operators and their commutation relations; shift operators and their commutation relations; the effect of shift operators on an eigenvalue of the angular momentum; some theorems and problems. **Translational motion of a part** Free particle; particle in a box with infinite potential barrier; quantization and quantum numbers; symmetry of the wave functions; use of the box model; cubical box and degeneracy; quantum mechanical tunneling and problems.	25%
II	**Rotational motion of a particle**	25%

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	Particle on a sphere; normalization of the wave functions; rotation of a diatomic molecule and problems **Vibrational motion of a particle:** One dimensional harmonic oscillator; Hermite's differential equation; recursion formula for the Hermite's differential equation normalization and the characteristic of eigenfunctions of a harmonic oscillator; polynomials of different degree and problems. **The hydrogen like atoms:** The r-dependent part of the wave function; Laguerre and associated Laguerre polynomials; radial eigen function wave functions of hydrogen like atom	
III	**Organometallic chemistry-1** An introduction of organometallic compounds, Main group organometallic compounds, Applications of organometallic compounds, Electron count in complexes, Classification of Metal carbonyl, Synergistic effect, Factors affecting the Magnitude of stretching frequency, Nature of Lewis acid other than a Metal, Bonding modes of CO, Synthesis of Metal Carbonyls, Reactions and Synthetic applications of Carbonylate ions.	**25%**
IV	**Organometallic chemistry-2** Metal carbonyl Clusters, Electron Counting in carbonyls clusters, Binuclear Clusters containing M-M multiple bonds, Zintl ions, Reactions of Organometallic Compounds (Concerted reaction, Radical reactions, ionic mechanism, oxidative coupling, reductive elimination, Migatory insertion, β-H elimination).	**25%**

Reference Books/Audio-visual Course:

1	Introductory Quantum Chemistry, A. K. Chandra, Tata McGraw-Hill Publishing Company Ltd. 4th ed. (2004).
2	Quantum Chemistry, R. K. Prasad, New Age International Publishers, 4th ed. (2010).
3	Quantum Chemistry, N. Levine, Pearson India Pvt. Ltd., 7th ed. (2016).
4	Quantum Chemistry Through Problem and Solutions, R. K. Prasad, New Age International Publishers, 1st ed. (2006).
5	Introduction to Magnetochemistry, Alan Earshaw, Academic Press, Academic press, London and new york 1st ed. (2013).
6	Elements of Magnetochemistry, Dutta and Symal, East-West Press Pvt. Ltd. 2nd ed. (2004).
7	Bio-inorganic Chemistry an Introduction, J. A. Cowan, Wiley-VCH, 2nd ed. (1997).
8	Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler, Saunders College Publishing, 9th ed. (2013).
9	Metal ions in Biochemistry, P. K. Bhattacharya, Alpha Science International Ed. 1st Ed. (2005).
10	Organomettlic & Bioinorganic Chemistry, Ajai Kumar, Aaryush Education, 3rd edition (2018)

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11	❖ **Books for further Reading :-** Organotransition Metal Chemistry, John F. Hartwing, University Science Books, Sausalito, 1st ed. (2009).
12	An Introduction to Quantum Chemistry, M. Satake, Y. Mido, H. Yasuhisa, S. Taguchi, M. S. Sethi, S. A. Iqbal, Discovery Publishing House, 2nd print (2006).
13	Elements of Bioinorganic Chemistry, G. N. Mukerjee, Arabinda Das, U. N. Dhur & Sons Pvt. Ltd. 4th ed. (1993).
14	Bioinorganic Chemistry, G. R. Chatwal, A. K. Bhagi, Himalaya Publishing House, 1st ed. (2014).
15	Bioinorganic Chemistry, Bertini, H. B. Gray, S. J. Lippard, University Science Books, 1st ed. (1994).
16	Inorganic Chemistry, Shriver and Atkins Oxford Press, 5th ed. (2009).
17	Bio-inorganic Chemistry, R.W. Hay – R.W. Hay, Ellis Horwood Limited Publishers, 1st ed. (1990).
18	Bioinorganic Chemistry, Bertini, Gray, Lippard, & Valentine Viva books Pvt Ltd (2007).

Supplementary learning Material:	
1	https://nptel.ac.in/courses/104101124
2	https://onlinecourses.nptel.ac.in/noc20_cy27/preview
3	https://www.coursera.org/lecture/corrosion/types-of-corrosion-TXKrG
4	https://archive.nptel.ac.in/courses/104/101/104101116/

Pedagogy:

- To motivate students and deepen their understanding of chemistry, instructors need to plan thoughtful lessons in advance and establish clear learning goals. Allowing students to reflect on their knowledge complemented by effective questioning from the instructor helps them solidify concepts.
- Other effective lesson formats appropriate for some topics in chemistry include role playing, manipulation of concepts via simulations, and differentiated instruction. Cognitive science discourages "teaching as telling," therefore careful planning is necessary to avoid this pitfall. If a lecture format is decided to be the most effective way to teach a concept, allow students to preview the information and provide them in advance with organizers to maximize participation and promote student understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will able: To calculate of commutative property, commutation relations of operators and also explain translational, rotational and vibrational motion of electron.	**20**

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CO-2	To calculate the energy levels of electron in translational, rotational and vibrational motion in different dimension. To determine the wave function of electron in translational, rotational and vibrational motion in different dimension. To solve the Schrödinger equation for different model systems. 6 Solve the total wave functions of hydrogen like atom.	**20**
CO-3	To analyze the chemical and physical properties of metal ions responsible for their biochemical action as well as the techniques frequently used in bioinorganic chemistry such as oxygen transport, e-transfer, communication, catalysis, transport, storage etc.	**20**
CO-4	Based on physical chemical theory, the student shall be able to evaluate if corrosion can occur under specific operating conditions in a given equipment or construction. In cases where corrosion can occur, the student shall be able to determine the probable corrosion type, estimate the corrosion rate and propose the most reasonable protection method with regard to safety, price and environmental considerations. The student shall be able to propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions. In addition, the student shall be able to perform troubleshooting, and select corrosion monitoring methods.	**20**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	April 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

Programme: **Master of Science (Organic Chemistry)**

Semester: **II**

Course Code: **201330202**

Course Title: **Organic Chemistry-II**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) To understand the way of reaction and its mechanism for organic compounds.

b) From this subject, students are able to find the specific reagent for specific conversion and also go through the verity of possibility for the conversion of reactant to product.

Unit	Description in details	Weightage (%)
I	**Organic Name Reactions-I and their applications:** Robinson ring Annulation, Wittig reaction and its modifications; Peterson olefination, Shapiro reaction, Bamford Steven's Reaction, Julia Olefination, Vilsmayer-Heck Reaction, Mitsonobu Reaction	25%
II	**Organic Name Reactions-II and their applications:** Stork Enamine reaction, Buchwald–Hartwig amination, Sonogashira Coupling, Brown's Hydroboration reactions; Bayer Villiger Reaction, Prevost and Woodward Hydroxylation, Suzuki Reaction, Stobbe condensation.	25%
III	**Reagents in Organic Synthesis [Oxidation]** :$Cr0_3$, $Mn0_2$, $KMn0_4$, $Se0_2$, $Pb(OAc)_4$, OsO_4, HIO_4, DMSO, H_20_2, Ozone, HgO, NBS, $K_3Fe(CN)_6$, DDQ, $Al(O\text{-}t\text{-}Bu)_3$ Some Miscellaneous Reagents in Organic Synthesis : Dess- Martin reagent Trimethylsilylhalide, alkyl lithium, LDA.	25%
IV	**Reagents in Organic Synthesis [Reduction]** :$Al(O\text{-}iPr)_3$, Zn/HCl, N_2H_4/OH-, $NaBH_4$, $LiAIH_4$, Complex Hydrides, Na/NH_3, Cat.H_2 ,TBTH Some Miscellaneous Reagents in Organic Synthesis: Wilkinson catalyst, Grignard Reagent and Gilman reagent, PTC, DCC.	25%

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Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Organic Reactions, Stereochemistry and Mechanism: P.S. Kalsi (New Age.)
2	Principles of Organic Synthesis: R.O.C Norman & J.M. Coxon (ELBS)
3	Mechanism in Organic Chemistry: Peter Sykes (Orient Longman)
4	Modern Methods of Organic Synthesis: W. Carruthers (Cambridge)
5	Organic Reaction Mechanism: V.K.Ahluwalia and R.K.Parashar (Narosa)
6	Organic Chemistry: Clayden, Greeves and Warren (Oxford)

Supplementary learning Material:	
1	https://nptel.ac.in/courses/104103111
2	https://www.youtube.com/watch?v=rrQ-LzoGZT8

Pedagogy:

- For teaching the organic chemistry at little bit higher level, recognition of previous topics and their connection with current topic is must. Considering that teaching methodology flow is like brief background of particular topic and followed by in-depth knowledge of that particular topic is provided and then after variety of examples related to that topic is given for practice to get desired result.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	U	A	N	E	C	
20	20	20	10	10	20	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students are able to interpret the reaction mechanism and also correlate the formation of product for the different reactions.	25
CO-2	Students are able to interpret reaction mechanism varios novel Pd-catalyzed reaction which is the present requirement of the verity of industries.	25
CO-3	With the help of knowledge and application of oxidizing/reducing reagents, conversion of stating material to product can be predicted by the students. The students are able to decide how different reagents can be used for same starting material and give different/same products.	25

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CO-4	Students are able to understand the behavioral effect of different reagents and selectivity of important reagents. They can apply that in-depth knowledge of reaction mechanism of various name reactions and reagents in a synthetic route for synthesis of various organic molecules.	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **II**

Course Code: **201330203**

Course Title: **Topics in Physical Chemistry-II**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) To learn and understand: simple and complex chemical reaction, enzyme catalyzed reaction, photochemical reactions and mechanism. Collision between molecules – Oscillatory reaction.
b) Group theory and its chemical applications.
c) Rules for constructing the character tables. Concepts of symmetry in molecule: Point group.
d) To understand the molecular vibration of symmetrical molecule, Binding in water molecule, calculations on naphthalene.

Unit	Description in details	Weightage (%)
I	**Chemical Kinetics – II :** Complex reactions :- Opposing reactions, Consecutive reactions, Parallel reactions, Reactions in flow systems, Ionic reactions and salt effect, enzyme catalyzed reactions, kinetics of fast reactions.	**25 %**
II	**Chemical Dynamics :** Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, kinetic and thermodynamic control of reactions, treatment of uni-molecular reactions. Dynamic chain (pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogenbromine and hydrogen-chlorine reactions) and oscillatory reactions (Belousov-Zhabotinsky reaction).	**25 %**
III	**Group theory in Chemistry :** Concepts of symmetry in molecule:- Symmetry elements, symmetry operations, definitions and theorems in group theory, examples of groups, subgroups and classes, Molecular Point groups :- Identification and classification, notation of point groups, Matrix representation of symmetry operations, Types of	**25 %**

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	matrices, matrix notations for symmetry elements : E, Cn, i, s, Sn. Matrix representation of point groups : product and square rule, inverse rule, matrices for C_3v, C_4v etc., Construction of character tables :-rules, reducible and irreducible representations, character of a representation, properties of a irreducible representations, orthogonality theorem, character tables for C_2v, C_3v, C_4v, D_nh, uses of character tables.	
IV	**Chemical Applications of Group Theory :** Molecular vibrations, molecular vibration of symmetrical AB_2 (bent) molecule, symmetry of normal modes of ethylene, tetrahedral hybridization, Hybridization in Boron Trifluoride (trigonal planar geometry), Binding in water molecule, calculations on naphthalene. Electronic spectra of carbonyl chromophore.	**25 %**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Elements of Physical Chemistry, Peter Atkins, Julio De Paula, David Smith,(Oxford University Press, 6th Edition)
2	Chemical Kinetics, K. J. Laidler, (McGrraw Hill Publication)
3	Chemical Applications of Group Theory, F. A. Cotton, (Wiley Eastern Ltd., Third Edition)
4	Group Theory and Its Chemical Applications, P. K. Bhattacharya (Himalya Publishing House, Mumbai, Second Revised Edition).
5	Group theory in Chemistry, M. S. Gopinathan, V. Ramakrishnan (Vishal Publishing Co. Second Edition)
6	Symmetry and Spectroscopy of Molecules, K. Veera Reddy (New Age International Publishers, Second revised Edition)
7	Symmetry and Group Theory For Chemists, N. N. Das, (Asian Books Private Limited, New Delhi, First Edition)
8	Physical Chemistry, Ira N Levine (Tata McGraw-Hill Publishing Company, New Delhi, Fifth Edition).
9	Physical Chemistry, Alberty and Stilby, (John Wiley & Sons, New York)

Supplementary learning Material:	
1	https://www.youtube.com/watch?v=VC-8TK6WUP0 https://www.youtube.com/watch?v=Irk0gZvnl4A https://www.youtube.com/watch?v=QdEaq8BXiBs https://www.youtube.com/watch?v=qxvJ6nVMvnw

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2	https://www.youtube.com/watch?v=lyzNVb-uyjc https://www.youtube.com/watch?v=LL3kVtc-4vY https://www.youtube.com/watch?v=dMF4RjiITGM
3	https://www.youtube.com/watch?v=WukUvN721Ag https://www.youtube.com/watch?v=WukUvN721Ag&t=394s https://www.youtube.com/watch?v=kgLYwxhceKM&list=PLYXnZUqtB3K8NdZkT4nzff6XC5cvY89Qv
4	https://www.youtube.com/watch?v=zXfCCupCXWg https://www.youtube.com/watch?v=CE4w6nbc5Ko https://www.youtube.com/watch?v=Av9f25sqLG0&list=PLj_Alq7xw30knZPTpa9whzqiSn_RZHGWP

Pedagogy:

- For student – teacher learning pedagogy: Currently, we are engaging with the five major approaches, which are constructivist, collaborative, integrative, reflective and inquiry based learning. In this learning process students can achieved their goal by improving results, understanding.
- For better understanding of theory in classroom, we have some models, from which theoretical fundaments can be easily cleared.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To gain the knowledge of steady state approximation michaelis- menten mechanism, lindemann-hinshelwood mechanism, chain reaction, Rate determining stapes and consecutive elementary reactions. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.	**25**
CO-2	To gain the knowledge regarding methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, kinetic and thermodynamic control of reactions, treatment of uni-molecular reactions.	**25**
CO-3	To learn concept of group theory to predict the shape of molecules, various transformation matrix, various class of symmetry including character tables. To learn rules for constructing the character table	**25**
CO-4	To learn concept of symmetry elements in molecules and application of group theory	**25**

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Next Review on (Month-Year):	March 2025

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **II**

Course Code: **201330204**

Course Title: **Lab Synthesis-II (201330201, 201330202 and 201330203)**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to...

a) Develop advanced laboratory skills used in inorganic synthesis including analytical techniques for identification and characterization of inorganic molecules.

b) With help of synthesis approach students can learn regarding the planning and synthesis of new compounds and optimization of reaction conditions.

c) To learn about kinetics based practicals, including transition temperature, distribution coefficient, steam distillation, rate of acid catalyst, critical micelle concentration determination of soap solution etc.

INORGANIC CHEMISTRY **(Weightage 33.33%)**

Total Credit : 4

❖ **(Inorganic-I)-Quantitative Analysis:**

1. Direct Titration (Cu^{+2}, Ni^{+2}, Ca^{+2}, Mg^{+2} and Fe^{+3})
2. Indirect Titration of Calcium
3. By Back Titration and Replacement titration
4. Determination of composition of complex and interference study.
5. Water Analysis

ORGANIC CHEMISTRY **(Weightage 33.33%)**

Total Credit : 4

❖ **List of Synthesis**

1. p-Bromoaniline from Acetanilide [Protection, Bromination and Deprotection]
2. p-nitroaniline from Acetanilide [Protection, Nitration and Deprotection]
3. p-nitrobromobenzene from bromobenzene
4. Picric acid from phenol
5. 2,4,6-tribromophenol/ 2,4,6-tribromoaniline [Bromination]
6. Methylorange from sulphanilic acid
7. 2,5-Dimethylbenzenesulfonic acid [Sulphonation]
8. Terphthalic acid from p-xylene [Oxidation]

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9. m-nitroaniline from nitrobenzene [nitration and partial Reduction]
10. TLC for separation and Rf value determination of components in a mixture

PHYSICAL CHEMISTRY **(Weightage 33.33%)**
Total Credit : 4

(Physical –I)

Sr. No. Description in detail

1. To determine the transition temperature of Glauber's salt by solubility method.
2. Determination of distribution coefficient of ammonia between chloroform and water.
3. Determine the surface tension of liquids (methyl acetate, ethyl acetate, chloroform, hexane.) and hence calculate the atomic parachloro of C, H &CI.
4. Determine the molecular weight of the given liquid by Steam distillation.
5. To determine the rate of acid-catalyst iodination of acetone in presence of Excess acid & acetone at room-temperature.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Advanced Practical Inorganic Chemistry – Gurdeep Raj Goel Publishing House, Meerut.
2	QualitativeInorganic Analysis. – A. I. Vogel, 6th Edition revised by G. Svehla ELBS London
3	Textbook of Chemistry Analysis – A. I. Vogel
4	Qualitative Chemistry semi micro analysis – edited by P. K. Agasyan CBS Publisher- Delhi.
5	Water Quality-An Introduction,Second edition ISBN: 978-3-319-17445-7 (Print) 978-3-319-17446-4 (Online) Authors: Claude E. Boyd
6	Inorganic Qualitative Analysis in the Laboratory, Clyde Metz, Elsevier,2012, ISBN : 978032316104
7	Elementary Practical Organic Chemistry (part-1 to 3) By A. I. Vogel (CBS publication)
8	Experimental Physical Chemistry by R. C. Das & B. Behera, (Tata McGraw hill Publishing Company Ltd., New Delhi)
9	A Laboratory Manual of Experiments in Physical Chemistry by D. Brennan and C. F. H. Tipper,(McGraw hill Publishing Company Ltd., London)
10	Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T. K. Chondhekar, (Anjali Publication, Aurangabad)
11	Advanced Practical Physical Chemistry by J. B. Yadav, (Goel Publishing House, Meerut)
12	Experimental Physical Chemistry by G. Peter Matthews, (Clarendon Press, Oxford, London)
13	Experimental Physical Chemistry by V. D. Athawale and ParulMathur, (New Age International Publishers, New Delhi)
14	Advanced Physical Chemistry Experiments by Gurtu and Gurtu, (Pragati Prakashan, Meerut)
15	Advanced Physico-Chemical Experiments by J. Rose, (Sir Isaac Pitman & Sons Ltd., London)
16	Experiments in Physical Chemistry by D. P. Shoemaker, C. W. Garland and J. W. Nibler, (McGrawHill International Edition, London).

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Supplementary learning Material:	
1	https://nptel.ac.in/courses/104106121
2	https://www.youtube.com/watch?v=w5VDZI09Z00

Pedagogy:

- Practical can be best taught by the demonstration method to explain and teach them in correct way which decreases the chance of accident and increase the changes of correct way of learning. Sometimes help of certain videos are also taken to explain how the experiments performed at the industry with help of laboratory facilities.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: to learn how to find % of purity of inorganic metal by different type of titration	**33.33**
CO-2	To communicate scientific information in a clear and concise manner both orally and in writing. Have developed their critical reasoning, judgment and communication skills. Students can improve the skill of doing any reaction which they learnt in their theory class so that the understanding becomes crystal clear.	**33.33**
CO-3	To learn and understand the rate of acid-catalyst iodination of acetone in presence of Excess acid & acetone at room-temperature. To learn and perform titration methods using indicator To learn distillation method using immiscible water-organic liquids separation and also learn about the molecular weight determination of the given liquid by steam distillation. Learn to preparation of various concentration surfactants solutions and using different concentration can determine the critical micelles concentration (CMC) using stalagmo meter To learn about determination of distribution coefficient of ammonia between chloroform and water. To determine the transition temperature of Glauber's salt by solubility method.	**33.33**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **II**

Course Code: **201330205**

Course Title: **Lab Analysis-II (201330201, 201330202 and 201330203)**

Course Group: **Core**

Course Objectives:
The objectives of this course are to enable students to...

a) Develop advanced laboratory skills used in inorganic synthesis including analytical techniques for identification and characterization of inorganic molecules.
b) With the help of this type of subject student may increase their interest in the field of organic chemistry and identify different methods of analyzing verity of organic compounds with different function group.
c) To learn about instrumental based practicals including conductometry, speactrophotometry, polarimetry, refractometry, potentiometry.

INORGANIC CHEMISTRY **(Weightage 33.33%)**
Total Credit : 4

- **(Inorganic-II)-Qualitative Analysis (6 + 1 Radicals)**

6– Cation Anion variable
1 – Rare earth element form the following:
Th, Ce, Li, Mo, Se, Te, V, Ti and Zr etc.

ORGANIC CHEMISTRY **(Weightage 33.33%)**
Total Credit : 4

- **Estimation**

1. Estimation of Aniline.
2. Polyhydric alcohol estimation.
3. Percentage halogen estimation by modified Stepanow's method
4. Estimation of aldehydes/ketones.
5. Sugar estimation [Reducing and Non-reducing].

PHYSICAL CHEMISTRY **(Weightage 33.33%)**
Total Credit : 4

Sr. No.	Description in detail
1.	To determine the molecular composition of ferric – salicylate complex by Job's

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method (Spectrophotometer).

2. To determine the rate of the saponification of ethyl acetate at different temperature conductometrically and calculate the energy of activation of the reaction (Conductometer).
3. (a) To determine the transport numbers of Ag^+ and NO_3^- ions in silver Nitrate solution potentiometrycally.
   (b) Determination of concentration/ amounts of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate (Potentiometer)
4. To verify the law of refraction for given mixture of glycol + water system. (Refractometer)
5. To find the rate constant of acid – catalyzed hydrolysis of sucrose. (Polari meter)

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Advanced Practical Inorganic Chemistry – Gurdeep Raj Goel Publishing House, Meerut.
2	QualitativeInorganic Analysis. – A. I. Vogel, 6th Edition revised by G. Svehla ELBS London
3	Textbook of Chemistry Analysis – A. I. Vogel
4	Qualitative Chemistry semi micro analysis – edited by P. K. Agasyan CBS Publisher- Delhi.
5	Water Quality-An Introduction,Second edition ISBN: 978-3-319-17445-7 (Print) 978-3-319-17446-4 (Online) Authors: Claude E. Boyd
6	Inorganic Qualitative Analysis in the Laboratory, Clyde Metz, Elsevier,2012, ISBN : 978032316104
7	Elementary Practical Organic Chemistry (part-1 to 3) By A. I. Vogel (CBS publication)
8	Experimental Physical Chemistry by R. C. Das & B. Behera, (Tata McGraw hill Publishing Company Ltd., New Delhi)
9	A Laboratory Manual of Experiments in Physical Chemistry by D. Brennan and C. F. H. Tipper,(McGraw hill Publishing Company Ltd., London)
10	Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T. K. Chondhekar, (Anjali Publication, Aurangabad)
11	Advanced Practical Physical Chemistry by J. B. Yadav, (Goel Publishing House, Meerut)

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12	Experimental Physical Chemistry by G. Peter Matthews, (Clarendon Press, Oxford, London)
13	Experimental Physical Chemistry by V. D. Athawale and ParulMathur, (New Age International Publishers, New Delhi)
14	Advanced Physical Chemistry Experiments by Gurtu and Gurtu, (Pragati Prakashan, Meerut)
15	Advanced Physico-Chemical Experiments by J. Rose, (Sir Isaac Pitman & Sons Ltd., London)
16	Experiments in Physical Chemistry by D. P. Shoemaker, C. W. Garland and J. W. Nibler, (McGrawHill International Edition, London).

Supplementary learning Material:	
1	https://nptel.ac.in/courses/104106121
2	https://www.youtube.com/watch?v=4UH9ciVrCes
3	https://www.youtube.com/watch?v=MT2L0sDUCD0 https://www.youtube.com/results?search_query=ph+metry+experiment https://www.youtube.com/watch?v=hgnICndJu6w&t=246s

Pedagogy:

- For analyzing different organic compounds with verity of functional groups, basic theoretical knowledge is explained as it is mandatory for better understanding of the methods for identifying the quantity and % purity of the given unknown samples. The detailed mechanism of the particular reaction is also explained using chalk and duster method for better understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	After completion of this course, the students will be able: To separate and identify of six component inorganic radicals and one rare earth element, as well as semi-micro analysis of inorganic radicals. After studying this course student will be able to learn separation and identification of inorganic radicals from ore.	**33.33**
CO-2	To understand the methods used for estimations of various organic compounds quantitatively Accuracy, observation power and confidence of the student increases.	**33.33**

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CO-3	To learn and perform experiment on ferric – salicylate complex on Spectrophotometer. Determination of absorption and maximum wavelength. To learn how to determine the rate of the saponification of ethyl/methyl acetate at different temperature conductometrically. Calculate the energy of activation of the reaction using Conductometer. To determine the transport numbers of Ag^+ and NO_3 ions in silver nitrate solution potentiometrycally. Determination of concentration/ amounts of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate using Potentiometer. Students can learn and perform experiment on refractometer using glycol + water system. To verify the law of refraction for given mixture. To learn and gain the knowledge of determination of rate constant of acid – catalyzed hydrolysis of sucrose using Polari meter.	**33.33**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **II**

Course Code: **201330206**

Course Title: **Comprehensive Viva – Voce**

Course Group: **Core**

Course Objectives:

The objectives of this course are to enable students to…

a) Actually, this is not a theory or practical subject; this is just a viva-voce of compilation of all theory subjects including inorganic chemistry, organic chemistry, physical chemistry and polymer chemistry.

b) The main objective of this subject is to improve knowledge of chemistry (All four theory subjects), this might be useful to face interview after M.Sc. To improve communication skill of students.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	-	1	-	50/20	-	-	50/20

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**The syllabus for this subject is already covered in all four theory subjects.**	-

Pedagogy:

For student – teacher learning pedagogy: Currently, we are engaging with the five major approaches, which are constructivist, collaborative, integrative, reflective and inquiry based learning. In this learning process students can achieved their goal by improving results and understanding.

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**30**	**10**	**10**	**15**	**15**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Viva voce examination is as important as the written mode of examination. Using this method, it is easy to test the flexibility and potential of the students for their higher order cognitive skills. It also provides direct contact with the students to assess their way of communication, presentation skills and in-depth knowledge of various theory subjects. It helps students to improve their own perception for their future career endeavour.	**100**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **II**

Course Code: **201330207**

Course Title: **Introduction to Biochemistry**

Course Group: **Elective**

Course Objectives:

The objectives of this course are to enable students to…

a) This subject is a blend of organic chemistry and biology. Due to such combination, the main objective of this subject is to apply the knowledge of chemistry to the biological molecules and do their detailed study.

b) The course is also deals with details study of certain natural products with their mode of action.

Unit	Description in details	Weightage (%)
I	**Vitamins:** Classification, introduction, chemistry, absorption, transport, mobilization and biochemical functions of Vitamins: A, D, E, K ,C, B1, B2, B6, B12, H ,CoA, Follic acid, Niacin **Lipids:** Nomenclature, Structure and physical properties of some naturally occurring fatty acids, triacelglycerol and waxes as sources of stored energy , insulation and water repellents, Types of membrane lipids , Introduction to glycerophospho lipids, galacto lipids, sphingo lipids , phospho lipids and sterols.	**25 %**
II	**Proteins:** Properties, Classification and Conventions of common amino acids, stereoisomerism in –amino acids, Peptides: Formation, Merrifield Synthesis, compositions and Sizes, protein Separation, Purification and Characterization ; Sequencing of Peptides: Sanger's method, Edman degradation, outline of other methods; Protein Sequences and Evolution; Oxygen binding Proteins –Hemoglobin and Myoglobin in oxygen transport and storage.	**25 %**

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III	**Carbohydrates:** Classification and stereochemistry, Biologically important hexose derivatives, Nomenclatre for disaccharides, structure and role of some Homo and Hetero Polysaccharides, Glycoconjugates : Proteoglycans, Glycoproteins and Glycolipids, Introduction to Glycobiology (The sugar code) Water: Interaction among biomolecules in aqueous systems, Buffering against pH changes in biological systems, participation of water in biological reactions	**25 %**
IV	**Enzymes:** Classification Nomenclature & extraction factors affections, catalytic activity and specificity in action, regulation of enzyme activity, enzyme inhibition, Illustrative enzymatic reactions using Chymotrypsin , Hexokinase , enolase and Lysozyme Nucleic acids: Components of nucleic acids, Nomenclature of nucleotides, structure of DNA – Chargaff's Rule of DNA Composition, Watson and Crick Model, structure and types of RNA.	**25 %**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Reference Books/Audio-visual Course:

1	Lehninger Principles of Biochemisrty, David L. Nelson and Michael M. Cox [Palgrave MacMillan / W.H.Freeman & company, New York]
2	Principles of Biochemisrtry, Donald J. Voet , Judith G. Voet , Charlotte W. Pratt [John Wiley & Sons
3	Biochemistery, U. Satyanarayana, Books & Allied (p) Ltd. , Kolkata(India)
4	Skoog, Holler, Niemon, "Principles of instrumental analysis" 5th edition, Saunder college publisher.
5	Robert D. Braun "Introduction to chemical analysis" McGraw-HILL International Edition.
6	Robert D. Braun "Introduction to instrumental analysis" McGraw-HILL International Edition. Gary D. Christian. "Analytical chemistry" 6th edition John Wiley & sons, Inc. 2004
7	Judith F. Rubinson, Kenneth A. Rubinson, "Contemporary Chemical analysis" Ist edition, Prentice-Hall International Inc., 1998.
8	B. K. Sharma. "Instrumental method of chemical analysis" 29th edition, GOEL Publishing house Meerut. 2011.
9	R. A. Day, Jr , A. L. Underwood., "Quantitative analysis" 6th edition, Prentice –Hall of India Private Limited, New Delhi. 2006.

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10	David Harvey. "Modern analytical chemistry" McGraw-HILL International Edition. 2000 chemistry series.
11	L. Huber, "Validation and qualification in analytical laboratories" 2nd Edition, 2007.
12	B. Sivasankar, “Instrumental Methods of Analysis” Oxford University Press, 2012.

Supplementary learning Material:	
1	https://nptel.ac.in/courses/104102016
2	https://nptel.ac.in/courses/104105076

Pedagogy:

- To teach the blend subject, a vast background of organic chemistry as well as biology is given to the students. Also during the teaching of individual topic depending upon the requirement certain video clips are shown for the depth understanding of the subject.

Suggested Specification table with Marks (Theory) (Revised Bloom’s Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To learn about the introduction, classification, absorption, transport, mobilization and biochemical functions of Vitamins. To familiarize the biological functions of lipids.	**25**
CO-2	To know the properties, Classification and Conventions of common amino acids, stereoisomerism in amino acids.	**25**
CO-3	To understand the classification and stereochemistry of biologically important hexose derivatives, nomenclature for disaccharides, structure and role of polysaccharides.	**25**
CO-4	To learn about classification, nomenclature & extraction factors affections, catalytic activity and specificity in action, regulation of enzyme activity.	**25**

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Next Review on (Month-Year):	March 2025

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **II**

Course Code: **201330208**

Course Title: **Analytical Chemistry**

Course Group: **Elective**

Course Objectives:

The objectives of this course are to enable students to…

a) To understand the fundamental of analytical chemistry.
b) To understand the classification analytical techniques and its importance.
c) To learn quality management system, good laboratory practices, classification of errors, minimization of errors, assessment of analytical data and statistical analysis.
d) To understand fundamentals of spectroscopy and components of optical instruments.
e) To understand the chromatography techniques, its importance, working principle, applications advantages and disadvantages.
f) To learn about various separation methods.

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Unit-1	Description in details	Weightage (%)
I	Fundamental of Analytical Chemistry: Definitions, classification of analytical techniques and importance, Classical and Instrumental methods, Factors affecting choice of analytical methods. Verification and validation in chemical analysis: Introduction, Fundamental definitions. Categories of validation. Quality Management System, Good laboratory practices.	25 %
II	Assessment of Analytical Data and Numerical Chemistry: SI units, calibrations in laboratory practice and numerical. Measures of central tendency, validation parameters: Accuracy, precision, mean andstandard deviation, calibration, classification of errors, minimization of errors, significant figures and computation, Q-test (Student t-test), tests for rejection of outlying data. numerical of statastical analysis	25 %
III	Fundamentals of spectroscopy and Components of optical instruments: Brief introduction to spectroscopy, Classification of spectroscopic techniques, Electromagnetic Radiation (EMR) and Interaction of EMR with Matters. Spectrometers and their components: Sources of radiations, wave length selectors, sample holders, detectors and signal processors and display units.	25 %
IV	Separation Methods : Introduction & classification of various separation methods. Chromatography techniques: General introduction, Principles and classification of chromatography according to types of chromatographic bed, physical state of mobile phase, mechanism of separation. Paper chromatography & Thin layer chromatography: Principle, types, choice of paper and solvent, location of spot and measurement of R_f Values. Gas Chromatography: Principle, Introduction, instrumentation.	25 %

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Reference Books/Audio-visual Course:

1	Skoog, Holler, Niemon, "Principles of instrumental analysis" 5th edition, Saunders college publisher.
2	Robert D. Braun "Introduction to chemical analysis" McGraw-HILL International Edition.
3	Robert D. Braun "Introduction to instrumental analysis" McGraw-HILL International Edition.
4	Gary D. Christian. "Analytical chemistry" 6th edition John Wiley & sons, Inc. 2004
5	Judith F. Rubinson, Kenneth A. Rubinson, "Contemporary Chemical analysis" Ist edition, Prentice-Hall International Inc., 1998.
6	B. K. Sharma. "Instrumental method of chemical analysis" 29th edition, GOEL Publishing house Meerut. 2011.
7	R. A. Day, Jr , A. L. Underwood., "Quantitative analysis" 6th edition, Prentice –Hall of India Private Limited, New Delhi. 2006.
8	David Harvey. "Modern analytical chemistry" McGraw-HILL International Edition. 2000 chemistry series.
9	L. Huber, "Validation and qualification in analytical laboratories" 2nd Edition, 2007.
10	B. Sivasankar, "Instrumental Methods of Analysis" Oxford University Press, 2012.

Supplementary learning Material:	
1	http://ndl.iitkgp.ac.in/document/MDl5cHdNUUlnd0lnZHNoQXlvOG5lTUY5emtpWkdqSkpEdkJjbEZMcWd4az0
2	http://ndl.iitkgp.ac.in/document/UDVkUys0K0NhdkVMb0Y2bE9VVHcxQT09

Pedagogy:

- For student – teacher learning pedagogy: Currently, we are engaging with the five major approaches, which are constructivist, collaborative, integrative, reflective and inquiry based learning. In this learning process students can achieved their goal by improving results, understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**20**	**20**	**10**	**10**	**20**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To know the principles of fundamentals of analytical chemistry. To know the methods of thermo-gravimetric analysis. To understand good laboratory practices and safety, Validation and verification process. To learn sampling and preparation of samples	**25**
CO-2	To calculate mean, median, mode and standard deviation calculation, Q-test, various errors as an analytical tool. To solve mean and standard deviation problems and to understand the accuracy and precision and classification error	**25**

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CO-3	To understand the principles of Spectro-photometric analysis and properties of electromagnetic radiations and knowledge of detectors. Students can also learn about wave length, wave number, frequency calculations etc.	**25**
CO-4	To get an extended knowledge about chromatographic techniques. To study principle, construction and working of GC and HPLC. To study about the instrumentation, sample injection system, columns used in HPLC and GC and choice of mobile phase To understand different types of separation techniques like distillation, solvent extraction, crystallization, and other separation techniques	**25**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	April 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: **201330301**

Course Title: **Organic Spectroscopy**

Course Group: **Core Subject**

Course Objectives:

The objectives of this course are…

a) Create good understanding of the various spectroscopy characterization techniques
b) Determine the structure of organic compounds utilizing the spectroscopic techniques
c) An important part of modern-day research and development
d) This course is focusing on the theory and applications in determining the structure of the organic molecule

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

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Detailed Syllabus:

Sr.	Contents	Hours
1	**UV Spectroscopy:** Theory and principles of electronic transition and UV absorption; chromophores and auxochromes; Woodward-Fieser rules for dienes and enones; characteristic absorptions in alkenes and alkynes, alcohols, ethers, amines, carbonyl compounds, Characteristic absorptions in aromatic compounds; Factors influencing λ_{max}, effects of conjugation, effect of solvent; Differentiation of compounds/ isomers by UV **Infrared Spectroscopy:** Theory and principles; molecular vibrations; calculations of vibrational frequencies; Factors influencing IR frequency; characteristic group absorptions in hydrocarbons, aromatic compounds, alcohol and phenols, ethers, carbonyl compounds, amines, nitriles, nitro compounds, carboxylic acids and halide, Differentiation of compounds/isomers by IR	**15**
2	**PMR Spectroscopy:** Proton resonance condition, Various aspects of PMR spectra (1) Number of signals, (2) Position of signals: chemical shifts, shielding and deshielding, (3) Splitting of the signals (spin-spin coupling), coupling constants – vicinal, geminal, long range and virtual couplings, (4) Intensity of signal (Peak area or integration); factors affecting chemical shifts, paramagnetic and diamagnetic anisotropy; Pople notation and spin assignments; chemical shift equivalence and magnetic equivalence; first order and second order spectra, complex PMR spectra; simplification of the complex PMR spectra- (1) Increasing field strength (high resolution spectra), (2) Use of shift reagents, (3) Spin-spin decoupling (Double resonance), (4) Proton exchange, (5) Deuterium exchange, (6) Nuclear Overhauser Effect (NOE); Differentiation of compounds/ isomers by PMR; To identify structure from PMR data	**15**
3	**^{13}C-NMR Spectroscopy:** Difficulties and solution for recording ^{13}C-NMR spectra; recording of ^{13}C-NMR spectra – scale, solvents, solvent signals and their positions, multiplicity, ^{13}C-^{1}H coupling constant; proton coupled and decoupled ^{13}C spectra, broad band decoupling, off resonance technique; Chemical shifts in ^{13}C spectra – chemical shift calculation for alkanes, alkenes and alkynes, chemical shift calculation in internal and terminal substituted compounds, aromatic compounds; To identify structure from ^{13}C NMR data; Use of ^{13}C spectra in differentiating compounds/isomers; ^{13}C-DEPT Spectra – Differentiation in Primary, Secondary and Tertiary Carbons by DEPT–45°, DEPT–90°, DEPT–135° spectra; 2D NMR Spectroscopy: Theory and Principles Of 2D NMR Spectroscopy (COSY); To interpret or to draw HOMCOR (^{1}H-^{1}H COSY, DQF-COSY, INADEQUATE),HETCOR (^{13}C-^{1}H COSY, ^{1}H-^{13}C COSY i.e. HMQC, HMBC), NOESY and TOCSY spectra. Introduction to NMR of nuclei other than proton and carbon.	**15**

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4	**Mass Spectroscopy:** Theory and principles of mass spectroscopy; Instrumentation; low and high resolution mass spectra; Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD), Fast Atom Bombardment (FAB), Electronspray Ionization (ESI) and Matrix Assisted Laser Desorption/Ionization (MALDI); Determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak; Fragmentations – rules governing the fragmentations, McLafferty rearrangement; Interpretation of mass spectra of different class of compounds – saturated and unsaturated hydrocarbons, aromatic hydrocarbons, alcohols, ethers, ketones, aldehydes, carboxylic acids, amines, amides, compounds containing halogens; To write possible fragmentation for given compound; To identify structure from mass spectral data; To identify structure from combined spectral data.	**15**

Reference Books/Audio-visual Course:

1	Spectroscopic Identification of Organic Compounds, R. M. Silverstein and F. X. Webster, 6th edition (John Wiley & Sons)
2	Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman and G. S. Kriz, 3rd edition (Thomson Brooks/Cole)
3	Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, 4th edition (Mcgraw – Hill Book Company)
4	Organic Spectroscopy, William Kemp, 3rd edition (Palgrave)
5	Organic Spectroscopy – Principles and Applications, Jag Mohan, 2nd edition (Narosa Publishing House)
	Spectroscopy of Organic Compounds, P. S. Kalsi, 5th edition (New Age International Publishers)
	Elementary Organic Spectroscopy: Principles and Chemical applications (revised edition), Y. R. Sharma (S. Chand Publishing)

Supplementary learning Material:	
1	https://ndl.iitkgp.ac.in/homestudy/science/ chemistry & biochemistry/chemistry video lecctrures:CEC, IR Spectroscopy-I & II
2	https://ndl.iitkgp.ac.in/homestudy/science/ chemistry & biochemistry/chemistry video lecctrures:CEC, Mass Spectroscopy
3	https://ndl.iitkgp.ac.in/homestudy/science/ chemistry & biochemistry/chemistry video lecctrures:CEC, NMR Spectroscopy-I
4	https://www.coursera.org/lecture/spectroscopy/what-is-spectroscopy-rcgq6
5	https://www.coursera.org/lecture/experimental-methods/lecture-1-basics-of-mass-spectrometry-1-jUxqK
6	https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu

Pedagogy:

- To motivate students and deepen their understanding of chemistry, instructors need to plan thoughtful lessons in advance and establish clear learning goals.
- Allowing students to reflect on their knowledge complemented by effective questioning from the instructor helps them solidify concepts.

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- Other effective lesson formats are appropriate for some topics in chemistry include role playing, manipulation of concepts via simulations and differentiated instruction.
- Cognitive science discourages "teaching as telling," therefore careful planning is necessary to avoid this pitfall. If a lecture format is decided to be the most effective way to teach a concept, allow students to preview the information and provide them in advance with organizers to maximize participation and promote student understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
5	**50**	**30**	**10**	**3**	**2**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To explain basic principles of UV-Visible spectroscopy and IR spectroscopy. To interpret IR and UV spectra,	**25**
CO-2	To know how nuclear spins are affected by a magnetic field, and be able to explain what happens when radiofrequency radiation is absorbed. To predict the number of proton and carbon NMR signals expected for the given organic compound. To predict the splitting pattern in the proton NMR spectrum of a given organic compound. With the aid of a chart of chemical shifts from ^{1}H and ^{13}C NMR, be able to assign peaks in an NMR spectrum to specific protons in a compound. To interpret integration of NMR spectra. To use NMR spectra to determine the structures of compounds, given other information such as a molecular formula. To calculate coupling constants from ^{1}H NMR spectra, and utilize the coupling constants for determining compound structure. To determine the compound structure based on information generated from mass spectrometry, IR, NMR, and elemental analysis.	**25**
CO-3	To determine the number of distinct carbon atoms in a molecule. To use the chemical shifts table to determine functional groups present in a molecule. To assign a chemical shift to each carbon in a given molecule.	**25**

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CO-4	To understand how the most common mass analyzers work: quadrupole (QMS), triple quadrupole (TQMS), cylindrical and linear ion trap (CIT-MS, LIT-MS), Fourier transform ion cyclotron resonance (FT-ICR-MS), Orbitrap-MS, time-of-flight (TOF-MS), and magnetic sector MS analyzers. To know the principles of the main ionization methods that are currently in use: electron ionization (EI), chemical ionization (CI), Penning ionization (PeI), electron capture negative ionization (ECNI), photoionization (PI), matrix-assisted laser desorption ionization (MALDI), fast atom bombardment (FAB), and electrospray ionization (ESI). To understand and describe the chemical-analytical performance of a mass spectrometer (mass resolution, mass accuracy, sensitivity, limit of detection, etc.) To interpret mass spectra (mostly ESI-generated) and know the basic principles of ion fragmentation.	**25**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	April2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: **201330302**

Course Title: **Disconnection Approach**

Course Group: **Core Subject**

Course Objectives:

The objectives of this course are….

a) To learn retrosynthetic approach towards organic synthesis
b) To learn various organic reactions and reagents used in them as tools applied in the art of organic synthesis
c) To know the importance of retrosynthesis in designing the synthesis of organic compounds
d) To identify and analyze the fundamentals of bond disconnections and evaluate synthetic routes to target molecules

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction and definition of disconnection, various terminology used in disconnection. One and two group disconnection, disconnection and synthesis of alcohols, olefins, simple ketones, acids and its derivatives, disconnections in 1,3-dioxygenated skeletons, preparation of β-hydroxy carbonyl compounds, α,β-unsaturated carbonyl compounds, 1,3-dicarbonyls, 1,5-dicarbonyls and use of Mannich reaction	15
2	**Illogical Two group disconnection:** Disconnection and synthesis of α-hydroxy carbonyl compounds, 1,2-diols, 1,4- and 1,6- dicarbonyl compounds. Disconnections based on Diels-Alder reaction and its use in organic synthesis. Functional group analysis: Strategy of saturated hydrocarbon synthesis, functional group addition to intermediates.	15
3	Disconnection and synthesis of acyclic and cyclic hetero compounds: Synthesis of ethers, amines, nitrogen, oxygen and sulphur containing five and six membered heterocycles. Synthesis of small ring compounds: Special method for small rings preparations, synthesis of 3 and 4 membered ring compounds. Use of ketenes in organic synthesis, Radical reactions in organic synthesis.	15
4	Protecting groups: Protection of organic functional groups, protecting reagents and removal of protecting groups. Protection of amine: Via N-benzylamine formation, amide formation, carbamate formation. Protection of alcohol: Via alkyl ether formation, benzyl ether formation, trityl ether formation, silyl ether formation, acetal formation, methoxyl methyl ether formation, ester formation. Protection of 1,2- and 1,3-diols, Protection of acid via ester formation, Protection of aldehyde via acetal formation, Protection of ketone via ketal formation. Fragmentation Reactions: Grob fragmentation: Polarization of C-C bond, fragmentation controlled by stereochemistry, ring expansion by fragmentation. Eschenmoser Fragmentation: Controlling double bond using fragmentation. Synthesis of some complex molecules: Synthesis of Mesoporhyrin – IX and Cephalosporin C. Synthesis of Nootkatone via Fragmentation of three membered, four membered and six membered ring.	15

Reference Books/Audio-visual Course:

1	Designing Organic Synthesis – A Programmed Introduction to the Synthon Approach, Stuart Warren, John Wiley & Sons (1994).
2	Organic Synthesis: The disconnection approach, Stuart Warren, John Wiley & Sons (1994).

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3	Selected Organic Synthesis, Ian Fleming, John Wiley & Sons (1977).
4	Organic Chemistry, 2nd edition by Jonathan Clayden, Nick Greeves & Stuart Warren, Oxford University Press.
5	Modern Methods of Organic Synthesis, 4th edition by W. Carruthers & Iain Coldham, Cambridge University Press.
6	Modern Organic Synthesis: An introduction by George S. Zweifel & Michael H. Nantz, W. H. Freeman & Company.
7	Greene's Protective Groups in Organic Synthesis, 4th edition, by P. G. M. Wuts and T. W. Greene, Willey Interscience.

Supplementary learning Material:	
1	**https://swayam.gov.in/**
2	**https://www.youtube.com/watch?v=cKTwIwVGbzY**

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
30	**40**	**15**	**5**	**5**	**5**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To explore synthesis of organic compounds through different disconnections via following useful guidelines, use of functional groups, name reactions and easily available starting materials.	**25**
CO-2	To understand the disconnections of molecules having two functional groups and FGA approach	**25**
CO-3	To learn the rules that need to be applied and the various reactions already known that can be effectively used for designing synthesis.	**25**
CO-4	To understand about protection-deprotection protocols and strategies in synthesis. The course will involve extensive problem solving which will help students develop confidence in their ability to design organic synthesis.	**25**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	April-2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: **201330303**

Course Title: **Heterocyclic Chemistry**

Course Group: **Core Subject**

Course Objectives:

The objectives of this course are….

a) provide a concise introduction to heterocyclic chemistry

b) Emphasis will be given on the most important heterocyclic systems particularly five and six-membered heterocyclic systems as well as fused heterocyclic systems with respect to their chemical synthesis, properties and characteristics of those systems will be discussed in details

c) for the different mechanisms for the formation and derivatization of the different heterocyclic ring systems

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

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Detailed Syllabus:

Sr.	Contents	Hours
1	Hantzsch-Widman nomenclature systems, Indole: Biological importance of indole derivatives, Reactions: protonation, nitration, sulphonation, halogenation, acylation, alkylation, reaction with aldehydes and ketones, reaction of α,β-unsaturated ketones, nitriles and nitro compounds. Mannich reaction, reaction with oxidizing agents, reaction with nucleophilic reagents, reaction with N-metallated indole. Reaction with reducing agents. Reaction with carbenes, electrophilic and photochemical reactions. Reaction of indolyl C-X compounds, electrophilic substitution reactions of substituted indoles. Synthesis: Fischer-indole synthesis (From phenyl hydrazone of aldehyde and ketone), Grandberg synthesis, Reissert synthesis, Modelung synthesis. Reactions and synthesis of benzo(b)thiophene and benzo(b)furan.	**15**
2	Reactions and Synthesis of bicyclic heterocycles Quinoline / Isoquinoline Reactions: Substitution of carbon: proton exchange, nitration, sulphonation, halogenation, reactions with nucleophilic reagents with hydride transfer: alkylation, arylation, amination, hydroxylation. Nucleophilic substitutions with displacement of halide, metal halogen exchange, reactions with reducing agents, Grignard reaction. Electrophilic substitution reactions of substituted quinoline and isoquinoline. Reissert reaction. Reactions of quinolone-N-oxide and isoquinoline-N-oxide with acid chloride, $POCl_3$, $SOCl_2$, diethylcyanophosphonate. Cyanine dyes. Synthesis of quinoline: Skraup synthesis, Combes synthesis, Conrad Limpach Knorr synthesis, Pfitzinger synthesis, Pomeranz-Fritsch synthesis. Synthesis of isoquinoline: Bischer-Napieralski synthesis Heterocyclic system containing two nitrogen atoms: Cinnoline, Quinazoline, Quinoxaline, Phthalazine: Synthesis and its reactions	**15**
3	Reactions and synthesis of six membered heterocycles containing nitrogen. Pyridine: Brief introduction, electrophilic substitution of substituted pyridines. Pyridine-N-oxide: Reactivity, electrophilic addition and substitution, nucleophilic addition and substitution reactions, Rearrangement, Electrophilic substitution reaction of substituted Pyridine-N-oxide, Synthesis of PNO. Diazines: Introduction, Reactions: Addition at nitrogen, Substitution at carbon, oxidizing agents, nucleophilic agents, replacement of hydrogen, replacement of good leaving group, Reaction of oxydiazine, Anrorc mechanism. Synthesis of diazines. Triazine: Introduction, reactions and synthesis. Tetrazine: Introduction, reactions and synthesis.	**15**

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4	Reactions and synthesis of oxygen containing heterocycle: Typical reactivity of pyrilium and benzopyrilium ions, pyrones and benzopyrones. Pyrilium salts: Reactions: electrophilic reagents, nucleophilic reagents and reducing agent. Synthesis from 1,5-dicarbonyl compounds, 1,3-dicarbonyl compounds and ketones. Alkene acylation. 2- and 4-Pyrone: Reactions: Electrophilic addition and substitution, nucleophilic reagents, cycloaddition reactions. Synthesis of 2- and 4-Pyrones. Benzopyrilium salt: Reaction with nucleophilic reagents, reducing and oxidizing agents, Synthesis from phenols and 1,3-dicarbonylcompounds, ortho-hydroxybenzaldehydes and ketones. Benzopyranones: Reaction with electrophilic reagents, nucleophilic reagents, oxidizing and reducing agents, cycloaddition and photochemical reactions. Synthesis of Coumarin: Phenols and 1,3-ketoesters, from o-hydroxy benzaldehydes and anhydrides. Synthesis of Chromone: From o-hydroxy acyl benzenes and esters. Isocoumarin synthesis. Azoles: Typical reaction of 1,2- and 1,3-azoles. 1,3-Azoles: Reactions: electrophilic reagents, Addition at nitrogen, substitution at carbon, nucleophilic reagents, C-metalled-1,3-azoles, alkyl-1,3-azoles. Synthesis. 1,2-Azoles: Reactions: electrophilic reagents, Addition at nitrogen, substitution at carbon, nucleophilic and reducing reagents. Synthesis.	**15**

Reference Books/Audio-visual Course:

1	Heterocyclic Chemistry, 4th Edition by J. A. Joule & K. Mills, Published by Chapman & Hall (1995).
2	Principles of modern heterocyclic chemistry, Edited by Leo A. Paquette, Published by Pearson Benjamin Cummings (1968).
3	Heterocyclic Chemistry, 3rd Edition by Thomas L. Gilchrist, Published by Prentice Hall (1997).
4	The Structure & Reactions of Heterocyclic Compounds, Edited by Michael Henry Palmer, Published by Edward Arnold (1967).
5	Heterocyclic chemistry by V. K. Ahluwalia, Narosa publishing house.

Supplementary learning Material:	
1	http://ndl.iitkgp.ac.in/document/bnZnR2hPaUVqRU9TbFc2Rmp1MVJzK1lMa2VJUUtzcVVVcnZrT1VFWlQ3bz0
2	https://www.youtube.com/watch?v=LVGmOoPH10M

Pedagogy:

To motivate students and deepen their understanding of chemistry, instructors need to plan thoughtful lessons in advance and establish clear learning goals. Allowing students to reflect on their knowledge complemented by effective questioning from the instructor helps them solidify concepts.

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Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
40	**30**	**10**	**10**	**5**	**5**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	At the end of this course, the student will be able: To know the rules of nomenclature and give names for simple aliphatic and aromatic heterocycle, and synthesis/reactivity of indole, benzo[b]furan, benzo[b]thiophene	**25**
CO-2	To provide theoretical understanding of heterocyclic chemistry and this includes various methods for ring synthesis and application of those methods for the preparation of specific groups of heterocyclic systems.	**25**
CO-3	To explain on a mechanistic level, reactions and synthesis of important nitrogen containing heterocycles; pyridines, diazines and their benzo-condensed analogs.	**25**
CO-4	Explain on a mechanistic level, reactions and synthesis of important oxygen containing heterocycles; pyrilium and benzopyrilium ions, pyrenes, benzopyrones and azoles.	**25**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: **201330304**

Course Title: **Spectral Exercise and Organic Separation Lab**

Course Group: **Core Subject**

Course Objectives:

a) This course aims to impart to the student, knowledge of the principles of separation and qualitative analysis of ternary mixture of organic compounds.

b) To use acid-base chemistry for separation of organic compounds.

c) The objective of this course to introduce the students to practical skills on the separation and identification of organic compounds employing exemplar reactions, methods, and techniques.

d) To predict structure of organic compounds from various spectral data

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Detailed Syllabus:

Sr.	Contents	Hours
1	**Separation and identification of Ternary Organic Mixture** **Minimum two (02) mixtures should be given from each of the following type** Solid + Solid + Solid Solid + Solid + Solid (one soluble) Solid + Solid + Liquid Solid + Liquid + Liquid Liquid + Liquid + Liquid	**15**
2	**Spectral Exercise** Structure interpretation of organic compounds from spectral data	**15**

Reference Books/Audio-visual Course:

1	Vogel's Textbook of practical organic chemistry, 5th edition, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell (Pearson Education)
2	Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, Sunita Dhingra (Universities Press)
3	Organic structures from spectra, 5th edition, L. D. Field, S. Sternhell, J. R. Kalman (Wiley: A John Wiley & Sons Ltd publication)
4	Elementary Organic Spectroscopy: Principles and Chemical applications (revised edition), Y. R. Sharma (S. Chand Publishing)

Supplementary learning Material:	
1	https://www.youtube.com/watch?v=hB1ZanteY8Q

Pedagogy:

- For effective teaching and the learning requirements, the methodology will be blend of practicals and demonstrations.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
10	**10**	**35**	**35**	**5**	**5**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**After completion of this course, the students will be able:** To develop practical skills in separation of organic mixtures and identify the unknown organic compound via performing various qualitative analyses. To get practical training on identification of various functional group and detection of extra elements (N, S, Cl, Br, I) present in organic compounds	**70**

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CO-2	The use of nuclear magnetic resonance spectroscopy, mass spectrometry and infrared spectroscopy for organic structure elucidation. Student will learn how to elucidate structure of organic compound from given analytical data	**30**

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CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: **201330305**

Curriculum Revision:

Course Title: **Project Work**

Course Group: **Core Subject**

Course Objectives:

a) To provide exposure to research problem and carry out research in the novel and fascinating topics of research in chemistry.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Research work in laboratory on a topic given by the supervisor	

Pedagogy:
Laboratory exercise and thesis writing

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %					
R	U	A	N	E	C
10	10	25	25	5	25

R: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating

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CVM UNIVERSITY
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: **201330306**

Course Title: **Synthesis and Application of Dyes and Intermediates Lab**

Course Group: **Core Subject**

Course Objectives:

a) From the synthesis of the dyes and intermediates students can correlate their theory knowledge with its respective practical.

b) The main objective of this course is to develop the skills required for their industrial career such as calculation the mole ratio, maintain the reaction conditions, work up of reaction, purification of product etc.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Synthesis of Azo dye (Including azoic dye, disperse azo dye and acid azo dye) and it's dying on various fiber.	
2	Synthesis & dying of Indigo (Vat dying)	
3	Synthesis of pyrazolone and coumarin derivative as intermediates of Azo dyes	
4	Synthesis of dyes, pigments and intermediates o-Cresolphthalein	
5	Synthesis of Phenolphthalein	
6	Synthesis of Fluorescein and its methylation	
7	Synthesis of Acetoacetanilide pigment	
8	Synthesis of Bisazo acid dye	
9	Synthesis of 1,5-Dinitroanthraquinone	
10	Synthesis of Quinazarin	

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Reference Books/Audio-visual Course:

1	Vogel's Textbook of practical organic chemistry, 5th edition, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell (Pearson Education)
2	Comprehensive practical organic chemistry: Preparation and Quantitative analysis, V. K. Ahluwalia, Renu Aggarrwal (Universities Press)

Supplementary learning Material:	
1	https://www.youtube.com/watch?v=2zXNmIw8jZY

Pedagogy:
At this stage, using chalk and talk method we try to teach them the calculation of the mole ratio for every compounds. All students learn a new concept of dying with self-made dyes. They are also able to learn the different fasting properties of synthesized dye such as alkali fastness, water fastness, rubbing fastness, light fastness etc.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
15	**15**	**35**	**10**	**10**	**15**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To synthesis of different types of dyes at laboratory level.	**35**
CO-2	To learn the methods of dyeing on different fabrics with appropriate dye materials.	**50**
CO-3	To develop the ability of calculating the correct mole ratio for any organic reaction.	**15**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: **101330307**

Course Title: **Project Work**

Course Group: **Core Subject**

Course Objectives:

a) To provide exposure to research problem and carry out research in the novel and fascinating topics of research in chemistry.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Research work in laboratory on a topic given by the supervisor	

Pedagogy:
Laboratory exercise and thesis writing

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %					
R	U	A	N	E	C
10	10	25	25	5	25

R: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating

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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**After completion of this course, the students will be able:** To proceed for literature survey, synthesis and characterization of compounds/ materials using modern analytical and spectroscopic techniques and their study for various applications. The student will get training for working in research in academic and industries. The student will be trained in research for pursuing higher studies.	**100**

Curriculum Revision:	
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FACULTY OF SCIENCE

Course Outcomes (CO):

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: **201330308**

Course Title: **Comprehensive Viva – Voce**

Course Group: **Core Subject**

Course Objectives:

a) Actually, this is not a theory or practical subject; this is just a viva-voce of compilation of all theory subjects including inorganic chemistry, organic chemistry, physical chemistry and polymer chemistry. The main objective of this subject is to improve knowledge of chemistry (All four theory subjects), this might be useful to face interview after M.Sc. To improve communication skill of students.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	-	1	-	50/20	-	-	50/20

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	The syllabus for this subject is already covered in all four theory subjects.	

Pedagogy:

For student – teacher learning pedagogy: Currently, we are engaging with the five major approaches, which are constructivist, collaborative, integrative, reflective and inquiry based learning. In this learning process students can achieved their goal by improving results and understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	U	A	N	E	C	

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Sr.	Course Outcome Statements	%weightage
CO-1	Viva voce examination is as important as the written mode of examination. Using this method, it is easy to test the flexibility and potential of the students for their higher order cognitive skills. It also provides direct contact with the students to assess their way of communication, presentation skills and in-depth knowledge of various theory subjects. It helps students to improve their own perception for their future career endeavour.	**100**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: **201330309**

Course Title: **Selected Topics in Organic Chemistry**

Course Group: **Elective Subject**

Course Objectives:

a) To provide in depth knowledge of pericyclic reactions.
b) Students are able to understand the reaction condition for specific conversion and also go through the verity of possibility for the conversion of reactant to product.
c) Students can differentiate the concept of dyes and Intermediates with reference to its types, usefulness, synthesis and applications.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Detailed Syllabus:

Sr.	Contents	Hours
1	**Dyes:** Brief introduction to fundamentals of dyes; Classification of dyes based on structure and applications; Non textile dyes-Leather, food, hair, ink, photographic, indicator, NIR, Indigo dyes, Medicinal dyes, Security dyes.	15
2	**Pigments:** Organic and Inorganic Pigments-Introduction, classification, characteristics and applications. Organic pigments- Synthesis and evaluation. FBA-Characteristics, classification, synthesis and applications. **Uses and Synthesis of Dyes:** Crystal Violet, Ciba Blue 2B, Procian Brilliant M_5B, Tartrazine Yellow, Alizarin, Quinazarin, Acid Blue 23, Basic Blue 22, Acryflavine, Saframine T, Methylene Blue, Amido Yellow E, Polar Yellow Brown, Bismark Brown, Direct Deep Black, Congo Red, Fluorecein, Direct Black 38, Eriochrome Black T, Pyrazolone azo, Malachite Green, Rosaniline, Aniline Blue, Rohdomine B, Indoaniline.	15
3	**Pericyclic Reactions-I:** General introduction, Theories of pericyclic reactions: FMO, Woodward-Hoffmann rules, Huckel-Mobius rules. Electrocyclic reactions: Ring opening and closing reactions of 4n and 4n+2 system; cation (Nazarov reaction) and anion type molecules; small ring opening. Sigmatropic reactions: [1, n]; [2, 3] $-SeO_2$, Somellet-Haouser, Wittig, Mislow Evan's rearrangements; [3, 3]- Cope, Claisen, Claisen-Cope, Aza-Cope; [5, 5].	15
4	**Pericyclic Reactions-II:** Theories of pericyclic reactions: FMO, Woodward-Hoffmann rules, Huckel-Mobius rules. Cycloadditions: [2+2] thermal and photochemical; [4+2]-Diels-Alder reactions, diene and dinophile nature; Inter, intra and hetero cycloaddition reaction with region and stereoselectivity. [3+2]-dipolar cycloaddition, introduction of different dipoles, their reactions dipolarophiles (inter, intra) Cycloadditions reactions of more than six electrons. Group transfer reactions: Ene reactions: Syn β-elimination.	15

Reference Books/Audio-visual Course:

1	Colour Chemistry : Synthesis, Properties and applications of Organic dyes and pigments, A. T. Peters, H. S. Freeman
2	Organic chemistry, 7th edition, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Pearson
3	Organic chemistry, 2nd edition, J. Clayden, N. Greeves, S. Warren, Oxford university press
4	Modern methods of organic synthesis, 4th edition, W. Carruthers , Iain Coldham, Cambridge university press,

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5	Photochemistry and pericyclic reactions, Jagdamba Singh, Jaya Singh,
6	Advance organic chemistry: part A & B, Francis Carey
7	Pericyclic reactions, Ian Fleming, oxford
8	Molecular Orbitals and Organic Chemical Reactions, Student Edition, Ian Fleming, (2010), Wiley
9	Frontier orbitals and organic chemical reactions, Ian Fleming,
10	Aspects of organic photochemistry, William M. Horspool, Academic Press
11	Handbook of synthetic dyes and pigments, Vol. – 3 (Pigments), 2nd edition, K. M. Shah, Multi-tech publishing co. Mumbai
12	Handbook of synthetic dyes and pigments, Vol. – 2 (Intermediates), 2nd edition, K. M. Shah, Multi-tech publishing co. Mumbai
13	Synthetic dyes, Gurdeep R. Chatwal, 4th revised and enlarged edition, Himalaya Publishing House
14	The Chemistry of Synthetic dyes and pigments, by H. A. Lubs, Reinhold Publication (1955)
15	The production and applications of fluorescent Brighteing Agents, Milos Zahradnik, john Wiley & Sons. 1982
16	The Chemistry of Synthetic dyes, Volume I to IX, Edited by K. Venkataraman, Academic Press (1971)

Supplementary learning Material:	
1	https://nptel.ac.in/courses/104106077
2	https://nptel.ac.in/courses/116104046
3	https://www.slideshare.net/HarvinderSaini6/nir-near-infrared-dyes
4	https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Book%3A_Basic_Principles_of_Organic_Chemistry_(Roberts_and_Caserio)/28%3A_Photochemistry/28.05%3A_Color_and_Constitution

Pedagogy:

- There is merging of traditional theories for colour and constitution with modern methods. Also, different non-textile applications of the dye are discussed with verity of live examples. Pericyclic reactions can be taught by self-made pen model in in order to explain formation of the actual product with respect to its stereochemical outcome for the particular reaction.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	**40**	**15**	**10**	**10**	**5**	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To decide the reason for the appearance of the colour of any compound, and correlate it with the theoretical reasons. To classify the dyes based on its structure as well as their applications.	**25**
CO-2	To identify the type of class of pigment for its appropriate use. They apply their knowledge of FBA in daily life requirements.	**25**

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CO-3	To understand the way how the pericyclic reactions occurs.	**25**
CO-4	To understand the effect of different reaction pathways and about the symmetry of the product which in turn helpful in the development of new organic compounds with proper/required symmetry products.	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **III**

Course Code: 201330310

Course Title: Occupational Practices

Course Group: Elective Subject

Course Objectives:

a) The objective of this course is to learn about intellectual property rights, validation of analytical methods and processes and industrial safety and hazards.

b) To know about Industrial safety programs and toxicology, Industrial laws , regulations and source models.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Detailed Syllabus:

Sr.	Contents	Hours
1	Intellectual Property Rights: Introduction to intellectual properties; Need for protection of intellectual properties; Industrial property: patents, trademark, industrial design and geographical indications; Copyright and neighbouring rights; IPR legislations in India, World IP organizations and treaties; Indian patent act; Patentability; Patent applications; Patent registration and filing; Patent cooperation treaty.	15
2	Validation of analytical methods and processes: General principles of analytical method validation, parameters for method validation: specificity, selectivity, precision, accuracy, linearity and calibration curve, Range, Limit of detection and quantification, Robustness. Introduction to process validation; Regulatory basis for process validation; Pharmaceutical process validation; FDA guidelines; cGMP and GLP: cGMP guidelines viz. ICH/WHO/USFDA/EDQM/ Schedule M/NDA/AMDA.	15
3	Hazards: Classification Hazardous chemical, transportation of Hazardous chemicals, Storage, Handling and control measures for hazardous chemicals. Hazards and controls in Unit process and Unit Operations. Hazards – fire, mechanical, electrical, chemical and pharmaceutical, Monitoring & prevention systems, industrial effluent testing & treatment. Control of environmental pollution.	15
4	Concept of Industrial Safety: Accidents investigation and Analysis, Statutory provisions, Types of chemical hazards and control, control techniques, process flow chart and its importance for safety inspection, interpretation, use and training of MSDS, UN, HAZCHEM. Safety in chemical industry: General introduction, type of chemical hazards, Safety and risk phrases, Storage hazards and control, Prevention of overflow-pressure-temperature and process flow, Types of guards and valves for the vessel, its inlet and out let, need of remote and auto control valves, Process hazards and controls.	15

Reference Books/Audio-visual Course:

1	Intellectual Property Rights under WTO: Tasks Before India, Author: T. Rammappa – New Delhi, Wheeler Publishing, 2000.
2	Intellectual Property Rights: Text & Cases; Author: Dr. S. Balasubhramanian Dr. R. Radhakrishnan, Publisher: Excel Books N Delhi, ISBN: 8174466096, ISBN-13: 9788174466099.
3	How to Practice GMPs, Author: P.P. Sharma, Vandana Publications, Agra
4	Pharmaceutical Process Validation, Author: Ira R. Berry and Robert Nash, Publisher: Marcel Decker Inc. (2nd edition).
5	Accident prevention manual for industrial operations, National safety council, Chicago, 10th edition

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6	Safety and Accident prevention in chemical operation, 2nd edition, Howard H.
7	Handbook of occupational safety and Health by S. Lawrence.
8	MSDS – your guide to chemical safety
9	Engineering design for control of work place hazards, A. Richard
10	Safety managers Handbook, J. J. Keller and Associates Inc, USA.
11	Supervising safety for hazardous Processes, Dr. K. U. Mistry, Safety Health and Environment Association, 1st edition.
12	Fundamental of Industrial safety and health by Dr. K. U. Mistry

Supplementary learning Material:	
1	https://www.youtube.com/watch?v=Bj1_z56VEJ0
2	https://www.youtube.com/watch?v=v-eltsixu4I

Pedagogy:

- To motivate students and deepen their understanding of chemistry, instructors need to plan thoughtful lessons in advance and establish clear learning goals. Allowing students to reflect on their knowledge complemented by effective questioning from the instructor helps them solidify concepts.
- Other effective lesson formats are appropriate for some topics in chemistry include role playing, manipulation of concepts via simulations and differentiated instruction. Cognitive science discourages "teaching as telling," therefore careful planning is necessary to avoid this pitfall. If a lecture format is decided to be the most effective way to teach a concept, allow students to preview the information and provide them in advance with organizers to maximize participation and promote student understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	25	30	15	5	5	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To identify criteria's to fit one's own intellectual work in particular form of IPRs and Apply statutory provisions to protect particular form of IPRs.	**25**
CO-2	To apply the methods of prevention of fire and explosions	**25**
CO-3	To understand the methods of hazard identification and preventive measures	**25**
CO-4	To analyze the effect of release of toxic substances.	**25**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	April 2022
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Next Review on (Month-Year):	March 2025

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330401**

Course Title: **Natural Products**

Course Group: **Core Subject**

Course Objectives:

a) This course describes occurrence/sources of natural products from natural resources, their structure elucidation and chemical synthesis.

b) The objective of this course is to introduce students about the basic knowledge of vitamins, terpenoids, carotenoids, alkaloids and steroids.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction of Natural Products Classification, source and methods of isolation of natural products, General methods for the structure determination of natural products. Vitamins: Structure and synthesis of Vitamin A1, Vitamin B_1 (Thiamine), Vitamin B_6 (Pyridoxine) and Biotin (Vitamin H). Synthesis of Vitamin C, Vitamin B_2 (Riboflavin).	15
2	Alkaloids Introduction of Opium alkaloids, Structure and synthesis of Morphine, Rearrangement in opium alkaloids, synthesis of Reserpine and Tylophorine. Biogenesis of Alkaloids, Structure and synthesis of Cinchonine, Structure and synthesis of Tropine, Synthesis of 2-ethylpyridine, tropinic acid, tropinone and tropilidine from tropine, Synthesis of pimelic acid from tropinic acid.	15

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3	Terpenoids and Carotenoids Structure and synthesis of cicyclic sesqiterpenoids Eudesmol and Cadinene, structure and synthesis of ß-Carotene, synthesis of Caryophyllene and (-) Khusimone, molecular rearrangement of Caryophyllene and Logifolene. Biogenesis of Terpenoids and Carotenoids.	**15**
4	**Steroids** Structure and synthesis of Cholesterol, **Steroid Hormones:** Introduction, Androgens: Synthesis of Testosterone, Oestrogens: Total Synthesis of Oestrone, Gestrogens: Synthesis of Progesterone from Cholesterol. Synthesis of Cortisone, and Chemistry of bile acids. Biogenesis of Steroids.	**15**

Reference Books/Audio-visual Course:

1	The Chemistry of Natural Products, K. W. Bentley, Vol. I – V (Interscience).
2	Organic Chemistry, Vol. 2, I. L. Finar, 5th Edition (1994) ELBS Publication.
3	Natural Products Chemistry, Vol. I & II K. Nakanishi et al., Academic press publication (1974).
4	The Molecules of Nature, J. B. Hendrickson, W. A. Benjamin Inc. (1965).
5	Selected Organic Synthesis, Ian Fleming John Wiley (1977).
6	Chemistry of Natural Products, N. R. Krishnaswamy, University Press (India) Ltd. (1999).
7	Classical Methods in Structure Elucidation of Natural Products, Reinhard W. Hoffmann by Wiley-VHCA.

Supplementary learning Material:	
1	https://ndl.iitkgp.ac.in/homestudy/science/chemistry & biochemistry/chemistry video lecctrures:CEC, Alkaloids-II, Alkaloids-III & Alkaloids-IV
2	http://ndl.iitkgp.ac.in/document/bnZnR2hPaUVqRU9TbFc2Rmp1MVJzd1JobzA2Mmk2R2xDVkpaa0hjaUE2Zz0

Pedagogy:

- To motivate students and deepen their understanding of chemistry, instructors need to plan thoughtful lessons in advance and establish clear learning goals. Allowing students to reflect on their knowledge complemented by effective questioning from the instructor helps them solidify concepts.
- Other effective lesson formats are appropriate for some topics in chemistry include role playing, manipulation of concepts via simulations and differentiated instruction. Cognitive science discourages "teaching as telling," therefore careful planning is necessary to avoid this pitfall. If a lecture format is decided to be the most effective way to teach a concept, allow students to preview the information and provide them in advance with organizers to maximize participation and promote student understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
30	40	15	5	5	5	

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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To familiar with nomenclature, structure elucidation, general properties and methods of preparation of natural products	**25**
CO-2	To acquire knowledge of classification and importance of various natural products including vitamins, terpenes, steroids and alkaloids.	**25**
CO-3	The students will acquire knowledge of total synthesis of various natural products and biosynthesis	**25**
CO-4	The main outcome of the course is to provide experimental evidences in structure elucidation of various natural products such as terpenoids, alkaloids, vitamins, steroids.	**25**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330402**

Course Title: **Medicinal Chemistry**

Course Group: **Core Subject**

Course Objectives:

a) Shift focus of the students on the discovery, development, identification, and interpretation of the mode of action of biologically active compounds (Drug) at the molecular level.

b) The course emphasis on understanding the different systems of human body with medicinal point of view and the effect of drug on body.

c) The role of medicinal chemistry in drug development is most prominent in the discovery, optimization, and development.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Introduction to Medicinal Chemistry, Pharmacokinetics:** Drug administration, Drug absorption, drug distribution, drug metabolism (general pathway of drug metabolism: Oxidative, reductive and hydrolytic reactions), Drug excretion. Time course of drug action; First order and zero order, Time course of drug concentration change in plasma, Plateau effect, Some useful points and related examples. **Pharmacodynamics:** Receptors, Chemical messengers, Binding sites, Receptor types and subtypes (protein receptors, DNA receptors with examples of Agonists and Antagonists).	15

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2	**Psychoactive Drugs:** **Sedative and Hypnotics:** Classifications, SAR of Barbituric acid, Synthesis of Glutethimide, Oxazepam and methaqualone. **Antianxiety agents:** Introduction, Classification, SAR of Benzodiazepine, Mode of action; Synthesis and uses: Diazepam, Nitrazepam, Meprobamate, Hydroxyzine. **Antidepressants:** Introduction, Classification, Synthesis and uses: Isocarboxazid, Imipramine, Sertraline, Venlafaxine. **Cardiovascular Drugs Antianginal and Vasodilators:** Introduction and Classifications, Synthesis of Nitroglycerine, Nicorandil, Nifedipine, Bepridil, Minoxidil and Hydralazine and SAR of Dihydropyridines. **Antihypertensive drugs:** Introduction and Classifications, Synthesis of Captopril, Ramipril.	**15**
3	**Antineoplastics Agents:** Introduction, Classification, synthesis and drug profile. **Alkylating agents:** Melphalan, cyclophosphamide and dacarbazine. **Topoisomerase inhibitors**: Doxorubicin etoposide and dactinomycin. **Antimetabolites**: Mercaptopurine methotrexate and gemcitabine. **Tubulin binders:** Docetaxel paclitaxel and vincristine. **Antiviral Agents:** Introduction, Classification of drugs according to its mechanism of action and according to the treatment protocol. **Drug profile based on Nucleotide analogues:** Acyclovir, Idoxuridine, Rimantadine, **Non-Nucleoside RT inhibitors**: Nevirapine, Emivirine. Nucleoside RT inhibitors: Zalcitabine, Zidovudine. HIV protease inhibitors: Indinavir, Ritonavir.	**15**
4	**Antibiotics:** General Introduction, Chemical Classification. ß-lactam antibiotics: Penicillin, Cephalosporins, ß-lactamase inhibitors, Aminoglycosides, Tetracyclines, Chloramphenicol, Quinolone. Synthesis and application of Ciprofloxacin, Pefloxacin, Norfloxacin, Enrofloxacin, Ofloxacin, Levofloxacin, Chloramphenicol, Ampicillin, Amoxicillin,6-Amino Penicillanic acid, 7-Amino Cephalosporanic acid, 7-Amino-3-Deacetoxy Cephalosporanic acid (Precursors), Oxacillin, Cloxacillin, Dicloxacillin, Flucloxacillin, Cefriaxone, Cefuroxime. **Drug Design:** Concepts of drug design, Approaches to lead discovery, SAR, Combinatorial chemistry, Pro-drugs.	**15**

Reference Books/Audio-visual Course:

1	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical, Chemistry, 11th Edition by John H. Block & John M. Beale, Published by Lippincott Williams & Wilkins (2004).
2	Principles of Medicinal Chemistry, 4th Edition by William O-Foye, Thomas L. Lemke and David A. Williams, Published in India by B. I. Waverly Pvt. Ltd. New Delhi (1995).
3	Essential of Medicinal Chemistry, 2nd Edition by Andrejus korolkovas, Published by Wiley-India Edition (1988)
4	Instant Notes: Medicinal Chemistry, Edited by Graham L. Patric, Published by Viva Books Private Ltd. (2002)
5	Textbook of Medicinal Chemistry Vol. I & II by V. Alagarsamy Published by Elsevier (2010).

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6	Medicinal Chemistry 3rd Edition by Ashutosh Kar Published by New age international (P) Limited,Publishers (2005).
7	Medicinal Chemistry Edited by Alfred Burger Published by Interscience Publishers, John Wiley & Sons,New York (1951)
8	Burger's Medicinal Chemistry and Drug Discovery Vol. 3: Therapeutic agents Edited by Manfred E. Wolff Published by Interscience Publishers, John Wiley & Sons, New York (1996)
9	Burger's Medicinal Chemistry 4th Edition : Part III Edited By Manfred E. Wolff Published by Interscience Publishers, John Wiley & Sons, New York (1981)
10	Organic Chemistry, Vol. 2, I. L. Finar, 5th Edition (1994) ELBS Publication.
11	Natural Products Chemistry, Vol. I & II K. Nakanishi et al., Academic press publication (1974).
12	The Molecules of Nature, J. B. Hendrickson, W. A. Benjamin Inc. (1965).
13	Selected Organic Synthesis, Ian Fleming John Wiley (1977).
14	Chemistry of Natural Products, N. R. Krishnaswamy, University Press (India) Ltd. (1999).

Supplementary learning Material:	
1	https://ndl.iitkgp.ac.in/homestudy/science/ chemistry & biochemistry/chemistry video lectures: CEC, Drugs & Pharmaceuticals
2	https://www.youtube.com/watch?v=qBdYnRhdWcQ
3	https://www.youtube.com/watch?v=Ed1vs3ulaL0
4	https://www.youtube.com/watch?v=JmizB6lbdlI

Pedagogy:

- This is a hybrid branch which is combination of biology, pharmacy, analytical chemistry and most importantly organic chemistry. This can be taught by mixture of methods like chalk and board method, video, presentations etc., and also with deep discussion which includes vast discussion and verity of examples in order to keep the students attached with subject enthusiastically.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
15	20	35	10	10	10	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To understand the way how drug can be administrated, absorbed, distributed and metabolized also able to calculate the drug dose, decide the requirement of loading dose.	**25**
CO-2	To understand the relation of drug with different types of receptors, chemical messengers, binding site and DNA	**25**
CO-3	To understand the way how drug react with different systems of human body and their mode of action and with the help of that knowledge one can improve the understanding of drug behavior.	**25**

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CO-4	To understand the mode of action and classification of antibiotics. To decide the use of combination of drugs and also decide the require use of antibiotics. It also help them in their career of pharmaceutical drug synthesis.	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330403**

Course Title: **Stereochemistry of Organic Compounds**

Course Group: **Core Subject**

Course Objectives:

a) The objective of the course is to furnish an appropriate knowledge of effective and modern synthetic techniques aimed to the production of enantiomerically pure organic molecules.

b) This course aims to explain basic concepts in stereo chemistry and conformational analysis of organic molecules.

c) This course also includes the stereochemistry aspects of substitution and elimination reactions.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Detailed Syllabus:

Sr.	Contents	Hours
1	**Asymmetric Synthesis:** Introduction, Chemoselectivity, Regioselectivity, Stereoselectivity; Methodology of Asymmetric Synthesis; Classification of Asymmetric reactions: Substrate controlled, Chiral auxiliary controlled, Chiral reagent controlled and Chiral catalyst controlled; Substrate controlled asymmetric synthesis: Nucleophillic addition to carbonyl compounds; 1,2 – Asymmetric induction, Cram's rule, Prelog's rule and Felkin – Anh model; Asymmetric aldol reaction; Diastereoselective aldol reaction, Chiral auxiliary controlled asymmetric synthesis: α – Alkylation of chiral enolates, oxazoline; Use of chiral auxiliary in Diels – Alder reaction; Chiral reagent controlled asymmetric synthesis: Asymmetric hydroboration using IPC_2BH and $IPCBH_2$; Reduction with CBS reagent. M. P. V. Reduction; Chiral catalyst controlled asymmetric synthesis: Sharpless epoxidation; Asymmetric hydrogenations using chiral Wilkinson bisphosphine.	15
2	**Resolution and Conformational Analysis:** **Resolution:** Principle; General methods for resolution; Resolution of (±)-2-octanol, (±)-phenylethylamine, (±)-alanine. **Conformational analysis of acyclic compounds.**	15
3	**Conformational Analysis:** Conformational analysis of cyclic, fused, and bridged cyclic ring systems.	15
4	**Dynamic stereochemistry:** Selection of substrate for Alkene, Water addition, Nucleophilic attack on cyclic ring, Exo-Endo attack on bridgehead compound, Nucleophilic substitution reaction(S_N1, S_N2, S_Ni, NGP by π-bond and NGP by σ-bond), Elimination reaction (α-elimination, β-elimination, γ-elimination, 1,n-elimination), Regioselectivity of Elimination reaction, Dehalogenation of dihalide compounds, Diol formation, Epoxide formation, Epoxide ring opening.	15

Reference Books/Audio-visual Course:

1	Stereochemistry: Conformation and Mechanism, By P.S. Kalsi, 6th edition, New Age International (P) Ltd., Publishers (2005).
2	Stereochemistry and Mechanism through solved problems, By P.S. Kalsi, Wiley Eastern Ltd. (1994).
3	Stereochemistry of organic compounds, By D. Nasipuri, 2nd Edition, New Age International (P) ltd., Publishers (1994).
4	Stereochemistry of Carbon Compounds, By E.L. Eliel, Tata McGraw-Hill Pub. Co. Ltd. (1962).
5	Organic Chemistry, By J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford Uni. Press, N.Y. (2001).
6	Dynamic stereochemistry of chiral compounds: Principles and Applications By Christian Wolf, RSC Publishing (2008).
7	Organic Chemistry by J. Clayden, N. Greeves and S. Warren, 2nd edition, Oxford University Press, UK.
8	Modern Methods of Organic Synthesis; W. Carruthers and I. Coldham, 4th edition, Cambridge University Press, UK.

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Supplementary learning Material:	
1	https://onlinecourses.swayam2.ac.in/cec22_cy02/preview
2	https://onlinecourses.nptel.ac.in/noc22_cy18/preview

Pedagogy:

- To motivate students and deepen their understanding of chemistry, instructors need to plan thoughtful lessons in advance and establish clear learning goals. Allowing students to reflect on their knowledge complemented by effective questioning from the instructor helps them solidify concepts.
- Other effective lesson formats are appropriate for some topics in chemistry include role playing, manipulation of concepts via simulations and differentiated instruction. Cognitive science discourages "teaching as telling," therefore careful planning is necessary to avoid this pitfall. If a lecture format is decided to be the most effective way to teach a concept, allow students to preview the information and provide them in advance with organizers to maximize participation and promote student understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
35	35	10	5	5	10	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To have theoretical knowledge of various chiral reagents and chiral catalysts used in asymmetric syntheses and to analyze and predict the stereo chemical outcome of reaction.	**25**
CO-2	To predict and analyze the conformations of acyclic organic compounds and to have theoretical knowledge of resolution for separation of racemic mixtures.	**25**
CO-3	To predict and analyze the conformations of cyclic organic compounds and understand the various sterochemical aspects of many organic molecules that will help to study relative reactivity and relative product formation.	**25**
CO-4	The students will be able to recognize, classify, explain, and apply fundamental organic reactions such as S_N2, S_N1, S_Ni, E_2 and E_1 reactions	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330404**

Course Title: **Multi step Synthesis of Heterocyclic Compounds Lab**

Course Group: **Core Subject**

Course Objectives:

a) The objective of the course is to give an introduction to fundamental methods and procedures used in the multistep synthesis of heterocyclic compounds at laboratory scale.

b) To train the students in systematic approach and diligent handling of chemicals and chemistry laboratory equipment.

c) To achieve this, we will discuss the more important mechanisms of organic reactions and the structural effects and reactivity in these reactions.

d) To make able use TLC for monitoring the progress of the reaction.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Detailed Syllabus:		
Sr.	**Contents**	**Hours**
1	Multistep Synthesis of Heterocyclic Compounds (Minimum Sixteen (15) exercises) 1. Acridone 2. Antipyrin 3. Phenacetin 4. 2-Methylbenzimidazole 5. 2-Benzylbenzimidazole 6. Preparation of heterocyclic azo dye 7. 5-Chloro-3-methyl-1-phenyl-1H-pyrazolone-4-carboxaldehyde 8. 2-Phenylindole 9. 5-Nitroanthranilic acid 10. 2-Methyl-3-benzyl-4-ketoquinazoline 11. 2,3-Dimethyl-4-ketoquinazoline 12. Flavone 13. 2-Chloro-3-formyl-quinolones 14. 5-Hydroxy-1,3-benzoxathiazolone-2 15. p-Aminobenzene sulfonamide (Sulfa drug), 16. 2-Chloromethylbenzimidazole 17. 3-(4-Carbonyl-1-phenylpyrazol-3-yl)chromen-2-one 18. Miscellaneous • To monitor reaction by Thin Layer Chromatography (TLC)	

Reference Books/Audio-visual Course:

1	Vogel's Textbook of practical organic chemistry, 5th edition, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell (Pearson Education)
2	Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, Sunita Dhingra (Universities Press)
3	Organic structures from spectra, 5th edition, L. D. Field, S. Sternhell, J. R. Kalman (Wiley: A John Wiley & Sons Ltd publication)
4	Elementary Organic Spectroscopy: Principles and Chemical applications (revised edition), Y. R. Sharma (S. Chand Publishing)

Supplementary learning Material:	
1	https://www.youtube.com/watch?v=V0TqAfy2NGM
2	https://www.youtube.com/watch?v=ubM5hbPK8sE

Pedagogy:

- For effective teaching and the learning requirements, the methodology will be blend of practicals and demonstrations.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
10	15	50	10	5	10	

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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To carry out experiments, accurately record the results and analyze the results of such experiments.	**80**
CO-2	To have fundamental practical knowledge in the multistep synthesis of heterocyclic compounds on lab scale	**15**
CO-3	To learn use of TLC for monitoring the progress of the reaction.	**5**

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Version:	2
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330405**

Course Title: **Project Work**

Course Group: **Core Subject**

Course Objectives:

a) To provide exposure to research problem and carry out research in the novel and fascinating topics of research in chemistry.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Research work in laboratory on a topic given by the supervisor	

Pedagogy:

- Laboratory exercise and thesis writing

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	U	A	N	E	C	
10	15	35	25	5	10	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage

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CO-1	After completion of this course, the students will be able: To proceed for literature survey, synthesis and characterization of compounds/ materials using modern analytical and spectroscopic techniques and their study for various applications. The student will get training for working in research in academic and industries. The student will be trained in research for pursuing higher studies.	**100**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	April 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330406**

Course Title: **Spectral Analysis & Synthesis of Drugs, Intermediates and Esters Lab**

Course Group: **Core Subject**

Course Objectives:

a) This course aims to impart knowledge of laboratory set up, safe handling of chemicals, workup procedures and effective disposal of organic waste to the student. T

b) his subject also deals with various methods of preparing drugs, intermediates and esters in a single step.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Detailed Syllabus:

Sr.	Contents	Hours
1	Synthesis of Drugs, Intermediates and Esters Lab **Synthesis of Some Drugs and Intermediates (08 exercises)** 1. Yarayara (2-methoxy naphthalene) 2. 5,5'-Diphenylhydantoin 3. Benzimidazole 4. Benzotriazole 5. 2-Hydroxy-4-methylquinoline 6. 2,3-Diphenylquinoxaline 7. 6-Methyl-4-oxo-1,3,-dihydro-2-thiopyrimidine 8. Ethyl-6-methyl-2-oxo-4-phenyl-1,3,4-trihydro-5-pyrimidinecarboxylate **Synthesis of Various Esters (07 exercises)** 1. Benzocain (Ethyl-p-aminobenzoate) 2. Dibutyl maleate 3. Ethyl Cinnamate 4. Butesin (Butyl-4-aminobenzoate) 5. Isobutyl phenylacetate 6. Salol (Phenyl Salicylate) 7. Ethylphenylacetate **Demonstration of Column Chromatography**	
2	**Spectral Analysis** Structure interpretation of organic compounds from spectra. Minimum eight (08) exercises should be given.	

Reference Books/Audio-visual Course:

1	Vogel's Textbook of practical organic chemistry, 5th edition, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell (Pearson Education)
2	Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, Sunita Dhingra (Universities Press)

Supplementary learning Material:	
1	https://swayam.giv.in/

Pedagogy:

- For effective teaching and the learning requirements, the methodology will be blend of practicals and demonstrations.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
10	15	50	10	5	10	

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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To execute an experimental procedure, work independently, interpret experimental results, and draw a reasonable, accurate conclusion. Students will synthesize, isolate and purify organic compounds	**70**
CO-2	To generate spectral data from various spectra and also identify the structure of unknown organic compound using these spectral data. To Learn use of column chromatography in purification of impure products.	**30**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330407**

Course Title: **Project Work**

Course Group: **Core Subject**

Course Objectives:

a) To provide exposure to research problem and carry out research in the novel and fascinating topics of research in chemistry.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	8	4	-	-	50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Research work in laboratory on a topic given by the supervisor	

Pedagogy:

- Laboratory exercise and thesis writing

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %					
R	U	A	N	E	C
10	15	35	25	5	10

R: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating

Curriculum Revision:	
Version:	2
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330408**

Course Title: **Comprehensive Viva-Voce**

Course Group: **Core Subject**

Course Objectives:

a) Actually, this is not a theory or practical subject; this is just a viva-voce of compilation of all theory subjects including inorganic chemistry, organic chemistry, physical chemistry and polymer chemistry.

b) The main objective of this subject is to improve knowledge of chemistry (All four theory subjects), this might be useful to face interview after M.Sc. To improve communication skill of students.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
-	-	-	1	-	50/20	-	-	50/20

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**The syllabus for this subject is already covered in all four theory subjects.**	

Pedagogy:

- For student – teacher learning pedagogy: Currently, we are engaging with the five major approaches, which are constructivist, collaborative, integrative, reflective and inquiry based learning. In this learning process students can achieved their goal by improving results and understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %	**R**: Remembering; **U**: Understanding; **A**: Applying;

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R	U	A	N	E	C	**N**: Analyzing; **E**: Evaluating; **C**: Creating
20	30	10	10	15	15	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Viva voce examination is as important as the written mode of examination. Using this method, it is easy to test the flexibility and potential of the students for their higher order cognitive skills. It also provides direct contact with the students to assess their way of communication, presentation skills and in-depth knowledge of various theory subjects. It helps students to improve their own perception for their future career endeavour.	**100**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330409**

Course Title: **Topics in Organic Chemistry**

Course Group: **Elective Subject**

Course Objectives:

a) To provide exposure to research problem and carry out research in the novel and fascinating topics of research in chemistry.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Organometallic Chemistry** Transition metals in Organic reactions; 18-electron rule; Bonding and reactions in transition metal complexes: oxidative addition, reductive elimination, insertion reaction; Role of palladium in homogenous catalysis; Heck reaction; Cross coupling of organometallics and halides: Stille coupling, Suzuki coupling, Sonogashira reaction, Hiyama coupling, Kumada coupling, Zimmerman coupling; Allylic electrophile activation by Pd(0); Pd catalyzed amination of aromatic ring; Nucleophilic attack to Pd(II)-alkene organometallic complexes, Metathesis reactions.	15
2	**Name Reactions and Reagents** Sharpless asymmetric hydroxylation, Staudinger reaction, Corey-Fuchs reaction, Ritter reaction, Nef reaction, Mcmurry reaction, Luche reduction, Wacker oxidation, TEMPO, Noyori asymmetric hydrogenation, Apple reaction, Corey-winter olefin reaction.	15

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3	**Sulfur, Silicon and Phosphorous in Organic Chemistry** Sulfur and organosulfur compounds; Sulfur stabilized anions; Sulfonium salts; Sulfonium ylids, Reactivity comparison of silicon and carbon; Allyl silanes as nucleophiles; Role of S. Si and P in alkene synthesis; Stereoselective synthesis of alkene; Julia olefination; Peterson reaction, Witting reaction.	**15**
4	**Organic Chemistry – Problem Solving in Context to Competitive Examinations** Solving problems based on reaction mechanism, reagents, spectroscopy and stereochemistry with special emphasis on current research.	**15**

Reference Books/Audio-visual Course:

1	Organic Chemistry by J. Clayden, N. Greeves and S. Warren, 2nd edition, Oxford University Press, UK.
2	Modern Methods of Organic Synthesis; W. Carruthers and I. Coldham, 4th edition, Cambridge University Press, UK.
3	Name Reaction for Functional Group Transformation, E. J. Corey and Jie Jack Lie, John Wiley and Sons, New Jersey.
4	Name Reactions, Jie Jack Lie, 4th edition, Springer, New York.
5	Selected Organic Synthesis, Ian Fleming, John Wiley & Sons, New Jersey.

Supplementary learning Material:	
1	https://www.youtube.com/watch?v=8ATLlV5GvyE
2	https://www.youtube.com/watch?v=kj33slI9_L8
3	https://www.youtube.com/watch?v=D62R5PB5fk4

Pedagogy:

- To motivate students and deepen their understanding of chemistry, instructors need to plan thoughtful lessons in advance and establish clear learning goals. Allowing students to reflect on their knowledge complemented by effective questioning from the instructor helps them solidify concepts.
- Other effective lesson formats are appropriate for some topics in chemistry include role playing, manipulation of concepts via simulations and differentiated instruction. Cognitive science discourages "teaching as telling," therefore careful planning is necessary to avoid this pitfall. If a lecture format is decided to be the most effective way to teach a concept, allow students to preview the information and provide them in advance with organizers to maximize participation and promote student understanding.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
0	40	40	10	5	5	

Course Outcomes (CO):		
Sr.	**Course Outcome Statements**	**%weightage**

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CO-1	After completion of this course, the students will be able: To revisit and clearing basic knowledge of organic chemistry specifically the stereochemistry and organic reactions towards the formation of C-C bond. To acquaint students with the knowledge of organic reaction mechanisms of aromatic electrophilic substitution and aromatic nucleophilic substitution reactions. It provides an introduction to the synthesis of complex organic molecules. To acquaint students with the knowledge of transformations for C-X and C-C bond-formation, functional group reactivity, chemoselectivity, regioselectivity, and the strategy of multistep synthesis will be the core topics that are covered.	**25**
CO-2	To have knowledge of various novel name reactions and to solve the theoretical problems related to them.	**25**
CO-3	To formulate the P, S or Si product formed from a given set of reagents To identify the alkene-forming reaction type for a given set of reagents, To predict the stereochemistry of the (major) alkene product. To show how silyl ethers can be used as hydroxyl protecting groups in organic chemistry.	**25**
CO-4	To have some idea in problem solving in competitive examinations like NET, GATE etc. and how to approach to the question asked in such examination can be solved easily with correct way of problem solving method.	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **Master of Science (Organic Chemistry)**

Semester: **IV**

Course Code: **201330410**

Course Title: **Applied Organic Chemistry**

Course Group: **Elective Subject**

Course Objectives:

a) To familiarize themselves quickly with new developments, to be introduced to new areas and to make independent contributions to further developments of research and technology in their specialized area once they have finished their program.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
4	-	-	4	50/20	50/20	-	-	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Organic Chemistry in Industry** Introduction, Process Chemistry *versus* Research Chemistry, Pharmaceutical Industry: Drug Discovery, Drug development-Preclinical and clinical testing, Medicine, Future Problems and Opportunities. Agrochemical Industry: Herbicides, Fungicides and Insecticides. Dyes Industry: Textile and Food dyes.	15
2	**Organic Chemistry and Environment** Introduction, Pesticides, Focus on POPs and VOCs, Endocrine Disruptors, Chlorofluorocarbons and their Replacements, Polycyclic Aromatic Hydrocarbons, Plastics, Green Chemistry and the future.	15
3	**Organic Chemistry in Forensic Science** Introduction, Drugs of Abuse: Categories, Presumptive Tests, Instrumental Methods and Designer Drugs, Poisoning, Testing of Blood, Dyes, Inks and Paper, Trace Evidence, Fingerprints Visualization.	15

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4	**Organic Reactions Catalysis** Introduction, Catalysis by Acids and Bases, Lewis Acid Catalysis, Phase-Transfer Catalysis, Reactions Catalyzed by Metal Surfaces and Transition Metal Complexes, Enzyme and Organocatalysis.	**15**

Reference Books/Audio-visual Course:

1	Organic Chemistry: A Mechanism Approach; Penny Chaloner, CRC Press, Tailor and Francis; Florida.
2	Pharmaceutical Process development: Current Chemical and Engineering Challenges, J. Blacker and M. T. Williams, RSC Cambridge, UK.
3	Fine Chemicals: The Industry and Its Business, P. Pollak, 2nd Edition, Wiley.
4	The Evolution of Drug Discovery: From Traditional Medicines to Modern Drugs, E. Ravina, Wiley.
5	Name Reactions, Jie Jack Lie, 4th edition, Springer, New York.
6	Catalysis of Organic Reactions, John R. Sowa, Jr., CRC Press, Tailor and Francis, Florida.

Supplementary learning Material:	
1	https://www.youtube.com/watch?v=SSuhJnmEUlI
2	https://www.youtube.com/watch?v=WiwavkpN7_8
3	https://www.youtube.com/watch?v=VQj2gj_rrkQ

Pedagogy:

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
17	17	17	17	16	16	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	After completion of this course, the students will be able: To evaluate process and research chemistry in pharmaceutical, agrochemical, and dye industries.	**25**
CO-2	To explain the organic chemistry of environmental pollutants and green chemistry.	**25**
CO-3	To explain role of organic chemistry in forensic science.	**25**

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CO-4	To explain use of catalysis in organic reaction by transition metal catalyst, phase transfer catalyst, catalysis by acid, base enzyme, and metal surface	**25**

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