Academic Council Meeting No. and Date : _____

Agenda Number : _____

Syllabus for

Programme: Master of Science

Specific Programme : Organic Chemistry

[M.Sc. II (Chemistry)]

Level 6.5

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

Eligibility:

B.Sc. Chemistry

Duration: 2 years

Mode of Conduct:

Laboratory practicals / Offline lectures / Online lectures/hybrid mode

Program Outcome

The syllabus is aimed to achieve the objectives. The syllabus spanning three years covers the industry relevant courses. The learners will be ready for the jobs available in different fields like:

Electrochemistry, semiconductors, Polymer chemistry, instrumentation , glassware and instruments industries, environmental chemistry, pharmaceutical and drugs chemistry, Cement industry, food and drugs industry , medicinal chemistry dyes and paint industries, oil industries , various chemical laboratories (NGO and Govt) forensic sciences, FDA, Pollution controlled Boards, Alloy and Metallurgy , Perfumery Quality control &Assurance, Research & development (R & D) ,various digital skills such as chem. Draw, chemo-informatics, bioinformatics, computational chemistry and animation. Business Management Chemical technology, entrepreneur skill, pharmaceutical management, Hospital administrative management etc,

Program Specific Outcome

- Independent showcase adeptness in relevant laboratory skills, techniques, and the use of instrumentation with theoretical knowledge.
- Extensive global research opportunities for Ph.D. programs and academics through CSIR-NET, SET and GATE exams.
- Diverse job prospects in government and non-government industries like chemicals, pharmaceuticals, forensic sciences, cosmetics, food, polymers, health, and life sciences.
- R&D and synthetic division placements in polymer and material industries. Competitive exams by service commissions for careers in government organizations such as IISC, IIT, NCL, ONGC, ISRO, FSL, etc.

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Master program in 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 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 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**	

Sr. No.	Heading	Particulars
1	**Title of Course** **Specific Programme**	**M.Sc. Organic Chemistry Semester III and IV**
2	**Eligibility for Admission**	The B.Sc. Chemistry or equivalent qualification from other recognized university as per relevant ordinance.
3	**Passing marks**	Minimum D Grade or equivalent minimum marks for passing at the Graduation level.
4	**No. of Years/Semesters**	**One year/Two semester**
5	**Level**	**6.5**
6	**Pattern**	**Semester**
7	**Credits**	**22**
8	**Status**	**Revised**
9	**To be implemented from Academic year**	**2024-2025**

10	i) Cum Cr. for integrated 1 Yr. PG Degree Chemistry (After 4 Yrs. degree UG Chemistry) ii) PG Diploma in Chemistry (After 3 Yrs. degree UG) and Cum Cr. for 2 Yr. PG Degree iii) Master program in Chemistry (After 3 Yrs. degree UG)

Pedagogy:

$ Assignment Desk work, internal tests, Assignments, Quiz, ppt presentation You tube videos, referencing , MOOC, Problem solving, Project work, Industrial Visit, internship etc 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

$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning)

Assessment: Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment

Theory	40 %	60 %
Practical	-	100 %
Project	-	100%
Experimental learning	-	100 %
Internship	-	100 %

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Reframing of COs and Mapping of COs with POs.

Subject: Chemistry								
Course Name: Theoretical Organic Chemistry-I								
Course Code: 24BPCH3T01								
	Course Outcome	**Level**		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO**
CO 1	Discuss the methods of generation of structure.		**CO 1**	1	0	0	0	0

CO 2	Describe the concept of NGP.		**CO 2**	1	0	0	0	0
CO 3	Elaborate concept of pericyclic reaction.		**CO 3**	1	0	0	0	0
CO 4	Illustrate the types of pericyclic reaction.		**CO 4**	1	1	0	0	0
CO 5	Elaborate concept of point group based on symmetry.		**CO 5**	1	0	1	0	0
CO 6	Elucidate conformational analysis of medium ring like eight to ten members rings.		**CO 6**	1	0	0	0	
CO 7	Describe the principle and reactions involved in photochemistry.		**CO 7**	1	0	0	0	0
CO 8	Elaborate the photochemistry of carbonyl compound, olefins and arenes.		**CO 8**	1	0	0	0	0

0

Subject: Chemistry
Course Name: Synthetic Organic Chemistry-I
Course Code: 24BPCH3T02

	Course Outcome	**Level**		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	Discuss the name reactions and its mechanism with applications.	2	**CO 1**	1	0	0	0	0	0
CO 2	Describe the multicomponent reaction.	2	**CO 2**	1	0	0	0	0	0

CO 3	Discuss the generation of radicals in organic synthesis.	2	**CO 3**	1	0	0	0	0	0
CO 4	Elucidate characteristic reaction and radicals in synthesis.	2	**CO 4**	0	1	0	0	0	0
CO 5	Elaborate the study different types of Enamines, Ylides and α-C-H functionalization		**CO 5**	1	0	0	0	0	0
CO 6	Describe the Phosphorus, Sulfur and Nitrogen Ylides		**CO 6**	1	0	0	0	0	0
CO 7	Discuss the basics of metals/ non-metals in organic synthesis.		**CO 7**	1	0	0	0	0	0
CO 8	Illustrate the synthesis using organoborane and organosilicon compound		**CO 8**	1	1	0	0	0	0

Subject: Chemistry								
Course Name: Natural products and Spectroscopy								
Course Code: 24BPCH3T03								
	Course Outcome	**Level**		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO**
CO 1	Discuss the Biosynthesis of various natural products.	2	**CO 1**	1	0	0	0	0
CO 2	Describe Insect pheromones and Natural pigments.	2	**CO 2**	1	0	0	0	0
CO 3	Elucidate multi-step synthesis of natural products.	2	**CO 3**	1	0	0	0	0
CO 4	Discuss the classification of lipids and prostaglandin	2	**CO 4**	1	1	0	0	0

CO 5	Elucidate structure of various organic compounds with the help of spectroscopy.		**CO 5**	1	0	0	0	0
CO 6	Illustrate the ^{13}C –NMR spectroscopy.		**CO 6**	1	0	0	0	0
CO 7	Elaborate advanced NMR techniques		**CO 7**	1	0	0	0	0
CO 8	Determine Spectral problems based on UV, IR, ^{1}HNMR ^{13}CNMR		**CO 8**	1	0	0	0	0

Subject: Chemistry								
Course Name: Medicinal Chemistry								
Course Code: 24BPCH3T04								
	Course Outcome	**Level**		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO**
CO 1	Discuss the basic concept in medicinal and pharmaceutical chemistry and its therapeutic significance.	2	**CO 1**	1	0	0	0	0
CO 2	Describe the structural relationship with effective drug doses to the targeted disease.	2	**CO 2**	1	0	0	0	0
CO 3	Elaborate the Synthesis of various organic compound/ drugs their reaction and application of the same industrial point of view.	2	**CO 3**	1	0	0	0	0
CO 4	Elucidate the adverse effects of the drugs.	2	**CO 4**	0	0	0	0	0

Subject: Chemistry
Course Name: Biogenesis and Green Chemistry
Course Code: 24BPCH3T05

	Course Outcome	Level		PO 1	PO 2	PO 3	PO 4	PO
CO 1	Discuss the various biosynthesis of natural product and its derivatisation.	5	**CO 1**	1	0	0	0	1
CO 2	Elaborate the synthesis of various organic compound their reaction and application of the same industrial point of view.	2	**CO 2**	1	0	0	0	1
CO 3	Describe the Study of characterization of organic compound, determination of type, elemental detection and conformation of most probable structure.	2	**CO 3**	1	0	0	0	1
CO 4	Demonstrate the synthesis using Green catalysts and Green reagents	2	**CO 4**	1	0	0	0	1

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Reframing of COs and Mapping of COs with POs.

Subject: Chemistry								
Course Name: Paper 1(Theoretical organic chemistry-II)								
Course Code: 24BPCH4T01								
	Course Outcome	**Level**		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO**

CO 1	Discuss Study of thermodynamic parameters of chemical system.		**CO 1**	1	0	0	0	0
CO 2	Elaborate Uses of Hammett equation, deviations from Hammett equation.		**CO 2**	1	0	0	0	0
CO 3	Describe the Supramolecular chemistry.		**CO 3**	1	0	0	0	0
CO 4	Discuss structure and properties Using Synthetic molecular receptors		**CO 4**	1	1	0	0	0
CO 5	Describe the Stereochemistry		**CO 5**	1	0	0	0	0
CO 6	Construct the Molecular dissymmetry and chiroptical properties		**CO 6**	1	0	0	0	0
CO 7	Recognize Principles of asymmetric synthesis.		**CO 7**	1	1	0	0	0
CO 8	Discuss the chiral oxazolinesasymmetric transformations.		**CO 8**	1	0	0	0	0

DEPARTMENT OF CHEMISTRY **(M. Sc. II Organic Chemistry SEM IV)**

Subject: Chemistry
Course Name: Paper 2(Synthetic organic chemistry-II)
Course Code: 24BPCH4T02

	Course Outcome	Level		PO 1	PO 2	PO 3	PO 4	PO
CO 1	Describe the Protecting groups in Organic Synthesis		**CO 1**	1	0	0	0	0
CO 2	Discuss the introduction to Retrosynthetic analysis and synthetic planning using Selective organic transformations.		**CO 2**	1	0	0	0	0
CO 3	Elaborate -simplification, symmetry, high yielding steps, and recognisable starting material.		**CO 3**	1	0	0	0	0
CO 4	Evaluate One group C-C Disconnections and Two group C-C Disconnections		**CO 4**	0	1	0	0	0
CO 5	Describe the Electro-organic chemistry and Selected methods of Organic synthesis.		**CO 5**	1	0	0	0	0
CO 6	Determine the Selected Methods of Organic synthesis using Pd catalysed reaction.		**CO 6**	1	1	0	0	0
CO 7	Describe the basic concepts Transition and rare earth metals in organic synthesis		**CO 7**	1	0	0	0	0
CO 8	Elaborate the application of Ni, Co, Fe, Rh, and Cr carbonyls in organic synthesis.		**CO 8**	1	0	0	0	0

Subject: Chemistry
Course Name: **Natural products**

Course Code: 24BPCH4T03								
	Course Outcome	**Level**		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO**
CO 1	Classify steroids along with their structure and biological role.		**CO 1**	1	0	0	0	0
CO 2	Describe synthesis from 16-DPA.		**CO 2**	1	0	0	0	0
CO 3	Utilise various synthetic routes and synthesize androsterone, testosterone, oestrone, oestriol, oestradiol and progesterone		**CO 3**	1	0	0	0	0
CO 4	Apply different synthetic routes and synthesize cinerolone, jasmolone, allethrolone, exaltone and muscone.		**CO 4**	1	1	0	0	0
CO 5	Elaborate the Classification, sources and biological importance of vitamin		**CO 5**	1	0	0	0	0
CO 6	Outline the Synthesis of the following: B1,B2, B6, folic acid, B12, C, D1, E (α-tocopherol), K1, K2, H and classification ,occurance of Terpenoids.		**CO 6**	1	0	0	0	0
CO 7	Classify and synthesize antibiotics (penicillin-G, cephalosporin-C and chloramphenicol)		**CO 7**	1	0	0	0	0
CO 8	Describe naturally occurring insecticides and Terpenoids.		**CO 8**	1	0	0	0	0

Subject: Chemistry
Course Name: Heterocyclic chemistry

Course Code: 24BPCH4T04								
	Course Outcome			**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO**
CO 1	Understand the classification, nomenclature, and fundamental concepts of heterocyclic compounds, including common, systematic (Hantzsch-Widman), and replacement nomenclature for monocyclic (3-6 membered) systems.		**CO 1**	1	0	0	0	0
CO 2	Analyze the structure and electronic properties of key five- and six-membered heterocyclic compounds, including pyrazole, imidazole, oxazole, isoxazole, thiazole, and isothiazole.		**CO 2**	1	0	0	0	0
CO 3	Evaluate the reactivity and stability of heterocyclic compounds based on their electronic and structural characteristics, predicting their behavior in different chemical reactions.		**CO 3**	1	0	0	0	0
CO 4	Apply knowledge of synthetic strategies to design and execute the preparation of heterocyclic compounds such as pyridazines, pyrimidines, pyrazines, and oxazines, and explore their applications in pharmaceuticals and material science.		**CO 4**	0	0	0	0	0
CO 5	Demonstrate an understanding of the nomenclature of bicyclic and tricyclic fused heterocycles (5-6 membered) with up to three heteroatoms using common, systematic (Hantzsch-Widman), and replacement nomenclature.		**CO 5**	1	0	0	0	0
CO 6	Analyze the mechanisms and applications of nucleophilic ring-opening reactions of oxiranes, aziridines, oxetanes, and azetidines, evaluating their significance in organic synthesis.		**CO 6**	1	0	0	0	0
CO 7	Investigate the structural features, reactivity, and synthetic methods of fused heterocyclic systems, including coumarins, quinoxalines, cinnolines, indoles, benzimidazoles, benzoxazoles, benzothiazoles, purines, and acridines.		**CO 7**	1	0	0	0	0
CO 8	Apply knowledge of the reactivity and functional transformations of fused heterocyclic compounds to predict their chemical behavior and explore their applications in medicinal and materials chemistry.		**CO 8**	1	0	0	0	0

Subject: Chemistry								
Course Name: INTELLECTUAL PROPERTY RIGHTS								
Course Code: 24BPCH4T05								
	Course Outcome	**Level**		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO**
CO 1	Understand the fundamental concepts of Intellectual Property (IP), its historical evolution, different types, and the importance of protecting IP in various industries.		**CO 1**	1	0	0	0	1
CO 2	Analyze the patent system, including WIPO, PCT, traditional knowledge protection, software patents, and the balance between innovation and public health, with a focus on India's perspective.		**CO 2**	1	0	0	0	1
CO 3	Examine the processes and legal frameworks for obtaining and protecting Industrial Designs, Copyrights, Trademarks, and Geographical Indications, highlighting their differences and significance.		**CO 3**	1	0	0	0	1
CO 4	Evaluate the impact of IP rights on economic growth, industry innovation, and legal frameworks while assessing global and Indian perspectives on IP protection and enforcement		**CO 4**	1	0	0	0	1
CO 5	Understand the concepts of Trade Secrets, their scope of protection, associated risks, and the legal aspects involved in safeguarding confidential business information.		**CO 5**	1	0	0	0	0
CO 6	Analyze IP infringement issues, the role of the judiciary, and law enforcement agencies such as police and customs in enforcing intellectual property rights.		**CO 6**	1	0	0	0	0
CO 7	Evaluate the economic significance of intellectual property, including intangible asset valuation, licensing, technology transfer, and the legal framework governing IP in India.		**CO 7**	1	0	0	0	0
CO 8	Examine key international agreements on Intellectual Property, including WTO, TRIPS, GATT, GATS, Berne Convention, Budapest Treaty, Paris Convention, and their impact on global and Indian IP policies, biodiversity, and plant breeder rights.		**CO 8**	1	0	0	0	0

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

M.Sc.II Level 6.5 (Organic Chemistry)

Credit Distribution Structure of Programme

SEMESTER III			
Course Code	**Course Title**	**No. of lectures in Hrs.**	**Credits**
I] MANDATORY 3*4+2 =14			**14**
24BPCH3T01	**Theoretical organic chemistry-I**	**60**	**4**
24BPCH3T02	**Synthetic Organic Chemistry-I**	**60**	**4**
24BPCH3T03	**Natural products and Spectroscopy**	**60**	**4**
24BPCH3P01	Chemistry Practical -1 **Section I :** Separation of a ternary mixture of organic compounds and identification **Section II :** Preparation of derivatives using micro-scale technique	**60**	**2**
II] ELECTIVES (2T+2P) **Note: Select Any One subject among the electives given below**			**4**
24BPCH3T04	**Medicinal Chemistry**	**30**	**2**
24BPCH3P02	Chemistry Practical- 2 **Section I :** Single step preparations **Section II :** Purification methods	**60**	**2**
OR			
24BPCH3T05	**Biogenesis and Green chemistry**	**30**	**2**
24BPCH3P03	**Practical 3 based on 24BPCH3T5** **Section I :** Analysis and synthesis	**60**	**2**

	Section II : Preparation & Characterization		
OR			
III] RESEARCH PROJECT			**4**
24BPCH3RP1	Research Project	**120**	**4**
Total		**540**	**22**

Credit Distribution Structure

SEMESTER IV			
Course Code	**Course Title**	**No. of lectures in Hrs.**	**Credits**
I] MANDATORY			**12**
24BPCH4T01	Theoretical organic chemistry-II	**60**	4
24BPCH4T02	Synthetic organic chemistry-II	**60**	4
24BPCH4T03	Natural products	**30**	2
24BPCH4P01	Chemistry Practical -1 **Session-I -** Two steps preparations **Session-II-** Purification and Characterisation of compound	**60**	2
II] ELECTIVES (2T+2P) **Note: Select Any One subject among the electives given below**			**4**

24BPCH4T04	Heterocyclic chemistry	**30**	2
24BPCH4P02	**Chemistry Practical-II** **Session-I** and **Session -II** Combined spectral identification: Interpretation of spectral data of organic compounds	**60**	2
OR			
24BPCH2T05	**INTELLECTUAL PROPERTY RIGHTS**	**30**	2
24BPCH2P03	**Practical Based on 23BPCH2T5** **Case study**	**60**	2
III] RESEARCH PROJECT			
24BPCH4RP1	**Research Project**	**180**	**6**
Total		**570**	**22**

Semester III

Course Code 24BPCH3T01	Course Title Paper 1 (Theoretical organic chemistry-I)	Credits 4	No. of lectures 60 in hrs

Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to 1) Discuss the methods of generation of structure. 2) Describe the concept of NGP. 3) Elaborate concept of pericyclic reaction. 4) Illustrate the types of pericyclic reaction. 5) Elaborate concept of point group based on symmetry. 6) Elucidate conformational analysis of medium ring like eight to ten members rings. 7) Describe the principle and reactions involved in photochemistry. 8) Discuss the photochemistry of carbonyl compound,olefins and arenes.		
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 softelectrophiles 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	**15L**

	● The generalised Woodward-Hoffmann Rule Explanations for Woodward-Hoffmann Rules ● 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] H-shifts and C-shifts, supra and antarafacial migrations, retention and inversion of configurations. Cope (including oxy-	**15L**

	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.	
UnitI 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]	**15L**
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] $\pi \rightarrow {}^{*}\pi^{\star}$, $n \rightarrow {}^{*}\pi^{*}$ transitions, Norrish- I and Norrish-II cleavages, Paterno-Buchi reaction. Photoreduction,	**15L**

	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]	

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Course Code 24BPCH3T02	**Course Title Paper 2 (Synthetic Organic Chemistry-I)**	**Credits 4**	**No. of lectures 60 in hrs**

Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to

1) Discuss the name reactions and its mechanism with applications.
2) Describe the multicomponent reaction.
3) Discuss the generation of radicals in organic synthesis.
4) Elucidate characteristic reaction and radicals in synthesis.
5) Elaborate the study different types of Enamines, Ylides and α-C-H functionalization.
6) Describe the Phosphorus, Sulfur and Nitrogen Ylides
7) Discuss the basics of metals/ non-metals in organic synthesis.

8) Illustrate the synthesis using organoborane and organosilicon compound.		
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.	**15L**
Unit II :	**2.Radicals in organic synthesis.** 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: $S_{RN}Ar$ reactions**.**	**15L**

	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.	**15L**
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 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	**15L**

	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.	

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Course Code 24BPCH3T03	**Course Title Paper 3 (Natural products and Spectroscopy)**	**Credits 4**	**No. of lectures 60 in Hrs.**

Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to

1) Discuss the Biosynthesis of various natural products.
2) Describe Insect pheromones and Natural pigments.
3) Elucidate Multi-step synthesis of natural products.
4) Discuss the classification of lipids and prostaglandin.
5) Elucidate structure of various organic compounds with the help of spectroscopy .
6) Illustrate the ^{13}C –NMR spectroscopy.
7) Elaborate advanced NMR techniques.
8) Determine Spectral problems based on UV, IR, $^{1}HNMR$ $^{13}CNMR$.

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	**15L**

	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.	
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.	**15L**

	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).	
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]	**15L**
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.	**15L]**

	4.2 Spectral problems based on UV, IR, $_{1}$HNMR, $_{13}$CNMR (Including 2D technique) and Mass spectroscopy [5L]	

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Course Code 24BPCH3P01	Course Title Chemistry Practical	Credits 2	Lecture 60 in hrs.

Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to

- Be skillful in handling various glassware and instruments.
- Actively participate in chemical laboratories.
- Study of commercial analysis of various organic and inorganic compounds.
- Learned basics of chemical analysis.

Separation of a ternary mixture of organic compounds and identification including derivative preparations using micro-scale technique	**60**
1. 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

II] ELECTIVES (2T+2P)

NOTE: SELECT ANY ONE SUBJECT AMONG THE ELECTIVES GIVEN BELOW-

Course Code 24BPCH3T04	Course Title Paper 4 (E1: Medicinal Chemistry)	Credits 2	No. of lectures 30 in hrs.
Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to – 1) Discuss the basic concept in medicinal and pharmaceutical chemistry and its therapeutic significance. 2) Describe the structural relationship with effective drug doses to the targeted disease. 3) Elaborate the Synthesis of various organic compound/ drugs their reaction and application of the same industrial point of view. 4) Elucidate the adverse effects of the drugs.			
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		**15L**

	branching, ring-chain transformation, bioisosterism, combinatiorial (basic idea).	
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**

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Course Code 24BPCH3P02	Course Title Chemistry Practical	Credits 2	No. of lectures in 60 hrs

Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to

- Be skillful in handling various glassware and instruments.
- Actively participate in chemical laboratories.
- Study of commercial analysis of various organic and inorganic compounds.
- Learned basics of chemical analysis

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	**60 L**

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)**			
Course Code **24BPCH3T05**	**Course Title** **Paper 4** **(E2: Biogenesis and Green chemistry)**	**Credits** **2**	**No. of lectures in 30 hrs.**
Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to 1) Discuss Familiar with the various biosynthesis of natural product and its derivatisation. 2) Elaborate the synthesis of various organic compound their reaction and application of the same industrial point of view. **3)** Describe the Study of characterization of organic compound, determination of type, elemental detection and conformation of most probable structure. **4)** Discuss the synthesis using Green catalysts and Green reagents**.**			
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]**		**15L**

	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.	
Unit II	**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.**	**15L**

	4.3 Comparison of traditional processes versus green processes in the syntheses of ibuprofen, adipic acid, 4-aminodiphenylamine, p-bromotoluene and benzimidazole. [3L] 4.**4 Green Catayst s :** [2L] Nanocatalyst, Types of nanoctalysts, Advantages and Disadvantages of Nanocatalysts, Idea of Magnetically separable nanocatalysts.	

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15. Chemistry of natural products, V.K. Ahluwalia, Vishal Publishing Co

23BPCH3P03	Practical based on Biogenesis and Green chemistry	Credits 2	60Lectures in hrs
	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 5. 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**

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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
6. Food & Beverage Adulteration and Its Implications Theory & Practice By Gajanan Shirke · 2022 Notion Press and shroff publishiners
7. Handbook of Pharmaceutical Excipients By American Pharmacists Association · 2009 Paul J. Sheskey, Raymond C. Rowe 9781582121352
8. Advanced Air and Noise Pollution Control by Lawrence K. Wang, Norman C. Pereira, Yung-Tse Hung Volume 2 2005 SBN:9781592597796
9. Industrial Wastewater Treatment, Recycling and Reuse By Vivek V. Ranade, Vinay M Bhandari · 2014 ISBN:9780444634030 published by Elsevier Science

III] RESEARCH PROJECT

Course Code 24BPCH3RP1	III] Research Project	Credits 4	No. of lectures 120 L in hrs.
	Subject based project Allotment of topics, proposal writing , Preparation of Literature review Execution of planning of research starting of experimental work Report writing		**120L**

Semester IV

Course Code 24BPCH4T01	Course Title Paper 1(Theoretical organic chemistry-II)	Credits 4	No. of lectures 60 in hrs.

Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to

1) Discuss Study of thermodynamic parameters of chemical system.

2) Elaborate Uses of Hammett equation, deviations from Hammett equation.

3) Describe the Supramolecular chemistry.

4) Discuss structure and properties Using Synthetic molecular receptors

5) Describe the Stereochemistry

6) Construct the Molecular dissymmetry and chiroptical properties

7) Recognize Principles of asymmetric synthesis.

8) Discuss the chiral oxazolinesasymmetric transformations.

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**.**	**15 L**

		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]	
	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]	**15L**
	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	**15L**

		dichroism. ORD and CDcurves. Cotton effect and its applications. The octant rule and the axial α–haloketone rule with applications. [5L]	
	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]	**15L**

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33. Molecular Photochemistry, N. J. Turro, W. A. Benjamin.
34. Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill
35. Photochemistry, R. P. Kundall and A. Gilbert, Thomson Nelson.
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Course Code 24BPCH4T02	**Course Title Paper 2(Synthetic organic chemistry-II)**	**Credits 4**	**No. of lectures 60 in hrs.**

Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to

1) Describe the Protecting groups in Organic Synthesis
2) Discuss the introduction to Retrosynthetic analysis and synthetic planning using Selective organic transformations.
3) Elaborate -simplification, symmetry, high yielding steps, and recognisable starting material.
4) Discuss One group C-C Disconnections and Two group C-C Disconnections

5) Describe the Electro-organic chemistry and Selected methods of Organic synthesis.
6) Determine the Selected Methods of Organic synthesis using Pd catalysed reaction.
7) Describe the basic concepts Transition and rare earth metals in organic synthesis
8**)** Describe Application of Ni, Co, Fe, Rh, and Cr carbonyls in organic synthesis.

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]**	**15L**

	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, 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.	**15L**

	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.	
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.	**15L**
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.	**15L**

	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]**	
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).	

<table>
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<tr><td></td><td>Course Code
24BPCH4T03</td><td>Course Title
Paper 3: Natural products</td><td>Credits
2</td><td>No. of lectures 30 in hrs.</td></tr>
<tr><td></td><td colspan="4">Course Outcomes: Upon completion of this course, learners will achieved knowledge related to
1) Discuss the structure, classification, biological role of steroids.
2) Describe the different synthesis from 16-DPA.
3) Elaborate the Classification, sources and biological importance of vitamin
4) Discuss the Synthesis of the following: B1,B2, B6, folic acid, B12, C, D1, E (α-tocopherol), K1, K2, H and classification ,occurance of Terpenoids.</td></tr>
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	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]	**15L**
	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: 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.	**15L**

		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 .	

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Course Code 24BPCH4P01	**Course Title** **Section I -** Two steps preparations **Section II-** Purification and Characterisation of compound	**Credits 2**	**No of Lecture in hrs. 60**

Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to

1. Learners are expected to know-
(i) the planning of synthesis, effect of reaction parameters including stoichiometry, and safety aspects including MSDS
(ii) The possible mechanism, expected spectral data (IR and NMR) of the starting material and final product.
2. Learners are expected to purify the product by recryllization, measure its mass or volume, check the purity by TLC, determine physical constant and calculate percentage yield.
3. Be competent employee/entrepreneur as commercial chemical analysit of various organic and inorganic compounds

	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.	**60L**
	REFERENCES FOR PRACTICALS 24BPCH4P1 AND 24BPCH4P2 **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	

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SEMSTER IV

II] ELECTIVES (2T+2P)

Note: Select Any One subject among the electives given below

Course Code 24BPCH4T04	Course Title Elective : Heterocyclic chemistry	Credits 2	No of Lecture in hrs. 30

Course Outcomes: Upon completion of this course, learners will acquire knowledge about and able to -

1) Discuss to introduce about basic chemistry of the heterocyclic compounds.
2) Illustrate the structure reactivity and synthesis of heterocyclic compound.
3) Describe the fundamental theoretical understanding of bicyclic and tricyclic heterocyclic compound.
4) Explain the Nucleophilic ring opening reactions

Unit I	Heterocyclic compounds-I	15L

		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.	
	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.	**15L**
	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** **Combined spectral identification: Interpretation of spectral data of organic compounds**	**Credits 2**	**No of Lecture in hrs. 60**
	Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to			

	1) Based on concept and spectroscopic data learners able to elucidate structure of unknown and known compound. 2) To identify target and its validation, in case of structure based drug design	
	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).**	60L

Course Code 24BPCH4T05	**Course Title** **INTELLECTUAL PROPERTY RIGHTS**	**Credits** **2**	**No of Lecture in hrs. 30**
Unit 1:	**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]**		**15L**

	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.		
Unit 2:	**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] 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		**15L**
Course code 24BPCH2P3	.Course Title **Practical Based on 23BPCH2T05**	**Credits**	**No. of lectures in Hrs. 60**
	Case study and its report	**2**	60

III] RESEARCH PROJECT

Course Code 24BPCH4RP01	RESEARCH PROJECT	Credits 6	No. of lectures 120 L in hrs.
	Subject based project Completion of experiments part Project paper presentations or publication in conferences/workshop and seminars Report writing **Project presentation**		**180L**

Evaluation Scheme 60:40

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

Assignments/ Tutorials	Seminar	Ppt/video Presentation	Group discussion	Active Participation & Leadership qualities	Total
10	10	10	05	05	40

Theory Examinations:
SEM III - Paper 1, Paper 2 , Paper 3 and
SEM IV- Paper1, Paper 2
Suggested Format of Question paper

Duration: 2½ Hours **Total Marks: 60**

- **All questions are compulsory**

Q. 1		Answer ***any three*** of the following-	**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
	e	Based on Unit I	
	f	Based on Unit I	
Q. 2		Answer ***any three*** of the following-	**12**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
	d	Based on Unit II	
	e	Based on Unit II	
	f	Based on Unit II	
Q. 3		Answer ***any three*** of the following-	**12**

	a	Based on Unit III	
	b	Based on Unit III	
	c	Based on Unit III	
	d	Based on Unit III	
	e	Based on Unit III	
	f	Based on Unit III	
Q. 4		Answer ***any three*** of the following-	
	a	Based on Unit IV	
	b	Based on Unit IV	
	c	Based on Unit IV	
	d	Based on Unit IV	
	e	Based on Unit IV	
	f	Based on Unit IV	
Q. 5		Answer ***any three*** of the following	**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit II	
	d	Based on Unit II	
	e	Based on Unit III	
	f	Based on Unit III	
	g	Based on Unit IV	
	h	Based on Unit IV	

Theory Examinations: For SEM IV- Paper 3 and ELECTIVE Papers

Duration: 1.30 Hours **Total Marks: 30**

- **All questions are compulsory**

Q. 1	Answer ***any three*** of the following-		**10**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
	e	Based on Unit I	
	f	Based on Unit I	
Q. 2	Answer ***any three*** of the following-		**10**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
	d	Based on Unit II	
	e	Based on Unit II	
	f	Based on Unit II	
Q. 3	Answer ***any Two*** of the following-		**10**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit II	
	d	Based on Unit II	

Semester End Practical Examination:

Semester ____ Practical Examination "Month & Year '

Paper Code:- _____

Duration: - 03.00 hrs. **Total Marks**: - 50

Particulars	**Duration**	**Semester end external examination**
Laboratory work	2 Hrs + 2 Hrs	20 + 20

Viva		05
Journal		05
Total		**50**

Research project analysis in SEM III will depend on Report, presentation viva

- Total Marks 100

Research project analysis in SEM IV will depend on Report, presentation , publications viva

- Total Marks 150

Marks Distribution and Passing Criterion for Each Semester

Theory						**Practical**		
Course Code SEMIII / SEM IV	Internal	Min marks for passing	Theory Examination	Min marks for passing	Total	Course Code	Practical Examination	Min marks for passing
24BPCH 3T01 / 4T01	40	16	60	24	100	-	-	-
24 BPCH 3T02 / 4T02	40	16	60	24	100	-	-	-
24BPCH 3T03	40	16	60	24	100	-	-	-
Laboratory 1	-	-	-	-	-	24BPCH	**50**	**20**

						3PO1/4 P01		
ELECTIVE and MANDATORY 24BPCH4T03	20	08	30	12	50			
Laboratory 2	-	-	**-**	**-**	-	24BPCH 3P01/4P02	**50**	**20**
SemIII Research Project	-	-	-		100	**24BPCH 3RP01**	**100**	**40**
-	-	-	-	-	-	**24BPCH 4RP01**	**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

$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning)

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	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	Chemistry Practical -1 **Section I :** Separation of a ternary mixture of organic compounds and identification **Section II :** Preparation of derivatives using micro-scale technique	-	-	√	-	-	-	-

Optional Electives Semester 1 -								
24BPCH3T04	**Medicinal Chemistry**	√	√	-	-	--	--	√
24BPCH3P02	Chemistry Practical- 2 **Section I :** Single step preparations **Section II :** Purification methods	-	-	√	-	-	-	-
OR								
24BPCH3T05	**Biogenesis and Green chemistry**	√	--	-	--	--	--	√
24BPCH3P03	**Practical 3 based on 24BPCH3T05** **Section I : Analysis and synthesis** **Section II : Preparation & Characterization**	√	-	-	-	-	-	-
OR								
24BPCH3RP	**Research Project**	√	√	√	--	--	√	--
	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	Chemistry Practical -1 **Session-I -** Two steps preparations **Session-II-** Purification and Characterisation of compound	-	-	√	-	-	-	-
Optional Electives Semester 1 -Interdisciplinary Sciences								
24BPCH4T04	Heterocyclic chemistry	--	--	√	-	--	--	--
24BPCH4P02	**Chemistry Practical-II** **Session-I** and **Session -II** Combined spectral identification: Interpretation of spectral data of organic compounds	-	-	√	-	-	-	-
OR								
24BPCH2T05	**INTELLECTUAL PROPERTY RIGHTS**	--	--	√	--	--	√	--
24BPCH2P03	**Practical Based on 23BPCH2T05**							

	Case study							
III] RESEARCH PROJECT								
24BPCH4RP	**Research Project**	√	√	√	**--**	**--**	**-**	√
	Total	**2**	**1**	**7**	**0**	**0**	**1**	**2d**

Sign & Name of _____

BOS Chairman & Head Dept. Of Chemistry