Academic Council Meeting No. and Date: 9 / July 02, 2024

Agenda Number: 3 **Resolution Number: 41,42/ 3.15,3.35**

Vidya Prasarak Mandal's

B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme: Master of Science

Specific Programme:

ORGANIC CHEMISTRY

Programme Code: [BPCH]

[M.Sc. (Semester III and IV)]

Level 6.5

CHOICE BASED GRADING SYSTEM

Revised under NEP

From academic year 2024-25

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Sr. no	Heading	Particulars
1	**Title of the course**	**M.Sc. in Organic Chemistry**
2	**Eligibility for Admission**	Level 6.0
3	**Passing Marks**	**40%**
4	**Ordinances/Regulations (if any)**	**Nil**
5	**No of Years/Semesters**	**Two years, Four semesters**
6	**Level**	**P.G. 6.5**
7	**Pattern**	**Semester**
8	**Status**	**Revised as per NEP 2020**
9	**To be Implemented from Academic Year**	**2024-25**

B. N. Bandodkar College of Science, (AUTONOMOUS)-Thane

Master program in Organic Chemistry

Year (2 Yrs)	LEVEL	SEMESTER	Major				Research Methodology	On Job Training / Field project	Research project	Cum Credits	Degrees
			Mandatory		Electives anyone						
I	6.0	SEM-I	**3*4 + 2 = 14**		Credits 4		**Credits 4**	NA	NA	22	PG Diploma in **Organic Chemistry** (After 3 Yrs. degree UG)
			Course 1	Credits 4	Course 1= Credits 4						
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2 = Credits 4						
			Course 4	Credits 2	**OR**						
		SEM-II	Course 1	Credits 4	Course 1 = Credits 4		NA	**Credits 4**	NA	**22**	
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2 = Credits 4						
			Course 4	Credits 2	**OR**						
Cum Cr.for 1 Yr. PG Diploma			**28**		8		4	4		44	
II	6.5	SEM- III	Course 1	Credits 4	Course 1	Credits 4	NA	NA	**Credits 4**	22	Master program in **Organic Chemistry** (After 3 Yrs. degree UG)
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2	Credits 4					
			Course 4	Credits 2	**OR**						
		SEM IV	Course 1	Credits 4	Course 1	Credits 4	NA	NA	**Credits 6**	**22**	
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2	Credits 4					
					OR						
Cum Cr. for integrated 1 Yr. PG Degree				**26**	**8**				**10**	**44**	
Cum Cr. for 2 Yr. PG Degree				**44**	**16**		**4**	**4**	**10**	**88**	

PREAMBLE

The M.Sc. Level 6.5 (Chemistry) programme is aimed to make the learners employable and impart industry oriented training. The main objectives of the course are:

- To work and communicate effectively as a part of a team to achieve a common stated goal with a range of audiences in cooperation with technical and non-technical.
- To be capable of managing complex civic issues with consideration of the human, financial and environmental factors.
- To think analytically, creatively and critically in developing robust, extensible and highly maintainable technological solutions to simple and complex problems to be employed and excel in Chemistry.

The syllabus is aimed to achieve the objectives. The syllabus spanning two years covers the industry and society need relevant courses. Elective courses along with practicals are given on choice based of learner interest. Choice based any two semester given to the learner from two year Chemistry PG Course for integrated MSc chemistry course. The learners will be ready for the jobs available in different fields like mentioned in programme outcome.

Prof.(Dr.) Anita S.Goswami-Giri
BOS Chairperson

➢ PROGRAMME OUTCOMES (POs) OF MASTERS IN SCIENCE (M.Sc.)

The Postgraduate Programmes of Science are intended to cater quality education and attain holistic development of learners through the following programme outcomes:

PO1 – Domain Knowledge
Comprehend and demonstrate domain knowledge in specialized branch of science. Instil ability to apply it in upgrading professional, social and personal life.

PO2 – Development of Research Competence
Imbibe skills related to identification of research problem, formulating hypothesis, execution of research process, analysing data, interpreting the data, drawing conclusion and presenting research work. Encourage learners for doctoral studies.

PO3 - Digital Literacy
Enhance ability to access, select and use a variety of relevant information e-resources for creating new knowledge resources.

PO4 - Sensitization towards Environment
Build cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Team work
Encourage learner to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 – Competence for Employment
Promote field work, internships, industrial training, research projects, research paper presentations and publications to develop competence for adapting towards dynamic socio-economic changes and make learner employable.

Eligibility:
Level 6.0

Duration: 1 year (Level 6.5)

Mode of Conduct: Laboratory practicals / Offline lectures / Online lectures

Total Credits for the Program: 88

Starting year of implementation: 2024-25

PROGRAM SPECIFIC OUTCOMES (PSOS) FOR MSC BIODIVERSITY, WILDLIFE CONSERVATION AND MANAGEMENT

M.Sc. Organic Chemistry (First & Second Year)

PSO1 – Advanced Organic Knowledge
Demonstrate in-depth understanding of advanced organic chemistry concepts including reaction mechanisms, stereochemistry, heterocyclic chemistry, pericyclic reactions, and structure–reactivity relationships. (L4)

PSO2 – Synthetic and Practical Skills
Apply modern organic synthesis techniques, purification methods, and spectroscopic tools (UV-Vis, IR, NMR, MS) for the synthesis, characterization, and analysis of organic compounds. (L3)

PSO3 – Research and Problem-Solving Ability
Develop research aptitude by analyzing experimental data, interpreting literature, designing synthetic pathways, and solving complex chemical problems using logical and mechanistic reasoning. (L5)

PSO4 – Green and Sustainable Chemistry
Integrate principles of green chemistry and sustainability in organic synthesis by minimizing waste, reducing toxicity, improving atom economy, and adopting environmentally benign methodologies. (L5)

PSO5 – Professional and Industrial Readiness
Demonstrate competence for careers in pharmaceuticals, agrochemicals, fine chemicals, quality control, and R&D by understanding industrial processes, regulatory practices, and safety standards. (L4)
PSO6 – Communication, Ethics, and Lifelong Learning
Exhibit scientific communication skills, ethical research practices, teamwork, and lifelong learning abilities essential for academic pursuits, doctoral research, and interdisciplinary collaboration. (L6)

ASSESSMENT: WEIGHTAGE FOR ASSESSMENTS (IN PERCENTAGE) FOR MANDATORY AND ELECTIVE COURSE

Type of Course	**Formative Assessment / Internal Assessment**	**Summative Assessment**
Theory	40%	60%
Practical	-	100%

Internals Based on Unit 1 / Unit 2 / Unit 3/ Unit 4

Assignments/ Tutorials	Ppt/video Presentation	Active Participation & Leadership qualities	Total
15	15	10	40

VPM's B. N. Bandodkar College of Science (Autonomous), Thane
M.Sc. in Biodiversity, Wildlife Conservation and Management
Structure of Programme

Class	Sem	Course type	Course Code	Course Title	Credits
Part 2	SEM 3	**MANDATORY**	**24BPCH3T01**	Theoretical organic chemistry-I	4
			24BPCH3T02	Synthetic Organic Chemistry-I	4
			24BPCH3T03	Natural products and Spectroscopy	4
			24BPCH3P01	Practicals based on 24BPCH3T01 and 24BPCH3T02	2
		ELECTIVE	24BPCH3T04	Medicinal Chemistry	2
			24BPCH3P02	Practicals based on 24BPCH3T03 and 24BPCH3T04	2
			OR		
			24BPCH3T05	Biogenesis and Green chemistry	2
			24BPCH3P03	Practicals based on 24BPCH3T05	2
			24BPCH3RP1	Research Project - I Based on Chemistry	4
				Total	22
	SEM 4	**MANDATORY**	24BPCH4T01	Theoretical organic chemistry-II	4
			24BPCH4T02	Synthetic organic chemistry-II	4
			24BPCH4T03	Natural products	2
			24BPCH4P01	Practicals based on 24BPCH4T01 and 24BPCH4T02	2
		ELECTIVE	24BPCH4T04	Heterocyclic chemistry	2
			24BPCH4P02	Practicals based on 24BPCH4T03 and 24BPCH4T04	2
			OR		
			24BPCH2T05	INTELLECTUAL PROPERTY RIGHTS	2
			24BPCH2P03	Practical Based on 23BPCH2T05 Case study	2
			24BPCH4RP1	Research Project - II Based on Chemistry	6
				Total	22
TOTAL SEM 3 & SEM 4					**44**

Mode of Conduct: Laboratory and field practical / Offline / Online / Hybrid mode

VPM's B.N. Bandodkar College of Science (Autonomous), Thane

Curriculum Structure for the Post Graduate Degree Programme M.Sc. BiOrganic Chemistry

	SEMESTER – III	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
24BPCH3T01	**Theoretical organic chemistry-I**	-	-	-	-	-	-	-
24BPCH3T02	**Synthetic Organic Chemistry-I**	-	-	-	-	-	-	-
24BPCH3T03	**Natural products and Spectroscopy**	-	-	√	-	-	√	√
24BPCH3P01	Practicals based on **24BPCH3T01 and 24BPCH3T02**	-	-	√	-	-	-	-
Optional Electives Semester 1 -								
24BPCH3T04	**Medicinal Chemistry**	√	√	-	-	--	--	√
24BPCH3P02	Practicals based on **24BPCH3T03 and 24BPCH3T04**	-	-	√	-	-	-	-
OR								
24BPCH3T05	**Biogenesis and Green chemistry**	√	--	-	--	--	--	√

24BPCH3P03	**Practicals based on 24BPCH3T05**	√	-	-	-	-	-	-
OR								
24BPCH3RP1	Research Project - I Based on Chemistry	√	√	√	--	--	√	--
	Total	**4**	**2**	**4**	**0**	**0**	**2**	**3**
	SEMESTER – IV	**Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)**			**Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)**			
Course Code	**Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
24BPCH4T01	Theoretical organic chemistry-II	-	-	-	-	-	-	-
24BPCH4T02	Synthetic organic chemistry-II	-	-	√	-	-	-	-
24BPCH4T03	Natural products	√	-	√	-	-	-	√
24BPCH4P01	Practicals based on **24BPCH4T01 and 24BPCH4T02**	-	-	√	-	-	-	-
Optional Electives Semester 1 -Interdisciplinary Sciences								
24BPCH4T04	Heterocyclic chemistry	--	--	√	-	--	--	--
24BPCH4P02	Practicals based on **24BPCH4T03 and 24BPCH4T04**	-	-	√	-	-	-	-
OR								
24BPCH2T05	**INTELLECTUAL PROPERTY RIGHTS**	--	--	√	--	--	√	--
24BPCH2P03	**Practical Based on 23BPCH2T05**							

	Case study							
III] RESEARCH PROJECT								
24BPCH4RPI	Research Project - II Based on Chemistry	√	√	√	**--**	**--**	**-**	√
	Total	**2**	**1**	**7**	**0**	**0**	**1**	**2**

Dr. Anita Goswami -Giri

BOS Chairman & Head Dept. Of Chemistry

SEMESTER III
MANDATORY

Course Code 24BPCH3T01	Course Title Theoretical organic chemistry-I	Credits 04	No. of lectures 60

Course Outcomes:

At the end of the course students will be able to:

CO 1	Explain and predict organic reaction mechanisms involving reactive intermediates, neighbouring group participation, FMO interactions, and pericyclic reactions.	L2
CO 2	Analyze and predict the stereochemical and mechanistic features of cycloaddition, electrocyclic, and sigmatropic pericyclic reactions using orbital symmetry principles.	L2
CO 3	Interpret and analyze stereochemical features, conformational behavior, and reactivity of cyclic, fused, and bridged organic systems.	L5
CO 4	Explain and apply the principles of photochemistry to analyze excited-state processes and reaction mechanisms of organic molecules.	L4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	1	0	0	2
CO 2	3	3	1	0	0	2
CO 3	3	3	0	0	0	2
CO 4	3	3	1	1	0	2

Unit I:	**1. Organic reaction mechanisms** **1.1.** Organic reactive intermediates, methods of generation, structure, stability and important reactions involving carbocations, nitrenes, carbenes, arynesand ketenes**.[5L]** **1.2. Neighbouring group participation:** Mechanism and effects of anchimeric assistance, NGP by unshared/ lone pair electrons, π-electrons, aromatic rings, σ-bonds with special reference to norbornyl and **bicyclo[2.2.2]octylcation** systems (formation of non-classical carbocation) **[3L]** **1.3. Role of FMOs in organic reactivity:** Reactions involving hard and soft electrophiles and nucleophiles, ambident nucleophiles, ambident electrophiles, the α effect. **[2L]** **1.4. Pericyclic reactions: [5L]** Classification of pericyclic reactions; thermal and photochemical reactions. Three approaches: Evidence for the concertedness of bond making and breaking Symmetry-Allowed and Symmetry-Forbidden Reactions – ● The Woodward-Hoffmann Rules-Class by Class ● The generalised Woodward-Hoffmann Rule Explanations for Woodward-Hoffmann Rules	**15**

	● The Aromatic Transition structures [Huckel and Mobius] ● Frontier Orbitals ● Correlation Diagrams, FMO and PMO approach Molecular orbital symmetry, Frontier orbital of ethylene, 1,3 butadiene,1,3,5 hexatriene and allyl system.	
Unit II:	**2. Pericyclic reactions** **2.1 Cycloaddition reactions:** [7L] **2.2** Supra and antra facial additions, 4n and 4n+2 systems, 2+2 additions of ketenes. Diels-Alder reactions, 1, 3-Dipolar cycloaddition and cheletropic reactions, ene reaction, retro-Diels-Alder reaction, regioselectivity, periselectivity, torquoselectivity, site selectivity and effect of substituents in Diels-Alder reactions. **2.3 Other Cycloaddition Reactions- [**4+6] Cycloadditions, KeteneCycloaddition, Allene Cycloadditions, Carbene Cycloaddition, Epoxidation and Related Cycloadditions. **2.4 Other Pericyclic reactions:** Sigmatropic Rearrangements, Electrocyclic Reactions, Alder 'Ene' Reactions. **2.5 Electrocyclic reactions:[3L]** Conrotatory and disrotatary motions, 4nπ and (4n+2)π electron and allyl systems. **2.6 Sigmatropic rearrangements:** [5L] **2.7** H-shifts and C-shifts, supra and antarafacial migrations, retention and inversion of configurations. Cope (including oxy- Cope and aza-Cope) and Claisen rearrangements. Formation of Vitamin D from 7-dehydrocholesterol, synthesis of citral using pericyclic reaction, conversion of Endiandric acid E to Endiandric acid A.	**15**
Unit III:	**3. Stereochemistry-I** **3.1** Classification of point groups based on symmetry elements with examples (nonmathematical treatment). [2L] **3.2** Conformational analysis of medium rings: Eight **to** ten membered rings and their unusual properties**,** I-strain, transannular reactions. [3L] **3.3** Stereochemistry of fused ring and bridged ring compounds: decalins, hydrindanes, perhydroanthracenes, steroids, and Bredt's rule. [5L] **3.4 Anancomeric systems,** Effect of conformation on reactivity of cyclohexane derivatives in the following reactions (including mechanism): electrophilic addition, elimination, molecular rearrangements, reduction of cyclohexanones **(with $LiAlH_4$, selectride and MPV reduction)** and oxidation of cyclohexanols**.** [5L]	**15**

Unit IV:	**4 Photochemistry** **4.1 Principles of photochemistry:** [3L] Quantum yield, electronic states and transitions, selection rules, modes of dissipation of energy (Jablonski diagram), electronic energy transfer: photosensitization and quenching process. **4.2 Photochemistry of carbonyl compounds:** [8L] $\pi \rightarrow {}^{*}\pi^{*}$, $n \rightarrow {}^{*}\pi^{*}$ transitions, Norrish- I and Norrish-II cleavages, Paterno-Buchi reaction. Photoreduction, calculation of quantum yield, photochemistry of enones, photochemical rearrangements of α, β-unsaturated ketones and cyclohexadienones. Photo Fries rearrangement, Barton reaction. **4.3 Photochemistry of olefins:** [2L] cis-trans isomerizations, dimerizations, hydrogen abstraction, addition and Di- π-methane rearrangement including aza-di- π -methane. Photochemical Cross-Coupling of Alkenes, Photodimerisation of alkenes. **4.4 Photochemistry of arenes:** [1L] 1, 2- , 1, 3- and 1, 4- additions. Photocycloadditions of aromatic Rings. **4.5** Singlet oxygen and photo-oxygenation reactions. Photochemically induced Radical Reactions. Chemiluminescence. [1L]	**15**

References :

1. March's Advanced Organic Chemistry, Jerry March, 6th edition,
2. Organic Chemistry 2007, John Wiley and sons.
3. A guide to mechanism in Organic Chemistry, 6th edition, 2009,Peter Sykes, Pearson education, New Delhi.
4. Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press (2002).
5. Mechanism and theory in Organic Chemistry, T. H. Lowry and K. C. Richardson, Harper and Row.
6. Organic Reaction Mechanism, 4th edition, V. K. Ahluvalia, R. K.Parashar, Narosa Publication.
7. Reaction Mechanism in Organic Chemistry, S.M. Mukherji, S.P.Singh, Macmillan Publishers, India.
8. Organic Chemistry, Part A and B, Fifth edition,2007, Francis A.Carey and Richard J. Sundberg, Springer.
9. Carbenes, Nitrenes and Arynes. Von T. L. Gilchrist, C. W. Rees. Th. Nelson and Sons Ltd., London 1969.
10. Organic reactive intermediates, Samuel P. MacManus, Academic Press.
11. Organic Chemistry, J. Clayden, S. Warren, N. Greeves, P. Wothers, 1st Edition, Oxford University Press (2001).
12. Organic Chemistry, 7thEdition, R.T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson.
13. Advanced Organic Chemistry: Reactions & Mechanisms, second edition, B. Miller and R. Prasad, Pearson.
14. Organic reactions & their mechanisms, third revised edition, P.S. Kalsi, New Age International Publishers.

Course Code 24BPCH3T02	Course Title Synthetic Organic Chemistry-I	Credits 04	No. of lectures 60

Course Outcomes:

At the end of the course students will be able to:

CO 1	Explain mechanisms and synthetic applications of key name reactions, domino, multicomponent, and click reactions in organic synthesis.	L2
CO 2	Describe generation, stability, and reactivity of free radicals and their role in organic synthesis, including radical initiators, mechanisms, and key coupling reactions.	L2
CO 3	Explain the generation, reactivity, and synthetic applications of enamines, ylides, and α-C–H functionalization in C–C bond formation and olefination reactions.	L2
CO 4	Illustrate the role of metals and non-metals in organic synthesis, emphasizing mechanisms, regioselectivity, and bond-forming applications of organomercury, boron, silicon, tin, and selenium compounds.	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	1	0	1	2
CO 2	3	2	0	0	3	2
CO 3	3	2	0	0	1	2
CO 4	3	2	0	1	1	2

Unit I:	**1.0Name reactions with mechanism and application** 1.1 Mukaiyama esterification, Mitsonobu reaction, Darzen's Glycidic Ester syntheis, Ritter reaction, Yamaguchi esterification, Peterson olefination. [5L] **1.2 Domino reactions**: [3L] Characteristics; Nazerov cyclization **1.3 Multicomponent reactions**: [5L] Strecker Synthesis, Ugi 4CC, Biginelli synthesis, Hantzsch synthesis, Pictet-Spengler synthesis **1.4 Click Reactions**: [2L] Characteristics; Huisgen 1,3-Dipolar Cycloaddition.	**15**
Unit II:	**2.Radicals in organic synthesis.**	**15**

	2.1 **Introduction:** [3L] Generation, stability, reactivity and structural and stereochemical properties of free radicals, Persistent and charged radicals, Electrophilic and nucleophilic radicals. 2.2 **Radical Initiators**: [1L] azobisisobutyronitrile (AIBN) and dibenzoyl peroxide. **2.3 Characteristic reactions** - [4L] Free radical substitution, addition to multiple bonds. Radical chain reactions, Radical halogenation of hydrocarbons (Regioselectivity),radical cyclizations, autoxidations: synthesis of cumene hydroperoxide from cumene. **2.4 Radicals in synthesis**: [4L] Inter and intra molecular C-C bond formation via mercuric hydride, tin hydride, thiol donors. Cleavage of C-X, C-Sn, C-Co, C-S, O-O bonds. Oxidative coupling, C-C bond formation in aromatics: SRNAr reactions**.** ● **2.5** Hunsdiecker reaction, Pinacol coupling, McMurry coupling, Sandmeyer reaction, Acyloin condensation. [3L]	
Unit III:	**3.Enamines, Ylides and α-C-H functionalization** 3.1 **Enamines:** [4L] Generation & application in organic synthesis with mechanistic pathways, Stork enamine reaction. Reactivity, comparison between enamines and enolates. Synthetic reactions of enamines including asymmetric reactions of chiral enamines derived from chiral secondary amines. 3.2 **Phosphorus, Sulfur and Nitrogen Ylides:** [6L] Preparation and their synthetic applications along with their stereochemical aspects. Wittig reaction, Horner-Wadsworth-Emmons Reaction, Barton-Kellogg olefination. 3.3 **α-C-H functionalization:** [5L] By nitro, sulfoxide, sulfone and phosphonate groups: generation of carbanions by strong bases (LDA/n-butyl lithium) and applications in C-C bond formation. Bamford-Stevens reaction, Julia olefination and its modification, Seyferth–Gilbert homologation, Steven's rearrangement.	**15**
Unit IV:	**4.Metals / Non-metals in organic synthesis** 4.1 **Mercury in organic synthesis:** [3L] Mechanism and regiochemistry of oxymercuration and demercuration of alkenes, mercuration of aromatics, transformation of aryl mercurials to aryl halides. Organomercurials as carbene transfer reagents. 4.2 **Organoboron compounds:** [3L] Mechanism and regiochemistry of hydroboration of alkenes and alkynes, asymmetric hydroboration using chiral boron reagents, 9-BBN hydroboration,oxazaborolidine (CBS	**15**

	catalyst) and functional group reduction by diborane**.** 4.3 **Organosilicons:** [3L] Salient features of silicon governing the reactivity of organosilicons, preparation and important bond-forming reactions of alkyl silanes, alkenyl silanes, aryl silanes and allyl silanes. β-silyl cations as intermediates. Iodotrimethylsilane in organic synthesis. 4.4 **Silyl enol ethers**: [2L] Application: As nucleophiles (Michael reaction, Mukaiyama aldol reaction), in ring contraction reactions. 4.5 **Organotin compounds**: [2L] Preparation of alkenyl and allyl tin compounds; application in C-C bond formation, in replacement of halogen by H at the same C atom**.** 4.6 **Selenium in organic synthesis:** [2L] Preparation of selenols/ selenoxide, selenoxide elimination to create unsaturation, selenoxide and seleno acetals as α-C-H activating groups.	

REFERENCES

1. Advanced Organic Chemistry, Part A and Part B: Reaction and Synthesis, Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer Verlag
2. Modern Methods of Organic Synthesis, 4th Edition, W. Carruthers and Iain Coldham, Cambridge University Press, 2004.
3. Chem.Rev. 2002, 102, 2227-2302, Rare Earth Metal Triflates in Organic Synthesis, S. Kobayashi, M. Sugiura, H. Kitagawa, and W.W.L. Lam.
4. Organic Chemistry, Clayden Greeves Warren and Wothers,Oxford Press (2001).
5. Moder Organic Synthesis: An Introduction, G.S. Zweifel and M.H. Nantz, W.H. Freeman and Company, (2007).
6. Advanced Organic Chemistry: Reaction Mechanism, R.Bruckner, Academic Press (2002).
7. Principles of Organic Synthesis, R.O.C. Norman & J. M. Coxon,3rd Edn., Nelson Thornes
8. Organic Chemistry, 7th Edn, R. T .Morrison, R. N. Boyd, & S. K. Bhattacharjee, Pearson
9. Strategic Applications of Name Reactions in Organic Synthesis, L. Kurti & B. Czako (2005), Elsevier Academic Press
10. Advanced Organic Chemistry: Reactions & Mechanisms, 2nd Edn., B. Miller & R. Prasad, Pearson
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12. Organic Synthesis: The Disconnection Approach, Stuart Warren, John Wiley & Sons, 2004
13. Name Reactions and Reagents in Organic Synthesis, 2nd Edn., Bradford P. Mundy, Michael G. Ellard, and Frank Favoloro, Jr., Wiley-Interscience
14. Name Reactions, Jie Jack Lie, 3rd Edn., Springer
15. Organic Electrochemistry, H. Lund, and M. Baizer, 3rd Edn.,Marcel Dekker.

Course Code 24BPCH3T03	Course Title Natural products and Spectroscopy	Credits 04	No. of lectures 60

Course Outcomes:

At the end of the course students will be able to:

CO 1	Discuss the Biosynthesis of various natural products and describe Insect pheromones and Natural pigments.	L2
CO 2	Elucidate Multi-step synthesis of natural products and discuss the classification of lipids and prostaglandin,plant growth regulators and insect growth regulators.	L4
CO 3	Determine and interpret the structures of various organic compounds through spectroscopic methods.	L4
CO 4	Apply advanced spectroscopic techniques, including UV, IR, ^{1}H NMR, and ^{13}C NMR, to interpret spectral data and elucidate the structures of organic compounds.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	0	2	0	1
CO 2	3	2	0	2	0	2
CO 3	3	3	2	0	0	3
CO 4	3	2	2	0	0	3

Unit I:	**1. Natural products-I [5L]** **1.1 Carbohydrates:** Introduction to naturally occurring sugars: Deoxysugars,amino sugars, branched sugars. Structure elucidation of lactose and Dglucosamine (synthesis not expected).Structural features and applications of inositol, starch, cellulose, chitin and heparin**.** **1.2Natural pigments: [5L]** General structural features, occurrence, biological importance and applications of: carotenoids, anthocyanins, quinones, flavones, pterins and porphyrins (chlorophyll). Structure elucidation of β- carotene and Cyanin (with synthesis). Synthesis of ubiquinone from 3, 4, 5- trimethoxyacetophenone. **1.3 Insect pheromones: [3L]** General structural features and importance. Types of pheromones (aggregation, alarm, releaser, primer, territorial, trail, sex pheromones etc.), advantage of pheromones over conventional pesticides. Synthesis of bombykol from acetylene, disparlure from 6-methylhept-1-ene, grandisol from 2-methyl-1, 3-butadiene**.** **1.4 Alkaloids: [2L]** • Occurrence and physiological importance of morphine and atropine. Structure elucidation, spectral data and synthesis of coniine.	**15**

Unit II:	**2.Natural products-II** 2.1 **Multi-step synthesis of natural products: [8L]** Synthesis of the following natural products with special reference to reagents used, stereochemistry and functional group transformations: a) Woodward synthesis of Reserpine from benzoquinone b) Corey synthesis of Longifoline from resorcinol c) Gilbert-Stork synthesis of Griseofulvin from phloroglucinol d) Corey's Synthesis of Caryophyllene from 2-Cyclohexenone and Isobutylene e) Synthesis of Juvabione from Limonene f) Synthesis of Taxol. 2.2 **Prostaglandins: [2L]** Classification, general structure and biological importance. Structure elucidation of PGE_1. 2.3 **Lipids: [2L]** Classification, role of lipids, Fatty acids and glycerol derived from oils and fats. 2.4 **Insect growth regulators: [1L]** General idea, structures of JH_2 and JH_3 . 2.5 **Plant growth regulators: [2L]** Structural features and applications of arylacetic acids, gibberellic acids and triacontanol. Synthesis of triacontanol (synthesis of stearyl magnesium bromide and 12-bromo-1- tetrahydropyranyloxydodecane expected).	**15**
Unit III:	**3.0 Advanced spectroscopic techniques-I** 3.1 **Proton NMR spectroscopy: [7L]** Recapitulation, chemical and magnetic equivalence of protons, First order, second order, Spin system notations (A_2, AB, AX, AB_2, AX_2, AMX and A_2B_2-A_2X_2 spin systems with suitable examples). Long range coupling (Allylic coupling, 'W' coupling and Coupling in aromatic and heteroaromatic systems), Temperature effects, Simplification of complex spectra, nuclear magnetic double resonance, chemical shift reagents. 3.2 **^{13}C –NMR spectroscopy: [4L]** Recapitulation, equivalent and non-equivalent carbons (examples of aliphatic and aromatic compounds), $_{13}$C- chemical shifts, calculation of $_{13}$C- chemical shifts of aromatic carbons, heteronuclear coupling of carbon to $_{19}$F and $_{31}$P. 3.3 Spectral problems based on UV, IR, $_1$HNMR and $_{13}$CNMR and Mass spectroscopy. [4L]	**15**

Unit IV:	**4.0 Advanced spectroscopic techniques-II** 4.1 **Advanced NMR techniques: [10L]** DEPT experiment, determining number of attached hydrogens (Methyl/methylene/methine and quaternary carbons), two dimensional spectroscopic techniques, COSY and HETCOR spectra, NOE and NOESY techniques. 4.2 Spectral problems based on UV, IR, ^{1}HNMR, ^{13}CNMR (Including 2D technique) and Mass spectroscopy [5L]	**15**
	References **1.** Natural product chemistry, A mechanistic, biosynthetic and ecological approach, Kurt B.G. Torssell, Apotekarsocieteten Swedish Pharmaceutical Press. **2.** Natural products chemistry and applications, Sujata V. Bhat, B.A. Nagasampagi and S. Meenakshi, Narosa Publishing House, 2011. **3.** Organic Chemistry Natural Products Volume-II, O. P. Agarwal, Krishna Prakashan, 2011. **4.** Chemistry of natural products, F. F. Bentley and F. R. Dollish, 1974 **5.** Natural Product Chemistry Vol.1 and 2, K. Nakanishi J. Goto. S.Ito Majori and S. Nozoo, Academic Press, 1974. **6.** Chemistry of natural products, V.K. Ahluwalia, Vishal Publishing Co. 2008. **7.** Heterocyclic chemistry, 3rd edition, Thomas L. Gilchrist, Pearson Education, 2007. **8.** Heterocyclic Chemistry, Synthesis, Reactions and Mechanisms, R. K. Bansal, Wiley Eastern Ltd., 1990 9. Heterocyclic Chemistry, J. A. Joule and G. F. Smith, ELBS, 2nd edition, 1982. **10.** The Conformational Analysis of Heterocyclic Compounds, F.G. Riddell, Academic Press,1980. **11.** Principles of Modern Heterocyclic Chemistry, L.A. Paquette, W.B. Benjamin, Inc., 1978. **12.** An Introduction to the Chemistry of Heterocyclic Compounds, 2nd edition, B.M. Acheson, 1975. **13.** Natural Products: Chemistry and Biological Significance Interscience, J. Mann, R.S.Davidson, J.B.Hobbs, D.V. Banthrope and J. B. Harborne, Longman,Essex, 1994. **14.** Organic Chemistry, Vol 2, I.L. Finar, ELBS, 6th edition, Pearson. **15.** Stereoselective Synthesis: A Practical Approach, M. Nogradi, Wiley-VCH, 1995. **16.** Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier. **17.** Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publishers. **18.** Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers, 1998. **19.** New Trends in Natural Product Chemistry, Atta-ur-Rahman and M.I. Choudhary, Harwood Academic Publishers, 1998.	

Course Code 24BPCH3P01	Practicals based on 24BPCH3T01 and 24BPCH3T02	Credits 02	No. of lectures 60

Course Outcomes:

At the end of the course students will be able to:

CO 1	Separate a given ternary mixture (S–S–S, S–S–L, S–L–L, L–L–L) using suitable solvent and reagent systems based on differences in physical and chemical properties of the components	L4
CO 2	Identify the two specified components of the mixture using systematic micro-scale qualitative analysis and confirmatory tests.	L4
CO 3	Prepare an appropriate solid derivative of any one separated component and confirm its identity using melting point and literature data.	L3
CO 4	Interpret and record experimental observations, justify the choice of separation scheme/derivative, and follow good laboratory, safety, and waste-disposal practices during the analysis	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	0	1	1	3
CO 2	3	3	0	0	1	3
CO 3	3	2	1	0	0	3
CO 4	3	3	0	3	1	3

Separation of a ternary mixture of organic compounds and

identification including derivative preparations using micro-scale technique

Separation of a ternary mixture (S-S-S, S-S-L, S-L-L and L-L-L) (for solid mixture: water insoluble/ soluble including carbohydrates) based upon differences in the physical and the chemical properties of the components.

2. Identification of the two components (indicated by the examiner) using micro-scale technique.

3. Preparation of derivatives (any one of separated compound).

(Minimum 4 experiments)

SEMESTER III
ELECTIVE I

Course Code 24BPCH3T04	Course Title Medicinal Chemistry	Credits 02	No. of lectures 30

Course Outcomes:

At the end of the course students will be able to:

CO 1	Discuss the basic concept in medicinal and pharmaceutical chemistry and its therapeutic significance.	L2
CO 2	Describe the structural relationship with effective drug doses to the targeted disease.	L2
CO 3	Elaborate the Synthesis of various organic compound/ drugs their reaction and application of the same industrial point of view.	L4
CO 4	Elucidate the adverse effects of the drugs.	L4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	0	0	0	2
CO 2	3	1	0	0	0	2
CO 3	3	3	1	0	0	3
CO 4	3	3	0	1	0	3

Unit I:	**1.0 Drug discovery, design and development [7L]** Introduction, important terms used in medicinal chemistry: receptor, therapeutic index, bioavailability, drug assay and drug potency. General idea of factors affecting bioactivity: Resonance, inductive effect, bioisosterism, spatial considerations. Basic pharmacokinetics: drug absorption, distribution, metabolism (biotransformation) and elimination. Physical and chemical parameters like solubility, lipophilicity, ionization, pH, redox potential, H-bonding, partition coefficient and isomerism in drug distribution and drug-receptor binding**.** **1.2 Procedures in drug design:** [8L] Drug discovery without a lead: Penicillin, Librium. Lead discovery: random screening, non random (or targeted) screening. Lead modification: Identification of the pharmacophore, Functional group modification. Structure-activity relationship, Structure modification to increase potency and therapeutic index: Homologation, chain branching, ring-chain transformation, bioisosterism, combinatiorial (basic idea).	**15**

Unit II:	**2.0 Drug design, development and synthesis.** 2**.1 Introduction to quantitative structure activity relationship studies.** QSAR parameters: - steric effects: The Taft and other equations; Methods used to correlate regression parameters with biological activity: Hansch analysis- A linear multiple regression analysis. [5L] **2.2 Introduction to modern methods of drug design and synthesis-** [3L] Computer aided molecular graphics based drug design, drug design via enzyme inhibition (reversible and irreversible), bioinformatics and drug design. **2.3 Concept of prodrugs and soft drugs**. [3L] **(a)** Prodrugs: Prodrug design, types of prodrugs, functional groups in prodrugs, advantages of prodrug use. **(b)** Soft drugs: concept and properties. **2.4 Synthesis and application of the following drugs:** [4L] Fluoxetine, cetrizine, esomeprazole, fluconazole, zidovudine, methotrexate, diclofenac, labetalol, fenofibrate.	**15**
	REFERENCES **1.** Nelson, D. L, and Cox, M. M, (2008) Lehninger principles of **2.** Biochemistry 5th Edition, W. H. Freeman and Company, NY., USA. **3.** Stryer, Lubert; Biochemistry; W. H. Freeman publishers. **4.** Voet, D. and J. G. Voet (2004) Biochemistry, 3rd Edition, John Wiley & sons, Inc. USA. **5.** Zubay, Goffrey L; Biochemistry; Wm C. Brown publishers. **6.** V. Polshettiwar, R. Luque, A. Fihri, H. Zhu, M. Bouhrara and J-M Basset, Chem. Rev. 2011, 111, 3036-3075; **7.** R. B. Nasir Baig and R. S.Varma, Chem. Comm., 2013, 49, 752-770; **8.** M. B. Gawande, A. K. Rathi, P. S. Varma, Appl. Sci., 2013, 3, 656-674; **9.** J. Govan and Y. K. Gun'ko, Nanomaterials, 2014, 4, 222-214. **10.** K. Philippot and P. Serp, Nanomaterials in catalysis, First Edition. Edited by P. Serp and K. Philippot; 2013 Wiley –VCH Verlag GmbH & Co. K GaA **11.** D. Astruc, Nanomaterials and Catalysis, Wiley-VCH Verlag GmbH & Co. KGaA, 2008, 1-48; **12.** C. N. R. Roa, A. Muller and A. K. Cheetham, The chemistry of Nanomaterials, Wiley-VCH Verlag GmbH & Co. KGaA, 2005, 1-11; **13.** The organic chemistry of drug design and drug action, Richard B. Silverman, 2nd edition, Academic Press **14.** Medicinal chemistry, D.Sriram and P. Yogeeswari, 2nd edition, Pearson **15.** An introduction to drug design-S. S. Pandeya and J. R. Dimmock (New age international) **16.** Burger's medicinal chemistry and drug discovery. by Manfred E. Wolf	

Course Code 24BPCH3P02	Practicals based on 24BPCH3T04	Credits 02

Course Outcomes:

At the end of the course students will be able to:

CO 1	Apply column chromatography principles to purify organic compounds such as acetanilide, acetyl ferrocene, 3-nitroaniline, and fluorenone, demonstrating correct packing, loading, elution, and fraction analysis	L3
CO 2	Demonstrate steam-distillation techniques for isolating volatile organic compounds including 1-nitronaphthalene, 2-chlorotoluene, and 4-nitrophenol, while explaining the role of boiling point reduction and immiscibility in purification efficiency.	L3
CO 3	Perform vacuum-distillation techniques to purify organic compounds and evaluate how reduced pressure influences boiling behaviour and product quality	L5
CO 4	Synthesize target molecules (benzyl alcohol, methyl salicylate, 4-methylacetophenone, phenyl acetate, dimethyl phthalate) through appropriate reaction pathways and assess the purity of the products using suitable analytical methods.	L4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	1	0	1	3
CO 2	3	2	0	1	1	3
CO 3	3	3	0	1	0	3
CO 4	3	3	1	0	1	3

Single step organic preparation (1.0 g scale) involving purification by Steam distillation / Vacuum distillation or Column chromatography

I) Purification by column chromatography-

1) Preparation of acetanilide from aniline and acetic acid using Zn dust

2) Preparation of acetyl ferrocene from ferrocene.

3) Preparation of 3-nitroaniline from 1,3-dinitrobenzene.

4) Preparation of fluorenone from fluorene

II]. Purification by steam distillation-

1. Preparation of 1-nitronaphthalene from naphthalene.
2. Preparation of 2-chlorotoluene from *o*-toluidine
3. Preparation of 4-nitrophenol from phenol

III]. Purification by vacuum distillation-

1. Preparation of benzyl alcohol from benzaldehyde.
2. Preparation of methyl salicylate from salicylic acid.
3. Preparation of 4-methylacetophenone from toluene.
4. Preparation of phenyl acetate from phenol.
5. Preparation of dimethylphthalate from phthalic anhydride.

(Minimum 8 experiments)

SEMESTER III

ELECTIVE II

Course Code 24BPCH3T05	Course Title Biogenesis and Green chemistry	Credits 02	No. of lectures 30

Course Outcomes:

At the end of the course students will be able to:

CO 1	Discuss Familiar with the various biosynthesis of natural product and its derivatisation.	L2
CO 2	Elaborate the synthesis of various organic compound their reaction and application of the same industrial point of view.	L4
CO 3	Describe the Study of characterization of organic compound, determination of type, elemental detection and conformation of most probable structure.	L4
CO 4	Discuss the synthesis using Green catalysts and Green reagents**.**	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	0	1	0	1
CO 2	3	3	1	0	0	3
CO 3	3	3	1	0	0	3
CO 4	3	2	0	3	0	2

Unit I:	**Biogenesis and biosynthesis of natural products** Primary and secondary metabolites and the building blocks, general pathway of amino acid biosynthesis. [3L] **Acetate pathway: [4L]** Biosynthesis of malonylCoA, saturated fatty acids, prostaglandins from arachidonic acid, aromatic polyketides. **Shikimic Acid pathway:** [4L] Biosynthesis of shikimic acid, aromatic amino acids, cinnamic acid and its derivatives, lignin and lignans, benzoic acid and its derivatives, flavonoids and isofalvonoids. **Mevalonate pathway:** [4L] Biosynthesis of mevalonic acid, monoterpenes – geranyl cation and its derivatives,sesquiterpenes – farnesyl cation and its derivatives and diterpenes.	**15**

Unit II:	**Patenting** **Unit 4: Green chemistry [15L]** **4**.1 Introduction, basic principles of green chemistry. Designing a green synthesis: Green starting materials, green reagents, green solvents andreaction conditions, green catalysts.[1L] **4.2 Use of the following in green synthesis with suitable examples: [9L]** **a) Green reagents:** dimethylcarbonate, polymer supported reagents. **b) Green catalysts:** Acid catalysts, oxidation catalysts, basic catalysts, phase transfer catalysts [Aliquat 336, benzyltrimethyl ammonium chloride (TMBA), Tetra-n-butyl ammonium chloride, crown ethers], biocatalysts. **c) Green solvents:** water, ionic liquids, deep eutectic solvents, supercritical carbon dioxide. **d) Solid state reactions:** solid phase synthesis, solid supported synthesis **e) Microwave assisted synthesis**: reactions in water, reactions in organic solvents, solvent free reactions. **f) Ultrasound assisted reactions**	**15**
	References **1.** Bioorganic chemistry - A chemical approach to enzyme action by Herman Dugas and Christopher Penney. **2.** Medicinal Natural Products: A Biosynthetic Approach by Paul M.Dewick. 3rd Edition, Wiley. **3.** Natural product chemistry, A mechanistic, biosynthetic and ecological approach, Kurt B. G. Torssell, Apotekarsocieteten – Swedish pharmaceutical press. **4.** Natural products Chemistry and applications, Sujata V Bhat, B.A.Nagasampagi and S. Meenakshi, Narosa Publishing House. **5.** Natural Products Volume- 2, By O. P. Agarwal. **6.** Green Chemistry: An Introductory Text, 2nd Edition, Published by **7.** Royal Society of Chemistry, Authored by Mike Lancater. **8.** Organic synthesis in water. By Paul A. Grieco, Blackie. **9.** Green chemistry, Theory and Practical, Paul T. Anastas and John C.Warner. **10.** New trends in green chemistry By V. K. Ahulwalia and M. Kidwai, 2ndedition, Anamaya Publishers, New Delhi. **11.** An introduction to green chemistry, V. Kumar, Vishal Publishing Co. **12.** Organic synthesis: Special techniques. V.K.Ahulwalia and RenuAggarwal **13.** Chemistry of Natural Products, F. F. Bentley and F. R. Dollish, 1974.	

Course Code 23BPCH3P03	Practicals based on 24BPCH3T05	Credits 02

Course Outcomes:

At the end of the course students will be able to:

CO 1	Perform microwave-assisted and green synthesis of chemical compounds and prepare bio-based products such as biodiesel, disinfectants, polymers, and cosmetics.	L3
CO 2	Characterize synthesized products using standard analytical methods and evaluate their physical, chemical, and molecular properties.	L5
CO 3	Analyze environmental samples including industrial effluents, PET, and drinking water to assess quality and safety parameters.	L4
CO 4	Apply chemical principles to understand atom economy, pesticide action, and pharmacopeial drug analysis for practical and sustainable applications	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	0	3	1	3
CO 2	3	3	1	0	0	3
CO 3	3	3	1	3	1	3
CO 4	3	2	0	2	0	3

1. Microwave assisted synthesis: reactions in water (any one from the syllabus /preparation of Aspirin)
2. Synthesis of lignin from natural resources.
3. Industrial effluent Analysis
4. Pet /drinking water parameters

Preparation & Characterization (Any four)

1. Biodiesel -Preparation
2. Plant based disinfectant - Preparation & Characterization
3. Oil-Lipstick making
4. Atom economy -Traditional & green synthesis comparison
5. Pesticide - mode of action review
6. Polymer -Synthesis & mol. wt. determination
7. Color/Dye from waste of fruits and vegetables-
8. Drug -Indian pharmacopeia procedure for analysis (Ape) monograph for anyone drugs .

60 Hrs

References

1. Biodiesel production Feedstacks , catalyst and technology 2022 by Samuel Wiley publication ISBN:978-1-119-77133-3
2. The handbook of Soap manufacture 2007 by H.A. Appleton,W.H. Simmons
3. Surface Sciences and Adhesion Cosmetics 2021 by K.L Mittal, H.S.Bui
4. Green Processes,by Chao-Jun Li, Paul T. AnastasVolume 7Green Synthesis ISBN:9783527688494
5. Polymer Synthesis and Characterization A Laboratory Manual By Stanley R. Sandler, Wolf Karo, JoAnne Bonesteel, Eli M. Pearce · 1998

Course Code 24BPCH3RP1	Course Title Research Project - I Based on Chemistry	Credits 04	No. of Hours: 120

Course Outcomes:

At the end of the course, students will be able to:

CO 1	Formulate a research proposal and define objectives based on the assigned project topic.	L6
CO 2	Conduct a thorough literature review to identify gaps and justify the research study.	L5
CO 3	Plan and execute experimental work systematically, applying appropriate research methodologies.	L4
CO 4	Compile and present research findings effectively through structured report writing.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	3	1	0	1	2
CO 2	2	3	3	0	0	2
CO 3	3	3	1	1	2	3
CO 4	2	3	2	0	2	3

Subject based project

Allotment of topics, proposal writing ,

Preparation of Literature review

Execution of planning of research

starting of experimental work

Report writing

SEMESTER IV
MANDATORY

Course Code 24BPCH4T01	Course Title **Theoretical organic chemistry-II**	Credits 04	No. of lectures 60

Course Outcomes:

At the end of the course students will be able to:

CO 1	Apply linear free energy relationships to analyze substituent, steric, and solvent effects on organic reaction mechanisms.	L4
CO 2	Explain the principles of molecular recognition, self-assembly, and host–guest interactions in natural and synthetic supramolecular systems.	L2
CO 3	Apply and analyze stereochemical principles to determine optical purity, absolute configuration, and chiroptical properties of organic compounds.	L4
CO 4	Apply principles of asymmetric synthesis to design and interpret enantioselective reactions using chiral substrates, reagents, and catalysts.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	1	0	0	2
CO 2	3	2	0	0	0	2
CO 3	3	3	1	0	0	3
CO 4	3	3	1	1	0	3

Unit I:	**Physical organic chemistry** **1.1 Structural effects and reactivity: [7L]** Linear free energy relationship (LFER) in determination of organic reaction mechanism, The Hammett equation, substituent constants, theories of substituent effects, interpretation of σ-values, reaction constants ρ, Yukawa-Tsuno equation**.** 1.2 Uses of Hammett equation, deviations from Hammett equation. Dual parameter correlations, Inductive substituent constants. The Taft model, σ_I and σ_R scales, steric parameters Es and β. Solvent effects, Okamoto-Brown equation, Swain-Scott equation, Edward and Ritchie correlations, Grunwald-Winstein equation, Dimroth's E_T parameter, Solvatochromism Zscale, Spectroscopic Correlations, Thermodynamic Implications. [8L]	**15**

Unit II:	**Supramolecular chemistry** 2.1 Principles of molecular associations and organizations as exemplified in biological macromolecules like nucleic acids, proteins and enzymes. [3L] 2.2 Synthetic molecular receptors: receptors with molecular cleft, molecular tweezers, receptors with multiple hydrogen sites. [3L] 2.3 Structures and properties of crown ethers, cryptands, cyclophanes, calixarenes, rotaxanes and cyclodextrins. Synthesis of crown ethers,cryptands and calixarenes. [5L] 2.4 Molecular recognition and catalysis, molecular selfassembly. Supramolecular Polymers, Gelsand Fibres. [4L]	**15**
Unit III:	**Stereochemistry- II** **3.1** Racemisation and resolution of racemates including conglomerates: Mechanism of racemisation, methods of resolution: mechanical, chemical,kinetic and equilibrium asymmetric transformation and through inclusion compounds. [3L] **3.2** Determination of enantiomer and diastereomer composition: enzymatic method, chromatographic methods. Methods based on NMR spectroscopy: use of chiral derivatising agents (CDA), chiral solvating agents (CSA) andLanthanide shift reagents (LSR). [3L] **3.3** Correlative method for configurational assignment: chemical, opticalrotation, and NMR spectroscopy. [4L] **3.4** Molecular dissymmetry and chiroptical properties: Linearly and circularlypolarized light. Circular birefringence and circular dichroism. ORD and CDcurves. Cotton effect and its applications. The octant rule and the axial α–haloketone rule with applications. [5L]	**15**
Unit IV:	**Unit 4: Asymmetric synthesis** **4.1** Principles of asymmetric synthesis: Introduction, the chiral pool in Nature,methods of asymmetric induction – substrate, reagent and catalystcontrolled reactions. [3L] **4.2** Synthesis of L-DOPA [Knowles's Mosanto process]. Asymmetric reactionswith mechanism: Aldol and related reactions, Cram's rule, Felkin-Anhmodel, Sharpless enantioselective epoxidation, hydroxylation,aminohydroxylation, Diels-Alder reaction, reduction of prochiral carbonylcompounds and olefins. [9L] **4.3** Use of chiral auxiliaries in diastereoselective reductions, asymmetricamplification. Use of chiral BINOLs, BINAPs and chiral oxazolinesasymmetric transformations. [3L]	**15**

REFERENCES

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2. A guide to mechanism in Organic Chemistry, 6**th** edi, 2009,Peter Sykes, Pearson edu, New Delhi.
3. Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press (2002).
4. Mechanism & theory in Organic Chemistry, T. H. Lowry and K. C. Richardson, Harper and Row.
5. Organic Reaction Mechanism, 4th edition, V. K. Ahluvalia, R. K.Parashar, Narosa Publication.
6. Reaction Mechanism in Organic Chemistry, S.M. Mukherji, S.P.Singh, Macmillan Publishers, India.
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9. Organic reactive intermediates, Samuel P. MacManus, Academic Press.
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14. Organic Chemistry, W. G. Solomons, C. B. Fryhle, , 9th Edition, Wiley India Pvt. Ltd.,2009.
15. Pericyclic Reactions, S. Sankararaman, Wiley VCH, 2005.
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20. Modern methods of Organic Synthesis, 4th Edition W. Carruthers and Iain Coldham, Cambridge University Press 2004
21. Modern physical chemistry, Eric V Anslyn, Dennis A. Dougherty, Univ. science books,2006
22. Physical Organic Chemistry, N. S. Isaacs, ELBS/Longman
23. Stereochemistry of Carbon Compounds: Principles and Applications, D, Nasipuri, 3**rd** edition, New Age International Ltd.
24. Stereochemistry of Organic Compounds, Ernest L. Eliel and Samuel H. Wilen, Wiley-India edit
25. Stereochemistry, P. S. Kalsi, 4th edition, New Age International Ltd
26. Organic Stereochemistry, M. J. T. Robinson, Oxford Univ. Press, New Delhi, India edition, 2005
27. Bioorganic, Bioinorganic and Supramolecular chemistry, P.S. Kalsi and J.P. Kalsi. New Age International Publishers
28. Supramolecular Chemistry; Concepts and Perspectives, J. M. Lehn, VCH.
29. Crown ethers and analogous compounds, M. Hiraoka, Elsevier,1992.
30. Large ring compounds, J.A.Semlyen, Wiley-VCH, 1997.
31. Fundamentals of Photochemistry, K. K. Rohtagi-Mukherji, Wiley- Eastern
32. Essentials of MolecularPhotochemistry, A. Gilbert and J. Baggott, Blackwell Scientific Publication.

Course Code 24BPCH4T02	Course Title **Synthetic organic chemistry-II**	Credits 04	No. of lectures 60

Course Outcomes:

At the end of the course students will be able to:

CO 1	Apply principles of protecting groups, umpolung strategies, and retrosynthetic analysis to design efficient, selective, and systematic routes for organic molecule synthesis.	L5
CO 2	Develop strategic synthetic routes using one- and two-group C–C disconnections, applying retrosynthetic logic, selectivity control, and efficient bond-forming methodologies.	L6
CO 3	Explain electro-organic redox processes and apply modern synthetic methods—including organocatalysis, metal-catalyzed couplings, and supramolecular systems—for efficient and sustainable organic synthesis.	L4
CO 4	Interpret organometallic mechanisms and apply transition and rare-earth metal catalysts for C–C and C–heteroatom bond formation, metathesis, and selective redox transformations in organic synthesis.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	1	0	0	3
CO 2	3	3	1	0	0	3
CO 3	3	3	1	2	0	3
CO 4	3	3	1	1	0	3

Unit I:	**Designing Organic Synthesis-I** **1.1Protecting groups in Organic Synthesis: [3L]** Protection and deprotection of the hydroxyl, carbonyl, amino and carboxyl functional groups and its applications. **1.2Concept of umpolung (Reversal of polarity): [3L]** Generation of acyl anion equivalent using 1,3-dithianes, methyl thiomethyl sulfoxides, cyanide ions, cyanohydrin ethers, nitro compounds and vinylated ethers. **1.3 Introduction to Retrosynthetic analysis and synthetic planning: [9L]** Linear and convergent synthesis; Disconnection approach: An introduction to synthons, synthetic equivalents, disconnection approach, functional group interconversions (FGI), functional group addition (FGA), functional group removal (FGR) importance of order of events in organic synthesis, one and two group C-X disconnections (1,1; 1,2; 1,3 difunctionalized compounds), ● **Selective organic transformations:** interconversions (FGI), functional group addition (FGA), functional group removal (FGR) importance of order of events in organic synthesis, one and two group C-X disconnections (1,1; 1,2; 1,3 difunctionalized compounds), ● **Selective organic transformations:** chemoselectivity, regioselectivity,	**15**

	stereoselectivity, enantioselectivity.	
Unit II:	**Designing Organic Synthesis-II** **2.1General strategy: [3L]** choosing a disconnection-simplification, symmetry, high yielding steps, and recognisable starting material. **2.2 One group C-C Disconnections: [6L]** Alcohols (including stereoslectivity), carbonyls (including regioselectivity), Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis. 2.3 **Two group C-C Disconnections: [6L]** ● 1,2- 1,3- 1,4- 1,5- and 1,6- difunctionalized compounds, Diels-Alder reactions, α, β-unsaturated compounds, control in carbonyl condensations, Michael addition and Robinson annelation	**15**
Unit III:	**Electro-organic chemistry and Selected methods of Organic synthesis.** 3.1 **Electro-organic chemistry: [7L]** **3.1.1 Introduction**: Electrode potential, cell parameters, electrolyte, workingelectrode, choice of solvents, supporting electrolytes. **3.1.2 Cathodic reduction**: Reduction of alkyl halides, aldehydes, ketones, nitrocompounds, olefins, arenes, electro-dimerization. **3.1.3 Anodic oxidation:** Oxidation of alkylbezene, Kolbe reaction, Non-Kolbeoxidation, Shono oxidation. **3.2 Selected Methods of Organic synthesis. [8L]** Applications of the following in organic synthesis: **3.2.1** Crown ethers, cryptands, micelles, cyclodextrins, catenanes. **3.2.2** Organocatalysts: Proline, Imidazolidinone. **3.2.3 Pd catalysed cycloaddition reactions:** Stille reaction, Saeguse-Ito oxidation to enones, Negishi coupling. **3.2.4** Use of Sc(OTf), and Yb(OTf) as water tolerant Lewis acid catalyst in aldolcondensation, Michael reaction, Diels-Alder reaction, Friedel – Crafts reaction.	**15**

Unit IV:	**Transition and rare earth metals in organic synthesis** 4.1 **Introduction to basic concepts: [3L]** 18 electron rule, bonding in transition metal complexes, C-H activation, oxidative addition, reductive elimination, migratory insertion. 4.2 **Palladium in organic synthesis: [5L]** π-bonding of Pd with olefins, applications in C-C bond formation, carbonylation, alkene isomerisation, cross-coupling of organometallics and halides. Representative examples: Heck reaction, Suzuki-Miayura coupling, Sonogashira reaction and Wacker oxidation. Heteroatom coupling for bond formation between aryl/vinyl groups and N, S, or P atoms. 4.3 **Olefin metathesis** using Grubb's catalyst. [1L] 4.4 **Application of Ni, Co, Fe, Rh, and Cr carbonyls** in organic synthesis. 4.5 **Application of samarium iodide** including reduction of organic halides, aldehydes and ketones, α-functionalised carbonyl and nitro compounds. [4L] 4.6 **Application of Ce(IV)** in synthesis of heterocyclic quinoxaline derivatives And its role as a de-protecting agent**. [1L]**	**15**
	References: **1.** Advanced Organic Chemistry, Part A and Part B: Reaction and Synthesis, Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer Verlag **2.** Modern Methods of Organic Synthesis, 4th Edition, W. Carruthers and Iain Coldham, Cambridge University Press, 2004. **3.** Chem.Rev. 2002, 102, 2227-2302, Rare Earth Metal Triflates in Organic Synthesis, S. Kobayashi, M. Sugiura, H. Kitagawa, and W.W.L. Lam. **4.** Organic Chemistry, Clayden Greeves Warren and Wothers, Oxford Press (2001). **5.** Moder Organic Synthesis: An Introduction, G.S. Zweifel and M.H. Nantz, W.H. Freeman and Company, (2007). **6.** Advanced Organic Chemistry: Reaction Mechanism, R. **7.** Bruckner, Academic Press (2002). **8.** Principles of Organic Synthesis, R.O.C. Norman & J. M. Coxon, 3rd Edn., Nelson Thornes **9.** Chemistry, 7th Edn, R. T .Morrison, R. N. Boyd, & S. K. Bhattacharjee, Pearson **10.** Strategic Applications of Name Reactions in Organic Synthesis,L. Kurti & B. Czako (2005), Elsevier Academic Press **11.** Advanced Organic Chemistry: Reactions & Mechanisms, 2nd Edn., B. Miller & R. Prasad, Pearson **12.** Organic reactions and their mechanisms, 3rd revisededition, P.S. Kalsi, New Age International Publishers **13.** Organic Synthesis: The Disconnection Approach, Stuart Warren, John Wiley & Sons, 2004 **14.** Name Reactions and Reagents in Organic Synthesis, 2nd Edn., Bradford P. Mundy, Michael G. Ellard, and Frank Favoloro, Jr., Wiley-Interscience **15.** Name Reactions, Jie Jack Lie, 3rd Edn., Springer	

Course Code 24BPCH4T03	Course Title **Natural products**	Credits 02	No. of lectures 30

Course Outcomes:

At the end of the course students will be able to:

CO 1	Evaluate the structural, stereochemical, and biological features of steroidal compounds and critically assess the synthetic strategy for converting cholesterol or plant sapogenins into 16-dehydropregnenolone acetate (16-DPA).	L5
CO 2	Analyze multistep synthetic routes for converting 16-DPA into steroidal hormones and for synthesizing fragrance compounds, focusing on key reactions and functional group transformations.	L4
CO 3	Analyze the classification, sources, biological importance, and synthetic strategies of vitamins and antibiotics by correlating structural features, reaction pathways, and spectral data with their biological activity and therapeutic applications.	L4
CO 4	Analyze multistep synthetic pathways, structural features, stereochemistry, and spectral characteristics of antibiotics, naturally occurring insecticides, and terpenoids, by correlating reaction strategies and molecular architecture with their biological activity and applications.	L4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	0	1	0	2
CO 2	3	3	0	0	0	2
CO 3	3	3	1	1	0	3
CO 4	3	3	1	1	0	3

Unit I:	**Natural products-I** **1.1 Steroids: [5L]** General structure, classification. Occurrence, biological role, important structural and stereochemical features of the following: corticosteroids, steroidal hormones, steroidal alkaloids, sterols and bile acids. 1.2 Synthesis of 16-DPA from cholesterol and plant sapogenin. [2L] 1.3 Synthesis of the following from 16-DPA: androsterone, testosterone, oestrone, oestriol, oestradiol and progesterone. [5L] 1.4 Synthesis of cinerolone, jasmolone, allethrolone, exaltone and muscone [3L]Applications of wildlife forensics- Casework, Traceability, Intelligence	**15**
Unit II:	**Natural products-II** **2.1 Vitamins:** [5L] Classification, sources and biological importance of vitamin B1,B2, B6, folic acid, B12, C, D1, E (α-tocopherol), K1, K2, H (β- biotin) Synthesis of the following:	**15**

	Vitamin A from β-ionone and bromoester moiety. Vitamin B1 including synthesis of pyrimidine and thiazole moieties. Vitamin B2 from 3, 4-dimethylaniline and D(-)ribose Vitamin B6 from: 1) ethoxyacetylacetone and cyanoacetamide, 2) ethyl ester of N-formyl-DL-alanine (Harris synthesis) Vitamin E (α-tocopherol) from trimethylquinol and phytyl bromide Vitamin K1 from 2-methyl-1, 4-naphthaquinone and phytol. 2.2 **Antibiotics:** [6L] Classification on the basis of activity. Structure elucidation, spectral data of penicillin-G, cephalosporin-C and chloramphenicol. Synthesis of chloramphenicol (from benzaldehyde and β-nitroethanol) penicillin-G and phenoxymethylpenicillin from D-penicillamine and t-butyl phthalimide malonaldehyde (synthesis of D-penicillamine and t-butyl phthalimide malonaldehyde expected). **2.3Naturally occurring insecticides: [2L]** Sources, structure and biological properties of pyrethrums (pyrethrin I), rotenoids (rotenone). Synthesis of pyrethrin I. **2.4 Terpenoids: [2L]** Occurrence, classification, structure elucidation, stereochemistry, spectral data and synthesis of zingiberene .	
	REFERENCES **1.** Natural product chemistry, A mechanistic, biosynthetic and ecological approach, Kurt B.G. Torssell, Apotekarsocieteten –Swedish Pharmaceutical Press. **2.** Natural products chemistry and applications, Sujata V. Bhat, B.A. Nagasampagi and S. Meenakshi, Narosa Publishing House, 2011. **3.** Organic Chemistry Natural Products Volume-II, O. P. Agarwal Krishna Prakashan, 2011., **4.** Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A.Marston, Harwood Academic Publishers. **5.** Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers, 1998. **6.** New Trends in Natural Product Chemistry, Atta-ur-Rahman andM.I. Choudhary, Harwood Academic Publishers, 1998 **7.** Total. Synthesis of Longifolene, J. Am. Chem. Soc. 1961, 83, 1251.	

Course Code 24BPCH4P01	Course Title Practicals based on 24BPCH4T01 and 24BPCH4T02	Credits 2	No of Lecture in hrs. 60

Course Outcomes:

At the end of the course students will be able to:

CO 1	Execute the planning of synthesis, effect of reaction parameters including stoichiometry, and safety aspects including MSDS	L4
CO 2	Purify the product by recyclization, measure its mass or volume, check the purity by TLC, determine physical constant and calculate percentage yield.	L3
CO 3	Analyze the commercial chemical samples of various organic and inorganic compounds.	L4
CO 4	Execute multistep organic syntheses by applying appropriate reaction mechanisms, purification strategies, and spectral techniques to convert given starting materials into their corresponding target molecules.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	1	2	1	3
CO 2	3	2	1	0	1	3
CO 3	3	3	1	1	0	3
CO 4	3	3	1	0	1	3

Two steps preparations

1. Acetophenone → Acetophenone phenyl hydrazine → 2-phenyl Indole.
2. 2-naphthol → 1-phenyl azo-2-naphthol → 1-amino-2-naphthol.
3. Cyclohexanone → cyclohexanone oxime → Caprolactum.
   1. Hydroquinone → hydroquinone diacetate → 2,5-1 dihydroxyacetophenone.
4. 4-nitrotoluene → 4-nitrobenzoic acid → 4-aminobenzoic acid.
5. o-nitroaniline → o-phenylene diamine → Benzimidazole.
6. Benzophenone → benzophenone oxime → benzanilide.
7. o-chlorobenzoic acid → N-phenyl anthranilic acid →acridone.
8. Benzoin → benzil → benzilic acid.
9. Phthalic acid → phthalimide → anthranilic acid.
10. Resorcinol → 4-methyl-7-hydroxy coumarin → 4-methyl-7-acetoxycoumarin.
11. Anthracene → anthraquinone → anthrone.

REFERENCES FOR PRACTICALS 24BPCH4P01 AND 24BPCH4P02

1. Comprehensive Practical Organic Chemistry: Preparation andQuantitative Analysis- V.K. Ahluwalia and Renu Aggarwal, Universities Press India Ltd., 2000
2. Advanced Practical Organic Chemistry – N. K. Vishnoi, Third Addition, Vikas Publishing House PVT Ltd
3. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, NewAge International Publications
4. Systematic Identification of Organic compounds, 6th edition, R. L. Shriner, R. C. Fuson and D.Y. Curtin Wiley, New York.
5. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS
6. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall
7. Macro-scale and Micro-scale Organic Experiments, K. L. Williamson, D. C. Heath.
8. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
9. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark,Adward Arnold.
10. Vogel's Textbook of Practical Organic Chemistry, Fifth edition,2008, B.S.Furniss, A. J.Hannaford, P. W. G. Smith, A. R. Tatchell, Pearson Education.
11. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.

12. Organic structures from spectra, L. D. Field, S. Sternhell, John R.Kalman, Wiley, 4th ed., 2011.

SEMESTER IV
ELECTIVE I

Course Code 24BPCH4T04	Course Title Heterocyclic chemistry	Credits 02	No. of lectures 30

Course Outcomes:

At the end of the course students will be able to:

CO 1	Discuss basic chemistry of the heterocyclic compounds including their reactivity and synthesis of pyrazole, imidazole,oxazole, isoxazole, thiazole.	L2
CO 2	Illustrate the structure reactivity and synthesis of heterocyclic compound isothiazole, pyridazines, pyrimidine, pyrazines and oxazines.	L2
CO 3	Describe the fundamental theoretical understanding of bicyclic and tricyclic heterocyclic compound and Explain the Nucleophilic ring opening reactions	L4
CO 4	Discuss structure and reactivity of coumarins, quinoxalines,cinnolines, indole, benzimidazoles, benzoxazoles, benzothiazoles, Purines and acridines.	L4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	0	0	0	2
CO 2	3	1	0	0	0	2
CO 3	3	3	0	0	0	3
CO 4	3	3	0	0	0	3

Unit I:	**Heterocyclic compounds-I** 1.1 Heterocyclic compounds: Introduction, classification, Nomenclature of heterocyclic compounds of monocyclic (3-6 membered) (Common,systematic (Hantzsch-Widman) and replacement nomenclature) 1.2 Structure, reactivity, synthesis and reactions of pyrazole, imidazole,oxazole, isoxazole, thiazole, isothiazole, pyridazines, pyrimidine, pyrazines and oxazines.	**15**
Unit II:	**Heterocyclic compounds-II** 2.1 Nomenclature of heterocyclic compounds of bicyclic/tricyclic (5-6Membered) fused heterocycles (up to three hetero atoms)**.** (Common,systematic (Hantzsch-Widman) and replacement nomenclature) 2.2 Nucleophilic ring opening reactions of oxiranes, aziridines, oxetanes and azetidines.Structure, reactivity, synthesis and reactions of coumarins, quinoxalines,cinnolines, indole, benzimidazoles, benzoxazoles, benzothiazoles, Purines and acridines.	**15**

References

1. Heterocyclic chemistry, 3rd edition, Thomas L. Gilchrist, Pearson Education, 2007.
2. Heterocyclic Chemistry, Synthesis, Reactions and Mechanisms, R. K. Bansal, Wiley Eastern Ltd., 1990.
3. Heterocyclic Chemistry, J. A. Joule and G. F. Smith, ELBS, 2ndedition, 1982.
4. The Conformational Analysis of Heterocyclic Compounds, F.G.Riddell, Academic Press,1980.
5. Principles of Modern Heterocyclic Chemistry, L.A. Paquette, W.B.Benjamin, Inc., 1978.
6. An Introduction to the Chemistry of Heterocyclic Compounds, 2ndedition, B.M. Acheson, 1975.

Course Code 24BPCH4P02	Course Title Practicals based on 24BPCH4T03 and 24BPCH4T04	Credits 02

Course Outcomes:

At the end of the course students will be able to:

CO 1	Interpret UV, IR, PMR, CMR, and mass spectra to derive preliminary structural information of organic compounds.	L4
CO 2	Correlate spectral data from multiple techniques to deduce the complete molecular structure accurately.	L4
CO 3	Develop analytical reasoning and problem-solving skills under time-constrained conditions using spectral information.	L5
CO 4	Apply standard reference materials and textbooks effectively to confirm and refine structural assignments of organic compounds	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	1	0	0	3
CO 2	3	3	1	0	0	3
CO 3	3	3	0	0	1	3
CO 4	3	2	2	0	0	3

Session-I: Combined spectral identification: Interpretation of spectral data of organic compounds (UV, IR, PMR, CMR and Mass spectra).

A student will be given UV, IR, PMR, CMR, and Mass spectra of a compound from which preliminary information should be reported within first half an hour of the examination without referring to any book/reference material. The complete structure of the compound may then be elucidated by referring to any standard text-book/reference material etc

(Minimum 8 spectral analysis).

SEMESTER IV
ELECTIVE II

Course Code 24BPCH4T05	Course Title INTELLECTUAL PROPERTY RIGHTS	Credits 02	No. of lectures 30

Course Outcomes:

At the end of the course students will be able to:

CO 1	Understand the fundamentals, types, and historical evolution of intellectual property and its importance in protecting innovations.	L2
CO 2	Explain the processes, rights, and legal frameworks associated with patents, industrial designs, copyrights, trademarks, geographical indications, and trade secrets.	L2
CO 3	Analyze IP infringement issues, enforcement mechanisms, and the role of judiciary and law enforcement agencies in protecting IP.	L4
CO 4	Evaluate the economic value of IP, international agreements, and licensing/technology transfer in the Indian and global context.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	1	0	0	2
CO 2	3	1	1	0	0	3
CO 3	3	3	1	0	1	3
CO 4	3	3	2	0	0	3

Unit I:	**Introduction to Intellectual Property: [2L]** Historical Perspective, Different types of IP, Importance of protecting IP. **Patents: [5L]** Historical Perspective, Basic and associated right, WIPO, PCT system,Traditional Knowledge, Patents and Health care-balancing promoting innovation with public health, Software patents and their importance for India. **Industrial Designs: [2L]** Definition, How to obtain, features, International design registration. **Copyrights: [2L]** Introduction, How to obtain, Differences from Patents. **Trade Marks: [2L]** Introduction, How to obtain, Different types of marks – Collective marks,certification marks, service marks, trade names etc. **Geographical Indications: [2L]** Definition, rules for registration, prevention of illegal exploitation,importance to India.	**15**
Unit II:	**Trade Secrets: [2L]** Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. **IP Infringement issue and enforcement:** [2L]	**15**

	Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. **Economic Value of Intellectual Property:** [5L] Intangible assests and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer. **Different International agreements:** [6L] (a**) World Trade Organization (WTO):** [5L] (i) General Agreement on Tariffs and Trade (GATT), Trade ,Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade Related Services (GATS),Madrid Protocol. (iii) Berne Convention (iv) Budapest Treaty (**b) Paris Convention [6L]** WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity	

Course Code 24BPCH4P03	**Practical Based on 23BPCH2T05**	**Credits 02**

Course Outcomes:

At the end of the course students will be able to:

CO 1	Analyze real-world chemical processes, reactions, and industrial practices to identify underlying principles and challenges.	L4
CO 2	Apply theoretical and experimental knowledge to propose solutions for chemical, environmental, and industrial problems.	L5
CO 3	Develop problem-solving, analytical, and critical-thinking skills by interpreting chemical data from case studies.	L4
CO 4	Communicate chemical findings effectively through structured reports, presentations, and data-driven discussions.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	1	1	0	3
CO 2	3	3	1	2	0	3
CO 3	2	3	1	0	1	3
CO 4	2	3	2	0	2	3

	Case study and its report	**60 Hrs**

Course Code 24BPCH4RP1	Course Title Research Project - II Based on Chemistry	Credits 06	No. of Hours: 180

Course Outcomes:

At the end of the course students will be able to:

CO 1	Formulate a research proposal and define objectives based on the assigned project topic.	L6
CO 2	Conduct a thorough literature review to identify gaps and justify the research study.	L5
CO 3	Plan and execute experimental work systematically, applying appropriate research methodologies.	L4
CO 4	Compile and present research findings effectively through structured report writing.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	3	1	0	1	2
CO 2	2	3	3	0	0	2
CO 3	3	3	1	1	2	3
CO 4	2	3	2	0	2	3

General Guidelines

Subject based project

Completion of experiments part

Project paper presentations or publication in conferences/workshop and seminars

Report writing

Project presentation

Evaluation Scheme 60:40 (Subjected to change to 50:50 as per new guidelines of NEP)
Internals Based on Unit 1 / Unit 2 / Unit 3/ Unit 4

Assignments/ Tutorials/ Class test	Ppt/video Presentation or other activities	Active Participation & Leadership qualities	Total
15	15	10	40

Theory Examinations: For Paper 1, Paper 2, Paper
Suggested Format for MAJOR Question paper

24BPCH_T0_/0_/20_

Duration: 2 hr. 30 min **Total Marks: 60**

N.B.

1. **All questions are compulsory**
2. **Draw neat labeled diagram wherever necessary**
3. **All questions carry equal marks**

Q.1.	**(A)**		**Attempt any two** **CO 1**	**8**
		(I)		
		(II)		
		(III)		
		(IV)		
Q.1.	**(B)**	**(I)**	**Attempt any one**	**4**
		a		
		b		
		(II)	**Attempt any one**	**3**
		a		
		b		

Q.2.	**(A)**		**Attempt any two** **CO 2**	**8**
		(I)		
		(II)		
		(III)		
		(IV)		
Q.2.	**(B)**	**(I)**	**Attempt any one**	**4**
		a		
		b		
		(II)	**Attempt any one**	**3**
		a		
		b		
Q.3.	**(A)**		**Attempt any one** **CO 3**	**8**
		(I)		
		(II)		
		(III)		
		(IV)		
Q.3.	**(B)**	**(I)**	**Attempt any one**	**4**
		a		
		b		
		(II)	**Attempt any one**	**3**
		a		
		b		
Q.4.	**(A)**		**Attempt any one** **CO 4**	**8**
		(I)		
		(II)		
		(III)		
		(IV)		

Q.4.	**(B)**	**(I)**	**Attempt any one**	**4**
		a		
		b		
		(II)	**Attempt any one**	**3**
		a		
		b		
			**********	

Theory Examinations: For ELECTIVE Paper
24BPCH_T0_/0_/20_

Duration: 1 hr. 30 min **Total Marks: 30**

N.B.

1. **All questions are compulsory**
2. **Draw neat labeled diagram wherever necessary**
3. **All questions carry equal marks**

Q.1.	**(A)**		**Attempt any two CO 1**	**8**
		(I)		
		(II)		
		(III)		
		(IV)		
Q.1.	**(B)**	**(I)**	**Attempt any one CO 2**	**4**
		a		
		b		

		(II)	**Attempt any one**	**3**
		a		
		b		
Q.2.	**(A)**		**Attempt any two** **CO 3**	**8**
		(I)		
		(II)		
		(III)		
		(IV)		
Q.2.	**(B)**	**(I)**	**Attempt any one** **CO 4**	**4**
		a		
		b		
		(II)	**Attempt any one**	**3**
		a		
		b		

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Semester End Practical Examination:
Practical examination of each paper for 50 marks will be held for three and half hours

Semester ____ Practical Examination "Month & Year"
Paper Code:- _____

Total Duration: - 03.½ hrs. **Total Marks**: - 50

Distribution of marks
Question 1 - (performance & result/identification) – 20 marks
Question 2 - (performance & result/identification) – 10 marks
Question 3 - (identification) – 10 marks
Question 4 - (viva voce) – 05 marks
Question 5 - (journal/field report) – 05 marks

Marks Distribution and Passing Criterion for Each Semester

Theory						Practical		
Course Code SEM III / SEM IV	Internal	Min marks for passing	Theory Examination	Min marks for passing	Total	Course Code	Practical Examination	Min marks for passing
24BPCH3T01/4T01	40	16	60	24	100	-	-	-
24BPCH3T02/4T02	40	16	60	24	100	-	-	-
24BPCH3T03/4T03	40	16	60	24	100	-	-	-
Laboratory 1	-	-	-	-	-	24BPCH3P01	**50**	**20**
24BPCH3T04 or 3T05/4T04 or 4T05	20	08	30	12	50			
Laboratory 2	-	-	-	-	-	24BPCH3P02 or 3P03/4P01 or 4P02	**50**	**20**
						24BPCH3P03 (Research Project - 4 credits)	**100**	**40**
						24BPCH4P03 (Research Project - 6 credits)	**150**	**60**

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project-based learning/case studies/self-study like seminar, term paper or MOOC

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