



KAVAYITRI BAHINABAI CHAUDHARI  
NORTH MAHARASHTRA UNIVERSITY,  
JALGAON

**Academic Curriculum  
(For Affiliated Colleges of KBCNMU)**

**MASTER OF SCIENCE  
In  
ORGANIC CHEMISTRY  
PART- II**

**(Semester III and IV)**

**Choice Based Credit System, 60:40 Pattern  
(Outcome Based Curriculum)**

**As per UGC Guidelines**

**w. e. f. 2022-23**

**2022**

**KAVAYITRI BAHINABAI CHAUDHARI  
NORTH MAHARASHTRA UNIVERSITY, JALGAON**

**Summary of Distribution of Credits under CBCS Scheme  
for  
M.Sc. Organic Chemistry  
at**

[Affiliated Colleges of Kavayitri Bahinabai Chaudhari North Maharashtra University,  
Jalgaon w.e.f. 2022-23]

<b>Sr. No</b>	<b>Type of course</b>	<b>Sem I</b>	<b>Sem II</b>	<b>Sem III</b>	<b>Sem IV</b>
01	Core	12	12	12	08
02	Core Skill based	02	20	-	12
03	Elective	-	-	04	04
04	Project	-	-	-	06
05	Audit	02	02	02	02
06	Total Credits	16	34	18	32

<b>Subject Type</b>	<b>Core</b>	<b>Core Skill based</b>	<b>Elective</b>	<b>Project</b>	<b>Audit</b>	<b>Total</b>
<b>Credits</b>	<b>44</b>	<b>34</b>	<b>08</b>	<b>06</b>	<b>08</b>	<b>100</b>

Total Credits = 100

# Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

## M. Sc. Part-II Organic Chemistry (Sem-III and IV) Choice Based Credit System (Outcome Based Curriculum)

[At Affiliated Colleges w.e.f. 2022-23]

### *Course credit scheme*

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	
I	3	12	<b>12</b>	1	2 + 0	02	1	2	2	<b>16</b>
II	3	12	<b>12</b>	4	2 + 18	20	1	2	2	<b>34</b>
III	3	12	<b>12</b>	1	4 + 0	04	1	2	2	<b>18</b>
IV	2	08	<b>08</b>	4	4 + 18	22	1	2	2	<b>32</b>
Total Credits	<b>44</b>			<b>48</b>			<b>8</b>			<b>100</b>

(T, Theory; P, Practical)

### *Structure of Curriculum*

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
<b>(A) Prerequisite and Core Courses</b>										
(A)	Theory	14	4	14	4	12	3	08	2	48
	Practical	-	-	18	3	-	-	18	3	36
<b>(B) Skill Based / Subject Elective Courses</b>										
1	Theory /Practical	-	-	-	-	4	1	4	1	08
<b>(C) Audit Course (No weightage in CGPA calculations)</b>										
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			2
4	Professional and Social + Value Added Course							2	1	2
	Total Credit Value	16	5	34	8	18	5	32	7	100

**List of Audit Courses (Select any ONE course of Choice from Semester II; Semester III and Semester IV)**

<b>Semester I (Compulsory)</b>		<b>Semester II (Choose One)</b>		<b>Semester III (Choose One)</b>		<b>Semester IV(Choose One)</b>	
		<b>Personality and Cultural Development</b>		<b>Technology + Value Added Course</b>		<b>Professional and Social + Value Added Course</b>	
<b>Course Code</b>	<b>Course Title</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Course Code</b>	<b>Course Title</b>
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Practicing Sport Activities	AC-301B	Cyber Security	AC-401B	Seminar on Review of Research Paper
		AC-201C	Practicing Yoga	AC-301C	Molecular Docking	AC-401C	Current Affairs
		AC-201D	Introduction to Indian Music	AC-301D	Technical Report Writing	AC-401D	Intellectual Property Rights (IPR)

**Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon**  
**M. Sc. Part-II Organic Chemistry (Sem-III and IV)**  
**Choice Based Credit System (Outcome Based Curriculum)**

**Semester-III**

Course Code	Course Type	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
CH-350	Core	Organic Reaction Mechanism	04	--	04	40	--	60	--	100	--	04
CH-351	Core	Spectroscopic Methods in Structure Determination	04	--	04	40	--	60	--	100	--	04
CH-352	Core	Organic Stereo Chemistry	04	--	04	40	--	60	--	100	--	04
CH-353	Elective	Choose one out of two CH-353 A/B (A) Heterocyclic Chemistry (B) Green Chemistry	04	--	04	40	--	60	--	100	--	04
AC-301 (A)/(B)/(C)/(D)	Audit Course	Choose one out of four (AC-301 A/B/C/D) (Technology + Value Added Course)	02	--	02	100	--	--	--	100	--	02

**List of Audit courses to be offered in Semester-III:**

AC-301 (A): Computer Skills

AC-301 (B): Cyber Security

AC-301 (C): Molecular Docking

AC-301 (D): Technical Report Writing

**Semester-IV**

Course Code	Course Type	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
CH-450	Core	Chemistry of Natural Products	04	--	04	40	--	60	--	100	--	<b>04</b>
CH-451	Core	Synthetic Methods in Organic Chemistry	04	--	04	40	--	60	--	100	--	<b>04</b>
CH-452	Elective	Choose one out of two CH-452 A/B (A) Drug Chemistry (B) Applied Organic Chemistry	04	--	04	40	--	60	--	100	--	<b>04</b>
*CH-O-2	Core Skill base	Organic Chemistry Practical Course-II	--	12	12	--	40	--	60	--	100	<b>06</b>
*CH-O-3	Core Skill base	Organic Chemistry Practical Course-III	--	12	12	--	40	--	60	--	100	<b>06</b>
*CH-O-4	Core Skill base	A Short Research Project	--	12	12	--	40	--	60	--	100	<b>06</b>

AC-401 (A)/ (B)/(C)/ (D)	Audit Course	Choose one out of four (AC-401 A/B/C/D) (Professional & Social + Value Added Course)	02	--	02	100	--	--	--	100	--	02
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\* To be started from Semester-III & evaluated at the end of Semester-IV

**List of Audit courses to be offered in Semester-IV:**

AC-401 (A): Human Rights

AC-401 (B): Seminar on Review of Research Paper

AC-401 (C): Current Affairs

AC-401 (D): Intellectual Property Rights

## KAVAYITRI BAHINABAI CHAUDHARI

### NORTH MAHARASHTRA UNIVERSITY, JALGAON

**Syllabus for M.Sc. Part-II Organic Chemistry**  
(Semester - III & IV) (With Effect from 2022-23)

#### Course Structure for Second Year

The following will be the structure for revised syllabus from June 2022 for Semester III and Semester IV.

Course Code	Course Type	Title of the Course
<b>SEMESTER - III</b>		
CH-350	Core	Organic Reaction Mechanism
CH-351	Core	Spectroscopic Methods in Structure Determination
CH-352	Core	Organic Stereochemistry
CH-353	Elective	Choose one out of four (CH-353 A/B/C/D)
AC-301 (A)/(B)/(C)/(D)	Audit Course	Choose one out of four (AC-301 A/B/C/D) (Technology + Value Added Course) AC-301 (A): Computer Skills AC-301 (B): Cyber Security AC-301 (C): Molecular Docking AC-301 (D): Technical Report Writing
<b>SEMESTER - IV</b>		
CH-450	Core	Chemistry of Natural Products
CH-451	Core	Synthetic Methods in Organic Chemistry
CH-452	Elective	Drug Chemistry
*CH-O-2	Core Skill base	Organic Chemistry Practical Course-II
*CH-O-3	Core Skill base	Organic Chemistry Practical Course-III
*CH-O-4	Core Skill base	A Short Research Project
AC-401 (A)/(B)/(C)/(D)	Audit Course	Choose one out of four (AC-401/402/403/404) (Professional & Social + Value Added Course) AC-401 (A): Human Rights AC-401 (B): Seminar on Review of Research AC-401 (C): Current Affairs AC-401 (D): Intellectual Property Rights

**Important Notes:**

1. Each theory course prescribed for M. Sc. should be covered in 4 lectures, each of 60 minutes duration per week per course including lectures, tutorials, seminars, classroom discussions etc. (Total 60 hrs / theory course)
2. Out of the 60 lectures in each course about 10 lectures will include tutorials, student seminars, classroom discussions and tests.
3. Each practical course will require 12 hours of laboratory work per week per semester and will be extended over two semesters. All three practical courses will be examined at the end of the academic year. (Total 180 hrs / practical course)
4. There should not be more than 10 students in a batch for M. Sc. Practical course.
5. For theory course the question paper (Internal/External) should include numerical, short answer, long answer, MCQ questions to test understanding of subject.
6. The marks for each paper are distributed as external examination 60 marks and internal examination 40 marks. For internal assessment of each theory and practical course, 2 written tests will be taken.
7. The 80 % attendance of students is compulsory.
8. Students should visit at least two chemical industries in two years of M. Sc. and submit the observations/report to the Department.
9. The duration of practical examination will be of six hours.
10. At the time of examination of the **CH-O-4** (A Short Research Project) Viva-voce, the internal and external examiner should be a research guide recognized by the university.

## Semester-wise Course Structure of M.Sc. Organic Chemistry

### Program at a Glance

Name of the program (Degree)	: M. Sc. (Organic Chemistry)
Faculty	: Science and Technology
Duration of the Program	: Two years (four semesters)
Medium of Instruction and Examination	: English
Exam Pattern	: 60: 40 (60 marks University exam and 40 marks continuous internal departmental exam/assessment)
Passing standards	: 40% in each exam separately (Separate head of passing)
Evaluation mode	: CGPA
Total Credits of the program	: 100 (50 core credits including 6 credits of project/dissertation, 34 skills enhancement credits, 08 subject elective credits and 08 audit credits)

#### **Program Objectives for M.Sc. Program:**

1. To impart the profound theoretical and practical knowledge of the specific science discipline along with the fundamental core concepts
2. To train the students to employ modern techniques, tools, methodologies, equipment, hardware/software etc. to perform objective oriented scientific and planned experiments.
3. To groom the students for all-round development and mould them in a trained workforce to provide teaching-learning, research, business, professional supports in the various science disciplines.
4. To make the student to develop the ability to think analytically, independently and draw logical conclusions to solve real-life problems.
5. To utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.

### Program Outcomes (PO) for M.Sc. Program:

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	PO	Cognitive level
PO1	Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their irrelevances in the day-to-day life.	2
PO2	Administer the skills in handling scientific instruments, planning and performing in laboratory experiments	3
PO3	Analyze the given scientific experimental data critically and systematically and the ability to draw the objective conclusions.	4
PO4	Develop various skills such as communication, managerial, leadership, entrepreneurship, teamwork, social, research etc., which will help in expressing ideas and views clearly and effectively	3
PO5	Model and formulate the real problems and find solution based-on knowledge acquired	6
PO6	To evaluate how developments in any science subject helps in the development of other science subjects and vice-versa and how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments.	5

### Program Specific Objectives for M.Sc. Organic Chemistry program:

- Determine molecular structure by using UV, IR, NMR and Mass.
- Draw mechanism for organic reactions.
- Learn the basic skills of research.
- To learn chemistry of natural products and drugs.
- Study of stereo-chemical aspects of organic reactions.
- Design the organic synthesis using retro synthesis and synthetic catalyst/reaction.
- To get laboratory skills of organic synthesis.

### Program Specific Outcomes (PSOs) for M.Sc. Organic Chemistry program:

After successful completion of two-year master's degree program in Organic Chemistry, should be able to;

PSO No.	PSO	Cognitive level
PSO1	Demonstrate an understanding of the basic concepts, fundamental principles, and the scientific theories related to Organic Chemistry and their relevancies in the day-to-day life, industry, and health.	2
PSO2	Gain proficiency and skills in laboratory techniques of Chemistry with	3

	handling scientific instruments, planning and performing in laboratory experiments.	
<b>PSO3</b>	Develop various skills such as communication, managerial, leadership, entrepreneurship, teamwork, social, research etc., which will help in expressing ideas and views clearly and effectively.	<b>3</b>
<b>PSO4</b>	Analyze the given scientific experimental data (reactants, products, reagents, catalyst, solvent, temperature, yield, purity, spectral data etc.) critically and systematically and the ability to draw the objective conclusions.	<b>4</b>
<b>PSO5</b>	Learn to work as a team as well as independently to retrieve information, carry out research investigations and result interpretations.	<b>5</b>
<b>PSO6</b>	Develop the ability to understand and practice the ethics of surrounding scientific research.	<b>5</b>
<b>PSO7</b>	Design, synthesis, characterization, and applications of organic compounds.	<b>6</b>

**CH-350: Organic Reaction Mechanism****(60 L, 100 Marks and 4 Credits)**

	<p><b>Course Objectives:</b> To make the students conversant with the</p> <p>CO-1. Learn in detailed strength of acid and bases. Understand the Linear free energy relationship, Hammett and Taft equation, substituent and reaction constants.</p> <p>CO-2. Study of detailed mechanism of hydrolysis with breaking and formation of sigma bond.</p> <p>CO-3 Study of reaction of carbanion with detailed mechanism, coupling reactions along with name reactions.</p> <p>CO-4 Study of basics of photochemical reactions and learn various photochemical reactions.</p> <p>CO-5. Study of free radicals: generation of radicals, Nucleophilic electrophilic radicals, inter and intra molecular C-C bond formation, reactions of free radicals.</p> <p>CO-6. All the major types of organic reaction mechanisms.</p>	
	<b>Course Contents (Topics and subtopics)</b>	
1	<p><b>Physical Organic Chemistry:</b></p> <p><b>Strength of Acids and Bases: Factors affecting acidity and basicity:</b></p> <p>Comparative study of acidity and basicity of organic compounds on the basis of pKa values, Leveling effect and non-aqueous solvents. Acid and base catalysis – general and specific catalysis with examples. Aromaticity and solvation.</p> <p><b>Linear free energy relationship:</b></p> <p>Hammett plot, Hammett equation, substituent and reaction constants, physical significance of substituent constant and reaction constants, substituent constant involving through conjugation. Use of Hammett plot and equation. Deviations from straight line plot. Concave upward deviation. Concave downward deviation. Steric effects, Taft equation, Steric parameters, solvent effects, change of reaction constant.</p> <p><b>Ref. 1, 2, 3</b></p>	<b>14 L</b>
2	<p><b>Ester hydrolysis and decarboxylation:</b></p> <p>Classification, nomenclature and study of all eight mechanisms of acid and base catalyzed hydrolysis with suitable examples. Decarboxylation reaction.</p> <p><b>Ref.1, 4, 5, 6</b></p>	<b>07 L</b>
3	<p><b>Reaction of carbon nucleophiles with carbonyl groups:</b></p> <p>Carbanions: Generation of carbanion, kinetic and thermodynamic enolate formation, Regioselectivity in enolate formation, alkylation of enolates. Generation and alkylation of dianion, medium effects in the alkylation of enolates, oxygen versus carbon as the site of</p>	<b>12 L</b>

	<p>alkylation. Alkylation of aldehydes, ketones, esters, amides and nitriles. Chemistry of enolates and enamines, Kinetic and Thermodynamic enolates, Lithium and boron enolates in aldol and Michael reactions, Alkylation and acylation of enolates, Nucleophilic additions to carbonyls and stereochemical aspects through various models (Cram / Cram chelation / Felkin-Anh models); Organolithium, Organomagnesium, Organozinc, Organocopper reagents (restricted to 1,4-addition) in synthesis, Recall of Name reactions, their Mechanism and regiochemistry in the reactions under carbanion chemistry - Claisen, Dieckmann, Knoevenegal, Stobbe, Darzen, Acyloin &amp; Benzoin condensations, Shapiro reaction, etc</p> <p><b>Ref. 2,7, 8, 9, 10, 11</b></p>	
<b>4</b>	<p><b>Reactive intermediate: Carbene and Nitrenes</b></p> <p>Method of generation, structure, stability and reactions involving carbene and nitrenes</p> <p><b>Ref. 2,7, 12, 13</b></p>	<b>05 L</b>
<b>5</b>	<p><b>Photochemistry</b></p> <p>Introduction to Basic Principles of Photochemistry. Nature of transition (<math>n-\pi^*</math>, <math>\pi-\pi^*</math>, d-d transition and Charge transfer), Norrish type-I and Norrish type-II reaction, abstraction of <math>\gamma</math>-hydrogen in cyclic and acyclic compounds, formation of bicyclic and tricyclic compounds, Paterno-Buchi reaction (including reaction of enones, ynones and quinones), allenes, Photoreduction (toluene and 2-propanol) Photochemistry of alkene Intermolecular and intramolecular reactions, geometrical isomerization, Cyclization reactions, addition, Paterno Buchi reaction, Di-pi methane rearrangement including aza-di-pi methane. Photochemistry of aromatic compounds Isomerization, additions and substitutions.</p> <p><b>Ref. 12, 14</b></p>	<b>14 L</b>
<b>6</b>	<p><b>Free Radical Reactions:</b></p> <p>Formation, stability and detection of long and short-lived radicals. Homolysis and free radical displacement, Fragmentation, substitution, addition, oxidation, reduction, and rearrangements, Radical cyclisation in synthesis.</p> <p><b>Ref. 15</b></p>	<b>08 L</b>
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. A guide book to mechanism in Organic Chemistry 6<sup>th</sup> edition, By Peter Sykes: Orient Longman</li> <li>2. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford University Press</li> <li>3. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure,</li> <li>4. Jerry March "Advanced Organic Chemistry, Reactions, Mechanism And Structure " Fourth Edition Page No.374-396</li> <li>5. Morrison And Boyd, Sixth Edition Page No.753-754</li> </ol>	

<p>6. P.S.Kalsi Fourth Edition Pages No.269-275</p> <p>7. Advanced Organic Chemistry Part A and B 2<sup>nd</sup>edition, by F. A. Carey and R. J. Sundberg. Plenum Press. New York and London.</p> <p>8. Morrison R.T Boyd &amp; Bhattacharjee S.K,"ORGANIC CHEMISTRY" Seventh Edition 1992 Page No.69-72</p> <p>9. S.M.Mukherji, S.P. Singh Reaction Mechanism In Organic Chemistry</p> <p>10. Smith M.B &amp; March J ," MARCH'S ADVANCED ORGANIC CHEMISTRY ", Sixth Edition, John Wiley &amp; Son's, New Delhi 2007,Page No.249-265</p> <p>11. Arun Bahl And B.S Bahl Advanced Organic Chemistry</p> <p>12. Advance Organic Chemistry: Reactions, Mechanisms and Structure by Jerry March.</p> <p>13. Modern method of organic synthesis by W. Carruther (Cambridge)</p> <p>14. Organic Chemistry 5<sup>th</sup>edition, By S. H. Pine. MaGraw-Hill International editions. Page no. 1023-1041.</p> <p>15. Organic Chemistry 5<sup>th</sup>edition, By S. H. Pine. MaGraw-Hill International editions. Page no. 911-938</p> <p>16. Mechanism and structure in Organic Chemistry, Edwin S. Gould, Holt, Rinechart and Winston.</p> <p>17. Advanced Organic Chemistry 3<sup>rd</sup>edition, by R. O. C. Norman and J. M. Coxon 3<sup>rd</sup> edition ELBS.</p> <p>18. S.M.Mukherji, S.P. Singh Reaction Mechanism In Organic Chemistry</p> <p>19. Photochemistry and Pericyclic Reactions 3<sup>rd</sup> edition, by Jgdambasingh, Jaya Singh</p>	
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### Course Outcomes (COs):

Upon the completion of course, the student should be able:

CO No.	CO	Cognitive level
1	Understand basic concepts of strength of acids and bases, factors affecting the strength of acid and bases	2
2	Acquire the skills to identify the pathway of reaction.	3
3	Formulate his/her own reasoned opinions in the mechanistic side of organic reactions.	3
4	Predict the major and minor products of a variety of organic reactions with appropriate stereochemistry.	3



	respect of their structure determination. <b>Ref. 1, 8</b>	
<b>6</b>	<b>Problems:</b> Based on joint application of UV, IR, PMR, CMR and Mass spectroscopy (including reaction sequence and spectral analysis). <b>Ref. 1, 6,7</b>	<b>12 L</b>
	<b>References:</b> 1. Introduction to Spectroscopy – D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt college publishers). 2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons. 3. Spectroscopic methods in organic chemistry - D. H. Williams and I. Flemming Mc Graw Hill 4. Organic structures from spectra –Field L.D., Kalman J.R. and Sternhell S. 4th Ed. John Wiley and sons Ltd. 5. Organic spectroscopy-William Kemp, E L B with McMillan 6. Spectroscopy of organic molecule-PS Kalsi, Wiley, Esterna, New Delhi 7. Interpretation of NMR spectra-Roy H Bible 8. Mass spectrometry organic chemical applications, J H Banyon	
	<b>Course Out comes:</b>	
	The students will be able to - Interpret the spectral graphs. - Determine molecular structure by using UV, IR, NMR and Mass. - Learn the structure determination of organic molecules by spectroscopic methods and by using the applications of IR spectroscopy for functional group determination. - Determine the complete structure of compounds using UV, IR, PMR, CMR and Mass spectroscopic methods.	

**CH-352: Organic Stereochemistry****(60 L, 100 Marks and 4 Credits)**

	<b>Course Objectives:</b> To make the students conversant with the CO-1. To learn and apply various concepts such as stereochemistry and fundamental principles of stereoselectivity in organic chemistry. CO-2. Study of different types of pericyclic reactions. CO-3. Study of stereochemical aspects of fused and bridged rings. CO-4. Study of stereochemical aspects of six membered and other related rings CO-5 Study of prochirality and topocity.	
	<b>Course Contents (Topics and subtopics)</b>	
1	<b>Concept of Stereochemistry:</b> Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction. Prochirality and Topocity. <b>Ref. 1 (Pages: 465-488), 2, 3, 4 Pages: 187-206</b>	<b>10 L</b>
2	<b>Asymmetric Synthesis:</b> Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst-controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Racemic modification and resolution of racemic mixture (optical and kinetic). <b>Ref. 1, 5 (Pages: 1107-1125), 6</b>	<b>10 L</b>
3	<b>Stereochemistry of six membered rings &amp; their reactions:</b> Different shapes of cyclohexane and substituted cyclohexane ring, reactions associated with cyclohexyl skeleton. Mono, disubstituted cyclohexane-physical properties (optical activity/energetics), Stereochemistry of ring other than six membered rings. Trans annular effect, concept of I-strain. Conformational effects in larger rings, Anti butane segment. <b>Ref 1, 2, 4, 5, 6, 7, 9, 10 &amp; 11</b>	<b>10 L</b>
4	<b>Fused Rings and Bridged Rings:</b> Decaline, Perhydro phenanthrene, Perhydro anthracene, Bridged Compounds and Other related compounds <b>Ref. 1 (Pages 771-793) 2 (Pages 306-310; 318-323; 327-333)</b>	<b>10 L</b>
5	<b>Pericyclic Reactions:</b> 5.1 Introduction, Classification, Molecular orbital symmetry properties, three approaches: Co-relation diagram, FMO & PMO or ATS approach.	<b>20 L</b>

	<p>5.2 Electrocyclic reactions: Con rotatory &amp; Dis rotatory motions, <math>4n</math> and <math>4n+2</math> &amp; allyl system.</p> <p>5.3 Cycloaddition reaction: Antarafacial &amp; Suprafacial additions, <math>4n</math>, <math>4n+2</math> systems, Diels-Alder reaction and its stereochemistry, 2+2 addition of ketones, secondary orbital interaction in cycloaddition reaction, 1,3-dipolar cycloaddition and chelotropic reactions.</p> <p>5.4 Sigmatropic rearrangement: Suprafacial &amp; Antarafacial shifts of H and carbon moities, Claisen, Cope &amp;aza cope, Ene reactions and Fluxional molecule.</p> <p><b>Ref. 7, 8, 9</b></p>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Stereochemistry of organic compounds. E L.Eliel and S. H. Wilen</li> <li>2. Stereochemistry. Nasipuri(Second Ed.).</li> <li>3. Organic Chemistry- by Finar</li> <li>4. Stereochemistry- Confirmation and Mechanism (8th edition)-P. S. Kalsi</li> <li>5. Organic Chemistry-Clayden, Greeves, Warren and Wothers-OXFORD (Second Ed.)</li> <li>6. Stereoselective synthesis—Mihaly Nograd VCH, Weinheim,1995.</li> <li>7. Frontial orbitals and Organic Chemical Reactions. I N Flaming.</li> <li>8. Orbital Symmetry: Problem Solving Approach. R. E. Lehr and Merchand.</li> <li>9. Photochemistry and Pericyclic reactions- Jagadamba singh</li> <li>10. Stereochemistry, D. G. Morris, RSC Tutorial Chemistry Text 1, 2001</li> <li>11. Basic stereochemistry of organic molecules -Subrata Sen Gupta(Oxford)</li> </ol>	
	<p><b>Course Outcomes:</b></p>	
	<p>The students will be able to</p> <ul style="list-style-type: none"> <li>Differentiate stereoisomers.</li> <li>Understood stereochemical aspects of organic reactions.</li> <li>Understood the concept of asymmetric synthesis and resolution.</li> <li>Understood different types of pericyclic reactions.</li> <li>Understood stereochemical equivalence and nonequivalence.</li> </ul>	

**CH-353 A: Heterocyclic Chemistry****(60 L, 100 Marks and 4 Credits)**

	<b>Course Objectives:</b> To make the students conversant with the CO-1. Study of heterocyclic chemistry: Five and six members heterocyclic with one or two hetero atoms. CO-2. Study of condensed five- and six-member heterocyclic compounds. CO-3. Study the synthesis, reactivity, aromatic character and important reactions of heterocyclic compounds. CO-4 Students knows the importance of heterocycles in industry as well as drug discovery. CO-5 Create research oriented intrest among the students.	
	<b>Course Contents (Topics and subtopics)</b>	
1	Introduction, Synthetic Approaches & Reactions of following Heterocyclic Compounds A) Nomenclature of Heterocyclic system B) Three Membered and Four Membered Rings containing One Hetero Atom: Aziridine, Oxirane, Thiirane and Azetidine, Oxetane, Thietane <b>Ref. 1 (Pages: 1-41, 76-95), 2, 3</b>	<b>08 L</b>
2	<b>Five Membered Heterocyclic Compounds with One Hetero Atom:</b> Pyrrole, Furan, Thiophene <b>Ref. 1( Pages: 102-138), 2, 3</b>	<b>10 L</b>
3	<b>Five Membered Heterocyclic Compounds with Two Hetero Atoms:</b> Imidazole, Oxazole, Thiazole <b>Ref. 1 (Pages 183-214), 2, 3</b>	<b>06 L</b>
4	<b>Condensed Five-Membered Heterocycles:</b> Indole, Benzofuran, Benzothiophene <b>Ref. 1 (Pages 150-175), 2, 3</b>	<b>10 L</b>
5	<b>Six Membered Heterocyclic Compounds with One Hetero Atom:</b> Pyridine, Quinoline, Isoquinoline <b>Ref.1 (Pages: 222-261, 273-300), 2, 3</b>	<b>12 L</b>
6	<b>Six Membered Heterocyclic Compounds with Two Hetero Atoms and Heterocycles Containing a Ring-Junction Nitrogen:</b> Pyridazine, Pyrimidine, Pyrazine, Indazoline <b>Ref. 1 (pages 308-330), 2, 3</b>	<b>08 L</b>
7	<b>A) Heterocycles in Industry and Technology:</b> Heterocycles and Natural Colors, Dyes, Fluorescent Agents: Why They Shine, Safety and Aesthetics, Markers and Tracers, Imaging and Diagnostic Agents, Heterocycles as Food	<b>06 L</b>

	<p>Additives.</p> <p><b>B) Heterocyclic compounds in Drug Discovery:</b></p> <p>Introduction, Importance of Heterocycles in Life, Importance of Heterocycles in Drug Discovery: Five-Membered Heterocycles with One Heteroatom (Atorvastatin and Imipramine), Five-Membered Heterocycles with Two Heteroatoms (Cimetidine and Celecoxib), Six-Membered Heterocycles with One Heteroatom (Omeprazole), Six-Membered Heterocycles with Two Heteroatoms (Gefitinib and Eszopiclone).</p> <p><b>Ref 4: (Pages: 209-213, 218-225, 237-238), 5 (Pages: 5-16)</b></p>	
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<b>References:</b>		
	<ol style="list-style-type: none"> <li>Principles of Modern Heterocyclic Chemistry by Leo A. Paquette New York: Benjamin.</li> <li>Heterocyclic Chemistry: 5<sup>th</sup> Edition by John A. Joule, Keith Mills, A John Wiley &amp; Sons, Ltd., Publication.</li> <li>Heterocyclic Chemistry: 5<sup>th</sup> edition by Raj K. Bansal, New Age International (P) Ltd.</li> <li>Heterocycles in Life and Society: An Introduction to Heterocyclic Chemistry, Biochemistry and Applications, Second Edition. Alexander F. Pozharskii, Anatoly T. Soldatenkov and Alan R. Katritzky. 2011 John Wiley &amp; Sons, Ltd. Published 2011 by John Wiley &amp; Sons, Ltd. ISBN: 978-0-470-71411-9</li> <li>Heterocyclic chemistry in drug discovery edited by Jie Jack Li. Copyright 2013 by John Wiley &amp; Sons, Inc. All rights reserved. Published by John Wiley &amp; Sons, Inc., Hoboken, New Jersey.</li> </ol>	
<b>Course Outcomes:</b>		
	<p>On completion of this course, the students will be able to:</p> <ul style="list-style-type: none"> <li>Understood various methods of synthesis of heterocyclic compounds.</li> <li>Acquire skill to predict reactivity of heterocyclic compounds.</li> <li>To predict the product and suggest the mechanism.</li> <li>Understand the importance of heterocycles in industry as well as in drug discovery.</li> </ul>	

**CH-353 B: Green Chemistry**  
**(60 L, 100 Marks and 4 Credits)**

	<p>Course Objectives: To make the students conversant with the</p> <p>CO-1. To study the importance of green and sustainable development in Chemistry,</p> <p>CO-2. To study a state-of-the-art strategy to design green and sustainable protocol for organic transformations,</p> <p>CO-3. To be familiar with the current progress in green synthesis,</p> <p>CO-4. To understand the role of catalysts, solvents in organic transformations,</p> <p>CO-5. To understand different energy sources for greener development, and</p> <p>CO-6. To explore the principles of green chemistry towards biomass treatment.</p>	
	<p><b>Course Contents (Topics and subtopics)</b></p>	
<p style="text-align: center;"><b>1</b></p>	<p><b>Brief Introduction of Green Chemistry.</b></p> <p>What is Green and Sustainable development in Chemistry? Need for Green and Sustainable Chemistry. Goals of Green Chemistry. Boundaries/Hurdles to achieve the goals of Green Chemistry.</p> <p><b>Ref.1, 2, 3, 4</b></p>	<p><b>06 L</b></p>
<p style="text-align: center;"><b>2</b></p>	<p><b>Designing a Chemical synthesis in accordance with the Principles of Green Chemistry.</b></p> <p>Twelve principles of Green Chemistry with their brief explanations and examples, Selection and Designing of a process using these principles such as Waste/byproducts minimization, Atom Economy, Control the formation of hazardous/toxic products, designing safer and cost-efficient chemicals for the synthesis, selection of appropriate solvents, separation agents and other auxiliary substances, green solvents, processes without solvent, immobilized solvents, supercritical fluids and ionic liquids, energy requirements for the synthesis (use of microwaves, ultrasonic energy), proper selection of starting materials (avoiding unnecessary derivatization as well as blocking/protecting groups), catalyst and use of catalytic reagents (wherever possible) in preference to stoichiometric reagents, optimizing reaction conditions in such a way that they leads the formation of biodegradable products, avoids chemical accidents and associated with the development of analytical techniques to prevent or minimize the formation of hazardous substances in chemical processes.</p> <p><b>Ref. 4,5 , 6, 7, 8, 9, 10, 11, 12</b></p>	<p><b>24 L</b></p>
<p style="text-align: center;"><b>3</b></p>	<p><b>Examples of Green Synthesis/Reactions.</b></p> <p>1. Green Synthesis of the following compounds: styrene, adipic acid, catechol, 3-dehydroshikimic acid, methyl methacrylate, 4-aminodiphenylamine, Free radical bromination, (S)-metolachlor, citral, nicotinic acid, ibuprofen, paracetamol, furfural.</p>	<p><b>24 L</b></p>

	<p>2. Microwave assisted reactions in water as reaction medium: Hofmann Elimination, Hydrolysis of important organic functions including benzyl chloride, benzamide, n-phenyl benzamide, methyl benzoate, Oxidation of alcohols.</p> <p>Microwave assisted reactions in organic solvents as a reaction medium: Esterification and Trans esterification, Fries rearrangement, Diels-Alder Reaction.</p> <p>Microwave assisted solid state transformations: Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of azoles (pyrimidine and pyridine).</p> <p>3. Ultrasound assisted reactions: Esterification, oxidation, reduction, coupling (diazocoupling) and cross-coupling reactions (Stille, Suzuki, and Heck), Strecker synthesis, and Reformatsky reaction, Simmons-Smith Reaction.</p> <p>4. Use of dimethyl carbonate in organic transformations, use of heterogeneous catalysis, zeolites, silica, alumina, supported catalysis- bio catalysis.</p> <p><b>Ref. 9, 13, 14, 15</b></p>	
4	<p><b>Future Trends in Green Chemistry.</b></p> <p>Green chemistry in Agriculture; enhancement of ethanol yield from the corn dry grind Process by conversion of the Kernel Fiber fraction.</p> <p>Green Chemistry in polymer synthesis; Designing and applications of bio-composites. Exploring green chemistry towards biomass treatment.</p> <p><b>Ref. 16 (PP 12-26, 63-77), 17 (pp 317-352), 18 (1-10)</b></p>	06L
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. P. T. Anastas, I. J. Levy and K. E. Parent. Green Chemistry Education Changing the course of chemistry. ACS Symposium Series 1011 (2009).</li> <li>2. P. T. Anastas and T. C. Williamson. Green Chemistry Designing chemistry for the environment. ACS Symposium Series 626 (1996).</li> <li>3. R. L. Lankey and P. T. Anastas. Advancing sustainability through green chemistry and engineering. ACS Symposium Series 823 (2002).</li> <li>4. A. S. Matlack. Introduction to Green Chemistry. Marcel Deckkar (2001).</li> <li>5. M. Lancaster. Green chemistry; An introductory text. Royal Society of Chemistry (2002).</li> <li>6. P. T. Anastas and J. B. Zimmerman. Innovations in Green Chemistry and Green Engineering Selected Entries from the Encyclopedia of Sustainability Science and Technology. Springer (2013).</li> <li>7. C. A. M. Afonso and J. G. Crespo. Green Separation Processes. Willey-VCH (2005).</li> <li>8. P. T. Anastas and C. A. Farris. Benign by Design Alternative Synthetic Design for Pollution Prevention. ACS Symposium Series 577 (1994).</li> <li>9. V.K. Ahluwalia and M.R. Kidwai. New Trends in Green Chemistry. Anamalaya Publishers (2005).</li> <li>10. P. T. Anastas. L. G. Heine. Green Chemical Syntheses and Processes. ACS Symposium Series 767 (2002).</li> <li>11. D. J. Constable and C. Jimenez-Gonzalez. Handbook of Green Chemistry. Volume 11: GreenMetrics. Willey-VCH (2018).</li> <li>12. M. Doble and A. K. Kruthiventi. Green Chemistry and Engineering. Elsevier (2007).</li> <li>13. P. Tundo, A. Perosa and F. Zecchini. Methods and reagents for green chemistry; An introduction. John Willey and Sons (2007).</li> </ol>	

	<p>14. R. A. Sheldon, I. Arends and U.Hanefeld. Green Chemistry and Catalysis. Willey-VCH (2007).</p> <p>15. M. C. Cann. Green Organic Chemistry in Lecture and Laboratory. CRC Press, Taylor and Fransis Group (2012).</p> <p>16. W. M. Nelson. Agricultural Applications in Green Chemistry. ACS Symposium Series 887 (2004).</p> <p>17. S. C. Ameta and R. Ameta. Green Chemistry; Fundamentals and Applications. CRC Press (2013).</p> <p>18. S. Vaz Jr. Biomass and Green Chemistry; Building a Renewable Pathway. Springer (2018).</p>	
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**Course Outcomes (COts):**

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
1	Familiar with the Principles of green chemistry in detail	2
2	Learn how to develop a green and sustainable protocol for organic synthesis	3
3	Explore green and sustainable practices beyond organic synthesis	3

**CH-450: Chemistry of Natural Products****(60 L, 100 Marks and 4 Credits)**

	<b>Course Objectives:</b> To make the students conversant with the CO-1. To study the important features of terpenoids. CO-2. To study secondary metabolism of Amino acids. CO-3. To study the biosynthesis of natural products. CO-4. To apply the knowledge of different reagents for synthesis of natural product. CO-5. To understand the classification and uses of vitamins.	
	<b>Course Contents (Topics and subtopics)</b>	
1	<b>Structure, Stereochemistry and biogenesis of</b> 1) Hardwickiic acid 2) Podophyllotoxin <b>Ref.1, 2</b>	<b>12 L</b>
2	<b>Multistep Synthesis of Some Natural Products</b>  i) Reserpine (R.B.Woodward Synthesis) ii) Taxol (K.C. Nicolaou Synthesis) iii) Estrone (K.P.C.Vollhardt Synthesis) iv) Strychnine (L.E.Overman Synthesis) v) Prostaglandin ( E.J.Corey Synthesis) <b>Ref.3. (Pages 55-63, 65-81,153-165,641-652,655-671), .4</b>	<b>12 L</b>
3	<b>Secondary Metabolism:</b> Primary and secondary metabolism, Enzyme and Coenzyme, The Building Blocks. 1. Metabolites Derived from Mevalonates: Terpenoids – Mono, Sesqui, Di and Triterpenoids and Cholesterol. 2. Metabolites Derived from Shikimic acid: cinnamic acids, lignans and lignin, coumarins, flavonoids and terpenoid quinones. 3. Secondary metabolism of Amino acids: Alkaloids derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan. <b>Ref. 5 (6-17,95-142,173-189,192-243), Ref.6.( 7-30, 121-158, 167-226, 291-368), 7, 8, 9</b>	<b>28 L</b>
4	<b>Vitamins</b> a) Classification, sources and biological importance of vitamin B1, B2, B6, folic acid, B12, C, D1, E ( $\alpha$ -tocopherol), K1, K2, H ( $\beta$ - biotin). <b>b)synthesis of the following:</b> Vitamin B1(including synthesis of pyrimidine and thiazole moieties	<b>08 L</b>

	<p>Vitamin B2 from 3, 4-dimethylaniline and D (-) ribose</p> <p>Vitamin B6 from: Ethoxyacetylacetone and cyanoacetamide</p> <p>Vitamin E (<math>\alpha</math>-tocopherol) from trimethylquinol and phytol bromide</p> <p>Vitamin K1(<math>\alpha</math>- Phylloquinone) from 2-methyl-1, 4-naphthaquinone and phytol.</p> <p>Vitamin Folic acid from Guanidine and ethyl cyano acetate.</p> <p><b>Ref.10. (598-603,604-607, 615-617, 619-621, 623-625), Ref. 11 (116-156), 12, 13</b></p>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1.i) Tetrahedron Letter No.49, pp. 3751-3759, 1964. Pergamon Press Ltd. Printed in Great Britain.</li> <li>ii) Tetrahedron vol.35 Pages 2301-2310 Pergamon Press Ltd. Printed in Great Britain.</li> <li>2. i) J.C.S. Perkin Transactions II, 288-292, (1973).</li> <li>ii) J. Am. Chem. Soc. Vol.77.432-437,(1955).</li> <li>3. Classics in Total Synthesis: By Nicolaou, K. C. and Sorensen, E. J. (1996) Targets, Strategies, Methods, Wiley VCH.</li> <li>4. Principles of Organic Synthesis By-Norman, R. O. C. and Coxon, J. M. (1993). by Chapman and Hall, 3<sup>rd</sup> Edition, CRC Press.</li> <li>5.Secondary Metabolism, J. Mann, 2<sup>nd</sup> Edition (Oxford University Press).</li> <li>6. Medicinal Natural Products: A Biosynthetic Approach, By Paul M Dewick. A John Wiley and Sons, Ltd, Publication.</li> <li>7. Chemical aspects of Biosynthesis – J. Mann (1994).</li> <li>8. Biogenesis of Natural Products. By- Baldev Kumar, Harish Kumar Chopra. Narosa Publishing House Pvt.Ltd.</li> <li>9.Biosynthesis of Natural Products. P.Manitto.</li> <li>10. Organic Chemistry, Vol. II Stereochemistry and Chemistry of Natural Products By.I.L.Finar.</li> <li>11. Biochemistry, Dr U Satyanarayan and Dr U Chakrapani, Books and Allied (P) Ltd.</li> <li>12.Outline of Biochemistry By- E.E.Conn and P.K.Stumpf.4<sup>th</sup> edition John Wiley and Sons, New York and London</li> <li>13.Principles of Biochemistry by Lehninger, Macmillan Education</li> </ol>	
	<p><b>Course Outcomes:</b></p>	
	<p>Students will be able to</p> <ul style="list-style-type: none"> <li>• Learn the chemistry of terpenoids.</li> <li>• Learn the chemistry of Alkaloids derived from Amino acids.</li> <li>• Learn the structure, biogenesis of some natural products.</li> <li>• Utilized the knowledge of reagents in multi-step synthesis of biologically active members.</li> <li>• Explain the classification of vitamins and their biological importance.</li> </ul>	

**CH-451: Synthetic Methods in Organic Chemistry**  
(60 L, 100 Marks and 4 Credits)

	<p><b>Course Objectives:</b> To make the students conversant with the</p> <p>CO-1. Study of transition metal complexes in organic synthesis.</p> <p>CO-2. Study of different types of coupling reactions.</p> <p>CO-3. Study of Umpolung and Protecting Groups.</p> <p>CO-4. To learn and apply various concepts retrosynthesis.</p> <p>CO-5. Some Advanced Synthetic Reactions.</p>	
	<b>Course Contents (Topics and sub-topics)</b>	
<b>1</b>	<p><b>Applications following elements in organic synthesis</b></p> <p>a) Boron</p> <p>b) Thallium</p> <p><b>Ref.:</b></p> <p>1. Organic synthesis, The role of Boron and Silicon, Susan E. Thomas, Oxford University Press.</p> <p>2. Modern methods of organic synthesis – W. Carruthers (Cambridge) pp, 315-330</p> <p>3. Organic Synthesis, Jagdamba Singh and L.D.S. Yadav, A Pragati Edition, pp 354-357</p>	<b>05 L</b>
<b>2</b>	<p><b>Uses of transition metal complexes in organic synthesis</b></p> <p>i. Ni (Uses of Nickel carbonyl, Ni (COD)<sub>2</sub>)</p> <p>ii. Pd (Heck, Suzuki, Stille, Sonogashira, Negishi, Buchwald-Hartwig Couplings, Wacker process)</p> <p>iii. Pt (Hydrogenation)</p> <p>iv. Ru (Grubb's Catalyst, only Ring closing &amp; Ring Opening metathesis, polymerization)</p> <p>v. Co (Oxo process, Pauson Khand Reaction, Vollhardt co-trimerization)</p> <p>vi. Fe (Tetracarbonyl ferrate, Noyori reaction)</p> <p><b>Ref:</b></p> <p>1. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)</p> <p>2. Modern methods of organic synthesis – W. Carruthers (Cambridge) pp 75-105, 405-421.</p> <p>3. Organometallics in organic synthesis – J. M. Swan and D. C. Black (Chapman &amp; Hall)</p> <p>4. Organic Synthesis, Jagdamba Singh and L.D.S. Yadav, A Pragati Edition</p> <p>5. Modern Organic Synthesis an Introduction –G.S. Zweifel and M. H. Nantz, Second edition, Wiley Publication</p>	<b>14 L</b>
<b>3</b>	<p><b>Umpolung in Organic Synthesis</b></p> <p><b>Ref:</b></p> <p>1. Some modern methods of organic synthesis – W. Carruthers (Cambridge), pp 1-45</p> <p>2. Organic chemistry – J. Clayden, N. Greeves, S. Warren, Second edition (Oxford Press)</p> <p>3. Organic Reaction Mechanisms- V.K. Ahluwalia &amp; Rakesh K. Parashar (Fourth Edition), Narosa Publication pp, 128-134</p>	<b>04 L</b>
<b>4</b>	<p><b>Nitrogen, Phosphorous and Sulphur Ylides in Organic synthesis</b></p> <p><b>Ref:</b></p> <p>1. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers(Oxford Press)</p> <p>2. Some modern methods of organic synthesis – W. Carruthers (Cambridge)</p> <p>3. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)</p>	<b>05 L</b>

5	<p><b>Protecting groups in Organic Synthesis:</b> Protection &amp; deprotection of Hydroxyl, Carbonyl, amino and carboxylic acid functional groups &amp; its applications, solid phase peptide synthesis.</p> <p><b>Ref:</b></p> <ol style="list-style-type: none"> <li>1. Organic chemistry – J. Clayden, N. Greeves, S. Warren (Oxford Press)</li> <li>2. Modern Organic Synthesis an Introduction –G.S. Zweifel and M. H. Nantz, Second edition, Wiley Publication</li> <li>3. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)</li> <li>4. Protective groups in organic synthesis, T. W. Greene and P. G. M. Wuts, 2<sup>nd</sup> Ed. John Wiley and Sons, 1991.</li> </ol>	06 L
6	<p><b>Designing in Organic Synthesis:</b> Disconnection Approach: An introduction to synthons and synthetic equivalents, functional group interconversions.</p> <p><b>One group Disconnections: Disconnections</b> of simple alcohols, simple olefins, Aryl ketones, control, Disconnections of simple ketones &amp; acids, two group Disconnections: 1,3-Dioxygenated skeletons, -<math>\beta</math>-hydroxy carbonyl compounds, <math>\alpha</math>-<math>\beta</math> unsaturated carbonyl compounds, 1,3 dicarbonyl compounds, 1,5 dicarbonyl compounds –Use of Mannich reaction</p> <p><b>Two group Disconnections:</b> The 1,2 Dioxygenation pattern –<math>\alpha</math> -hydroxy carbonyl compounds, 1,2 diols, Illogical electrophiles ,1,4 Dioxygenation pattern - 1,4 dicarbonyl compounds, <math>\gamma</math> hydroxy carbonyl compounds, other illogical synthons ,1,6 dicarbonyl compounds, pericyclic reactions, Heteroatoms &amp; heterocyclic compounds</p> <p><b>Linear and Convergent Synthesis</b></p> <p><b>Ref.</b></p> <ol style="list-style-type: none"> <li>1. Designing of organic synthesis – S. Warren (Wiley) pp 4-318</li> <li>2. Organic chemistry – J. Clayden, N. Greeves, S. Warren, (Oxford Press)</li> </ol>	16L
7	<p><b>Some Advanced Synthetic Reactions</b></p> <ol style="list-style-type: none"> <li>a) <b>Click chemistry:</b> Introduction, Criteria for Click reaction. Sharpless azides cycloadditions</li> <li>b) <b>Olefination reactions:</b> Tebbe, McMurry, Julia-Lythgoe, Peterson’s Olefination</li> <li>c) <b>Fragmentaion reactions:</b> Eschenmoser, Grob.</li> <li>d) <b>Some other reactions:</b> Mitsunobu, Nef, Staudinger, Brook rearrangment.</li> </ol> <p><b>Ref:</b></p> <ol style="list-style-type: none"> <li>1. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)</li> <li>2. Some modern methods of organic synthesis – W. Carruthers (Cambridge)</li> <li>3. <a href="http://www.organicchemistryportal.com">www.organicchemistryportal.com</a></li> <li>4. <a href="http://www.synarchive.com">www.synarchive.com</a></li> </ol>	10 L
	<p><b>Course Outcomes:</b> The students will be able to</p> <ul style="list-style-type: none"> <li>• Understand and apply the specific protecting groups for the reactant to react the desirable functional group.</li> <li>• Design the synthetic pathway from target molecule by applying the retrosynthesis, disconnection approach.</li> <li>• Understand various synthetic methods in organic synthesis.</li> <li>• Understand advanced organic reactions.</li> </ul>	

**CH-452(A): Drug Chemistry**  
**(60 L, 100 Marks and 4 Credits)**

	<p><b>Course Objectives:</b> To make the students conversant with the</p> <p>CO-1. To learn structure features of various drug molecules.</p> <p>CO-2. Study of symptoms, treatment of different diseases.</p> <p>CO-3. Study of synthesis of various drugs molecules.</p>	
	<b>Course Contents (Topics and subtopics)</b>	
1	<p><b>Introduction to medicinal chemistry</b></p> <p>Classification, Nomenclature, Sources, Concepts of prodrugs and soft drugs, Receptor, Therapeutic index, Bioavailability, Drug assay and drug potency, Concept and definition of pharmacophore. Basic Pharmacokinetics: drug absorption, distribution, metabolism (biotransformation) and elimination, Pharmacokinetics- Drug targets: enzymes and receptors. Competitive, non-competitive inhibitors, Physical and chemical parameters like solubility, lipophilicity, ionization, pH, redox potential, H-bonding, partition coefficient and isomerism in drug distribution and drug-receptor binding, Factors affecting Absorption, Distribution, Metabolism, Elimination and Toxicity, Structure activity relationship.</p>	<b>10 L</b>
2	<p><b>Antibiotics:</b></p> <p>Introduction, Classification, Structure &amp; Uses of Streptomycin, Penicillin,</p>	<b>04 L</b>
3	<p><b>Antidiabetics:</b></p> <p>Introduction, Classification, Management of Diabetes Mellitus, Insulin &amp; Synthesis of Glibenclamide, Metformin</p>	<b>06 L</b>
4	<p><b>Anticancer / Antineoplastic agents:</b></p> <p>Introduction, Classification, Causes, Treatment of Cancer, Synthesis of Mechlorethamine, Melphalan.</p>	<b>08 L</b>
5	<p><b>Anti-HIV Drugs:</b></p> <p>Introduction, Classification, Causes, Prevention, Treatment, Synthesis of AZT</p>	<b>06 L</b>
6	<p><b>Cardiovascular Drugs:</b></p> <p>Introduction, Classification, Cardiovascular diseases, Synthesis of Amyl Nitrite, Sorbitrate, Atenolol. Antihypertension Drugs</p>	<b>12 L</b>
07	<p><b>Psychoactive Drugs:</b> Introduction, Classification, Synthesis of Diazepam, Alprazolam</p>	<b>05 L</b>
08	<p>Introduction, Classification, Synthesis of some common drugs: Paracetamol, Cetrizine, Pentaprazole, Aceclophenac..</p> <p><b>Ref 1 Pages 199, Ref 2. Pages 4, 214,428,429,255-256, Ref 6 Pages 1017, 1019-1022</b></p>	<b>09 L</b>

	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Medicinal Chemistry. G. R. Chatwal.</li> <li>2. Medicinal Chemistry—By A. Kar, Wiley, 2000.</li> <li>3. Strategies for Organic Drug synthesis and design—By D. Lednicer John Wiley 1998.</li> <li>4. Synthetic drugs—G. R. Chatwal—Himalaya, New Delhi 1995.</li> <li>5. Total synthesis of Natural product: The chiral approach Vol. III, S. Hanessian Pergamon Press 1983.</li> <li>6. Principles of Medicinal Chemistry (4<sup>th</sup> Edition) W. D. Foye, T. L. Lemke, D. A. Williams.</li> <li>7. Organic Chemistry of Drug action and Design. R. B. Siwerman, (Academic Press, 1993).</li> <li>8. Medicinal Chemistry - Alka L. Gupta.</li> <li>9. Medicinal Chemistry - V. K. Ahluwalia &amp; Madhu Chopra.</li> </ol>	
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<b>Course Outcomes (COs):</b>		
On completion of this course, the student will be able to:		
CO No.	CO	Cognitive level
<b>C102.1</b>	Acquire knowledge on metabolism of biomolecules	<b>3</b>
<b>C102.2</b>	Familiarise with amino acids, proteins, lipids, nucleic acids and enzymes	<b>4</b>
<b>C102.3</b>	Understand biochemical reactions in microbial cells and metabolic pathway diversity	<b>2</b>

**CH-452 :(B) Applied Organic Chemistry****(60 L, 100 Marks and 4 Credits)**

	<b>Course objectives</b> 1. Study of important pesticides 2. Study of plant growth regulators and insect repellents 3. To learn about toxic effects of Chemicals. 4. Study of synthesis of important dyes intermediates 5. To learn mechanism of polymerization and study of different polymers	
	<b>Course Contents (Topics and sub-topics)</b>	
<b>1</b>	<b>Agrochemical:</b> a. Carbamate pesticides: Introduction, carbaryl, Baygon, Aldicarb, Ziram, Zineb b. Organophosphorus pesticides: Malathion, monocrotophos, dimethoate, phorate, mevinphos c. Natural and synthetic pyrethroids: Isolation and structures of natural allethrin, fenvalerate, cypermethrin, d. Plant growth regulators: General survey synthesis of simple compounds e. Insect repellents: General survey and synthesis	<b>15 L</b>
<b>2</b>	<b>Chemical Toxicology</b> Toxic chemicals in the environments, Impact of toxic chemicals on enzymes, Biochemical effects of arsenic, cadmium, lead, mercury, carbon monoxide, nitrogen oxides, sulphur oxides.	<b>15 L</b>
<b>3</b>	<b>Dyes and Intermediates:</b> Synthesis of important dye intermediates. Commercial processes for Azo dyes, reactive dyes, optical brighteners, thermal sensitive dyes, dispenses dyes.	<b>15 L</b>
<b>4</b>	<b>Polymers:</b> Mechanism of polymerization. Study of polyesters, polyamides, PVC, polystyrene, polyvinyl acetate and polyvinyl alcohol, polyethene, viscose rayon, synthesis of polyethylene, polypropylene. Synthetic rubbers: Styrene-butadiene, butyl polyisoprene, phenol formation formaldehyde resin. Plasticisers and anti-oxidants for polymers, Natural polymers: Starch and cellulose.	<b>15L</b>
	<b>Reference Books</b> 1. Allan: Colour Chemistry 2. K. Venkataraman: Chemistry of Synthetic Dyes Vol- 1 to 7 3. Abrahart: Dyes & their intermediates 4. N. N. Melikov: The Chemistry of Pesticides and formulations 5. K. H. Buchel: Chemistry of Pesticides 6. R. Cleymlin: Pesticides 7. F. W. Billmeyer: Text book of Polymer Science	

	8. H. R. Alcock and F. W. Lambe: Contemporary Polymer Chemistry 9. J. M. G. Cowie, Blackie: Physics & Chemistry of Polymers 10. P. H. Groggins: Unit Processes in Organic Synthesis 11. B. Biollot & P. V. Wells: Perfumary Technology 12. M. Ash & I. Ash: A formulary of Cosmetic Preparations 13. A.K. De, Environmental Chemistry, 6 <sup>th</sup> Edition, New Age International Private Ltd., New Delhi.	
	<p><b>Course outcomes:</b> Students will able to</p> <ol style="list-style-type: none"> <li>1. Acquire knowledge of different agrochemicals.</li> <li>2. Familiar with Chemical toxicology.</li> <li>3. Familiar with dyes and intermediates.</li> <li>4. Familiar with preparation of various polymers.</li> </ol>	

**CH-O-2: Organic Chemistry Practical Course-II**  
**(180Hrs, 100 Marks and 6 Credits)**

**Course Objectives:** To make the students familiar with the

CO-1. To learn techniques for separation of ternary mixture carried out on micro-scale.

CO-2. Understand the isolation and separation technique of natural products.

CO-3. Interpretation of actual instrumental spectral data (UV, FT-IR, <sup>1</sup>H-NMR, CMR and Mass spectra)

**Ternary Mixture Separation (Minimum Ten)**

Separation of mixtures containing three components. The mixtures should also involve separation of nitro phenols, amino acids, low boiling substances, water soluble substances. Amines, Phenols and acids used should also contain other elements and functional groups. The mixture separation should be carried out on micro-scale using ether. The purity of the separated compounds should be checked by TLC.

**Isolation and separation of Natural products: (Any Four)**

**It should involve solvent extraction, chromatographic & distillation techniques.**

- 1) Isolation of Hesperdin from orange peel
- 2) Isolation of Eugenol from cloves
- 3) Isolation of Caffeine from tea
- 4) Isolation of Nicotine from tobacco
- 5) Isolation of Piperine from blackpepper
- 6) Isolation of Lactose and casein from milk
- 7) Isolation of Cellobiose-octa-acetate from cotton
- 8) Isolation of Stigmasterol from soya bean oil
- 9) Isolation of β-carotene from carrot

**Spectral interpretation of UV, IR, <sup>1</sup>H-NMR, CMR and Mass Spectra: (Minimum 10 Organic Compounds)**

**References:**

1. Vogel's, Practical Organic Chemistry.
2. Practical Organic Chemistry, R. K. Bansal.
3. Natural Product Isolation, Satyajit D. Sarker, Zahid Latif, Alexander I. Gray, 2<sup>nd</sup> Ed. Springer.
4. Practical Organic Chemistry by Mann & Saunders.
5. Organic Structures from Spectra, 4th Edition, L. D. Field, S. Sternhell, J. R. Kalman, John Wiley & Sons, Ltd.

**Course Outcomes (COs):**

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
CH-O-2.1	Separate the ternary mixture with proper technique and identification of the type of given compound.	4
CH-O-2.2	Isolate and separate the organic compounds from natural products	3
CH-O-2.3	Collect the data and solve the structure by given spectral data.	3

**CH-O-3: Organic Chemistry Practical Course-III**  
**(180 Hrs, 100 Marks and 6 Credits)**

**Course Objectives:** To make the students conversant with the  
CO-1. To learn techniques for preparation of compounds.  
CO-2. To learn two stage, three stage, multicomponent synthesis.  
CO-3. To learn total synthesis technique.

● **Drying of Organic Solvents:**

Dry various commonly used organic solvents with several different drying agents. Recommending to optimum drying agents/conditions that can be used to rapidly and reliably generate solvents with low residual water content by means of commonly available materials found in most synthesis laboratories

Solvents: THF, Toluene, Dichloromethane, Acetonitrile, Methanol, Ethanol etc.

● **Two Stage Preparations Monitored by TLC (Minimum Six)**

- 1) Benzaldehyde - Benzoic acid - Benzamide
- 2) Benzaldehyde - Benzylidene Acetophenone - 4,5-dihydro 1,3,5-triphenyl-1H-pyrazole
- 3) Acetophenone - Oxime - Acetanilide.
- 4) Acetophenone- Benzalacetophenone - Epoxide
- 5) Nitrobenzene - m- Dinitrobenzene - m- Nitroaniline.
- 6) Nitrobenzene - n- Phenyl hydroxylamine - P amino Phenol
- 7) Acetophenone - Acetophenone Phenylhydrazone - 2-Phenyl Indole
- 8) Chlorobenzene- 2,4- dinitrochloro benzene - 2,4- dinitrophenol.

● **Three stage Preparation Monitored by TLC (Minimum Four)**

**Prep-1: Synthesis of P-NitroAniline from Aniline**

Step 1: Aniline to Acetanilide (Acetylation)

Step 2: Acetanilide to P- Nitroacetanilide (Nitration)

Step 3: P- Nitroacetanilide to P-Nitroaniline (Hydrolysis)

**Prep-2: Synthesis of Methyl Orange from Aniline**

Step 1: Aniline to sulphanilic acid (sulphonation)

Step 2: sulphanilic acid to Diazonium chloride (diazotization)

Step 3: Diazonium chloride to methyl orange (coupling reaction)

**Prep-3: Synthesis of p nitro benzoyl peroxide from P- nitro toluene**

Step 1: P- Nitrotoluene to p Nitro benzoic acid (Oxidation)

Step 2: P-Nitro benzoic acid to P-Nitro benzoyl chloride (Substitution)

Step 3: P-Nitro benzoyl chloride to P-Nitro benzoyl peroxide (Oxidation)

**Prep-4: Synthesis of p-Bromo Benzanilide from Benzophenone**

Step 1: Benzophenone to benzophenone oxime (Addition)

Step 2: Benzophenone oxime to benzanilide (Beckmann's rearrangement)

Step 3: Benzanilide to p-bromobenzanilide (Bromination)

**Prep-5: synthesis of Benzilic acid from Benzaldehyde**

Step 1: Benzaldehyde (using thiamine HCl) to Benzoin (condensation)

Step 2: Benzoin to Benzil (oxidation)

Step 3: Benzil to Benzilic acid (rearrangement)

**Prep-6: Synthesis of Benzylamine acid from phthalic anhydride**

- Step 1: Phthalic anhydride to phthalimide (Amide formation)  
Step 2: Phthalimide to N-Benzylphthalimide (N-Alkylation)  
Step 3: N-Benzylphthalimide to Benzylamine (Hoffman Degradation Reaction)

● **Four Stage Preparation Monitored by TLC (Any One)**

**Prep-7: Synthesis of o-chlorobenzoic acid from phthalic acid**

- Step 1: Phthalic acid to phthalic anhydride (Dehydration)  
Step 2: Phthalic anhydride to phthalimide (Amide formation)  
Step 3: Phthalimide- Anthranilic acid (Hoffman's reaction)  
Step 4: Anthranilic acid to o-chlorobenzoic acid (Diazotization followed by sandmayer's)

**Prep-8: Synthesis of Paracetamol from Benzene**

- Step 1: Benzene to Nitrobenzene (Nitration)  
Step 2: Nitrobenzene to N-phenyl hydroxylamine (reduction)  
Step 3: N-phenyl hydroxylamine to p-aminophenol (Bamberger Rearrangement)  
Step 4: p-amino phenol to p-hydroxy acetanilide/paracetamol (acetylation)

**Prep-9: Synthesis of m-Chloro-Nitrobenzene from Nitrobenzene**

- Step 1: Nitrobenzene to m-dinitrobenzene (nitration)  
Step 2: m-dinitrobenzene to m-nitroaniline (partial reduction)  
Step 3: m-nitro aniline to m-nitro diazonium chloride (diazotization)  
Step 4: m-nitro diazonium chloride to m-Chloro-nitrobenzene (sandmayers reaction)

● **Multicomponent Reactions involving Green Chemistry Principles (Any Four)**

Reactions involving 2,3,4 compounds should be carried out on the basis of Green Chemistry Principles. The synthesis should be carried out on a micro scale. The progress of reaction should be monitored by TLC.

- 1) Synthesis of 2-amino-4H-chromene scaffold using aromatic aldehyde under Solvent-free condition catalysed by sodium carbonate (Knoevenagel–Michael addition)
- 2) Synthesis of 1,4-dihydropyridines in aqueous ethanol in one-pot condensation and cyclization of various types of aliphatic and aromatic aldehydes with ethyl acetoacetate and ammonium hydroxide solution (Hantzsch synthesis)
- 3) Synthesis of dihydropyrimidinone: acid-catalyzed three component reaction between aromatic aldehyde, ethyl acetoacetate and urea/thiourea. (Biginelli reaction)
- 4) Synthesis of highly functionalized pyrazoles: An efficient one pot multicomponent reaction of phenyl hydrazine, malononitrile and aromatic aldehydes in water using molecular I<sub>2</sub> as catalyst
- 5) Synthesis of pyrano[2,3-c] pyrazole derivative, condensation of aromatic aldehydes, activated methylene reagent, ethyl acetoacetate, and hydrazine hydrate in water medium.
- 6) Synthesis of coumarin by Knoevenagel reaction using salicylaldehyde, and ethyl acetoacetate in presence of a base.

## References:

1. Vogel's, Practical Organic Chemistry.
2. Practical Organic Chemistry, R. K. Bansal.
3. Systematic lab experiment in Organic Chemistry by Arun Sethi.
4. Comprehensive Practical Organic Chemistry: By V.K. Ahluwalia, R. Aggarwal, V.K. Ahluwalia
5. Monograph on Green Chemistry Laboratory Experiments.
6. A Manual of Practical Organic Chemistry Day Sitaramam&Govindachari
7. Organic Experiments L.F.Fieser.
8. Systematic Identification of Organic Compounds, P.L.Shriner, R.C.Fuson&D.Y.Curtin.
9. Advanced Organic Synthesis by R.S.Monson Academic Press
10. Springer Science+Business Media B.V., Mol Divers (2010) 14:473–477  
DOI 10.1007/s11030-010-9246-5
11. Organic Process Research & Development 2002, 6, 817–818 Brindaban C. Ranu, \*AlakanandaHajra, and Suwendu S. Dey
12. New J. Chem., 2014, 38, 302, MadhulikaSrivastava,a Pratibha Rai,a Jaya Singhb and Jagdamba Singh\* DOI: 10.1039/c3nj01149f
13. Tetrahedron Letters, Somnath Ghosh ,ForidSaikh, Jhantu Das, Arun Kumar Pramanik,  
<http://dx.doi.org/10.1016/j.tetlet.2012.10.079>,
14. Scholars Research Library Der Pharma Chemica, 2011, 3 (5):81-86  
(<http://derpharmachemica.com/archive.html>), Samy A. El-Assaly
15. J. Org. Chem. Vol. 75, No. 24, 2010, pubs.acs.org/joc

## Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
CH-O-3	The students will be able to Understand the organic synthesis techniques.	2

**CH-O-4: A Short Research Project**  
**(180Hrs, 100 Marks and 6 Credits)**

**Course Objectives:**

**CO-1.** To make students familiarize themselves with the techniques such as synthesis, isolation, purification and characterization/analysis etc.

**CO-2.** To introduce students on how to generate new ideas based on literature survey and their Execution.

**CO-3.** To foster the self-confidence amongst the students to think and execute ideas Independently.

The project is allotted during the third semester. The students will get an opportunity to become a part of ongoing research activities in the respective supervisor's laboratory. This should make them familiar with the literature survey and the fundamental understanding of how to devise research methodology. It is expected that the student should learn the synthesis, isolation, purification and characterization techniques whatever applicable for their projects. Students whose projects are dependent on the instruments are expected to know SOP and their working principles. Full flexibility is given to the student in identifying the project depending on the resources and infrastructure available in the host organization. It is recommended to work on multidisciplinary projects but not mandatory. In any case, not more than 2-3 students should involve in the same project.

**The systematic approach towards the execution of the project should be as follows:**

1. Selection of topic relevant to priority areas of chemistry and allied sciences
2. Literature survey and devising research methodology based on the gaps in the literature
3. Good laboratory practices: Safety, MSDS, disposal of chemical waste etc.
4. Execution of the project by designing and performing suitable experiments
5. Interpretation of results and drawing important conclusions
6. To prepare a PowerPoint presentation using modern ICT tools
7. Students should present their research work in Avishkar/Webinars/Conferences
8. Maintaining lab notebooks and writing monthly progress report
9. Writing a dissertation with following components in a given order: Title of the Project, Certificates, Acknowledgement, Abstract and Keywords, Contents, Introduction, Literature, Aim of the Project, Materials and Methods, Results and Discussion, Conclusions and Future Perspectives, Contributions, Bibliography and References. Total three bound copies of the dissertation should be prepared (library, guide and student: each one copy). Student should note that plagiarism is strictly prohibited. Beside writing dissertation, students should write a manuscript/patent if the results obtained are worthy of publication.

10. Presentation during the university examination
11. The complete tenure of research project should be of one year. It should start at the third semester and will be end by the semester fourth.
12. Student should submit two progress report within the span of the project.
13. Student should be encouraged for applied and contemporary research work.
14. Weakly two days should be allotted to research project in a regular time table.
15. Each research group should not have more than four students.
16. Each research group should have different research topic

It highly recommended that the students should apply for the Summer Research Fellowship Programmes initiated by Science Academies of India - IAS, INSA, NASI. Similarly, there exist several other summer internship opportunities in the national institutes, reputed universities and industries. Students should explore these possibilities immediately after the completion of the second semester (M. Sc., Part - 1) meaning that applications should be sent much earlier. The exposure gained during the summer internship should build enough confidence amongst students to identify the right research project and its execution.

### **Examination Assessment (100 Marks):**

#### **Internal Examination (Internal Assessment) - 40 marks:**

<b>Activity</b>	<b>Marks</b>
Submission of progress reports signed by supervisor (at least 2 reports, 05 marks per report)	10
Outline of research work: - literature collected, experiment planning and design	08
Experimental work performed	08
Subject/topic related one workshop/course/instrumentation training (online/offline),	10
Regular attendance maintained by Research Supervisor	04

#### **External Examination (External Assessment) - 60 marks:**

<b>Activity</b>	<b>Marks</b>
Selection of topic of project work	05
Literature review	05
Characterization of intermediates / products	10
Overall quality of dissertation	10
Power point presentation	15
Oral discussion	10
Conference / Industrial Visit / Avishkar Participation	05

**Suggested readings:** Reference Books/Reviews/Journal Papers as suggested by the supervisor.

**Course Outcomes (COs):**

Upon the completion of course, the student should be able:

<b>CO No.</b>	<b>CO</b>	<b>Cognitive level</b>
<b>1</b>	To generate new research ideas based on the comprehensive literature survey	<b>3</b>
<b>2</b>	To acquire skill to execute the research project independently	<b>2</b>
<b>3</b>	To expertise in synthesis techniques and execution of research ideas would make the student quickly employable; either in industries or in academia for pursuing higher studies	<b>4</b>

## Audit Courses

**Technology + Value Added Course/ Professional & Social + Value Added Course**

**KAVAYITRI BAHINABAI CHAUDHARI  
NORTH MAHARASHTRA UNIVERSITY, JALGAON  
(For Affiliated Colleges of KBC NMU)  
Syllabus under CBCS  
M. Sc. Part-II Organic Chemistry  
Semester-III Audit Course (w.e.f. 2022-23)  
AC-301(A): Computer Skills**

**Credit: 02**  
**Marks: 100**

**Hours of instruction/week: 02**  
**Total hours of instruction: 60**

	<b>Course Objectives:</b> CO-1. Student will be able to understand various types of literature resources, technical reports. CO-2. Student will be able to make a technically sound presentation. CO-3. To learn the Ethics and plagiarism precautions to be taken while doing research. CO-4. To understand the process of writing research project report and research proposal. CO-5. At the end of this course, Student will be able to write a technically effective report.	
	<b>Course Contents (Topics and subtopics)</b>	
1	<b>Elements of Information Technology</b> 1.1 Information Types: Text, Audio, Video, and Image, storage formats 1.2 Components: Operating System, Hardware and Software, firmware 1.3 Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector, smart boards 1.4 Processor & Memory: Processor functions, speed, Memory types: RAM/ROM/HDD/DVD-ROM/Flash drives, memory measurement metrics	<b>04 L</b>
2	<b>Office Automation Text Processing</b> 2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View, Reading Layout View 2.2 Working with Files: Create New Documents, Open Existing Documents, Save Documents to different formats, Rename Documents, Close Documents 2.3 Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text, Spelling and Grammar, paragraphs, indentation, margins 2.4 Lists: Bulleted and Numbered Lists, 2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Move and Resize Tables, Moving the order of the column and/or rows inside a table, Table Properties	<b>10 L</b>

	<p>2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents,</p> <p>2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters</p> <p>2.8 Types of document files: RTF, PDF, DOCX etc</p>	
3	<p><b>Office Automation-Worksheet Data Processing</b></p> <p>3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets,</p> <p>3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns, Selecting Cells, Moving and Copying Cells</p> <p>3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, Auto Sum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns, and Cells</p> <p>3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts</p>	10 L
4	<p><b>Office Automation:</b></p> <p>4.1 Create a new presentation, Auto Content Wizard, Design Template, Blank Presentation, Open an Existing Presentation, PowerPoint screen, Screen Layout</p> <p>4.2 Working with slides: Insert a new slide, Notes, Slide layout, Apply a design template, Reorder Slides, Hide Slides, Hide Slide text, Add content, resize a placeholder or text box, Move a placeholder or text box, Delete a placeholder or text box, Placeholder or Text box properties, Bulleted and numbered lists, Adding notes</p> <p>4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replace fonts, Line spacing, Change case, Spelling check, Spelling options</p> <p>4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing row width, Adding a row/column, Deleting a row/column, Combining cells, Splitting a cell, Adding color to cells, To align text vertically in cells, To change table borders, Graphics, Add clip art, Add an image from a file, Save &amp; Print, slide shows, slide animation/transitions.</p>	12 L
5	<p><b>Internet &amp; Applications:</b></p> <p>5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing the Internet, Brief history, Browsing the Web, Hypertext and hyperlinks, browsers, Uniform resource locator</p> <p>5.2 Internet Resources: Email, Parts of email,</p> <p>5.3 Protecting the computer: Password protection, Viruses, Virus protection software, Updating the software, Scanning files, Net banking precautions.</p> <p>5.4 Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, LinkedIn, Orkut, online booking services</p> <p>5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing</p> <p>5.6 e-learning: e-Books, e-Magazines, e-News papers, OCW(open course wares): Sakshat</p>	08 L

	(NPTEL) portal, MIT courseware	
6	<b>Cloud Computing Basics</b> 6.1 Introduction to cloud computing 6.2 Cloud computing models: SAS, AAS, PAS 6.3 Examples of SAS, AAS, PAS (Drop Box, Google Drive, Google Docs, Office 365 Prezi, etc.)	06 L
	<b>References:</b> 1. TCI, "Introduction to Computers and Application Software", Publisher: Jones & Bartlett Learning, 2010, ISBN: 1449609821, 9781449609825 2. Laura Story, Dawna Walls, "Microsoft Office 2010 Fundamentals", Publisher: Cengage Learning, 2010, ISBN: 0538472464, 9780538472463 3. June Jamrich Parsons, Dan Oja, "Computer Concepts Illustrated series", Edition 5, Publisher Course Technology, 2005, ISBN 0619273550, 9780619273552 4. Cloud computing online resources	

<b>Course Outcomes (COs):</b>		
Upon the completion of course, the student should be able:		
CO No.	CO	Cognitive level
1	To create new document, work with existing documents.	2
2	To acquire skill to insert and resize tables.	3
3	To make power point presentation, auto content wizards.	4

**KAVAYITRI BAHINABAI CHAUDHARI  
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**Syllabus under CBCS**

**M. Sc. Part-II Organic Chemistry  
Semester-III Audit Course (w.e.f. 2022-23)**

**AC-301(B): Cyber Security**

**Credit: 02  
Marks: 100**

**Hours of instruction/week: 02  
Total hours of instruction: 60**

**Course Objectives:**

CO-1. Student will be able to understand different types of networks

CO-2. Student will be able to understand security concepts.

CO-3. Student will learn about cyber crimes

1	<p><b>Networking Concepts Overview</b> Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internet working, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet.</p>	06 L
2	<p><b>Security Concepts</b> Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security &amp; its types, Risk associated with improper physical access, Physical Security equipment. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows &amp; Linux.</p>	14 L
3	<p><b>Security Threats and vulnerabilities</b> Overview of Security threats, Hacking Techniques, Password Cracking, Types of password attacks, Insecure Network connections, Wi-Fi attacks &amp; countermeasures, Information Warfare and Surveillance. Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes,</p>	14 L
4	<p><b>Cryptography</b> Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure,</p>	10 L
5	<p><b>System &amp; Network Security</b> System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security</p>	06 L
6	<p><b>OS Security</b> OS Security Vulnerabilities updates and patches, OS integrity checks, Anti-virus software, Design of secure OS and OS hardening, configuring the OS for security, Trusted OS.</p>	04 L
7	<p><b>Security Laws and Standards</b> Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.</p>	06 L

**References:**

1. Principles of Computer Security, W.A. Cokline, G. White, 4<sup>th</sup> Edition, McGraw Hills.
2. Cryptography and Network Security Principles and Practices-William Stallings, 7<sup>th</sup> Edition, Pearson
3. Cryptography and Network Security -William Stallings, 4<sup>th</sup> Edition, Pearson
4. Cryptography and Network Security- Forouzan Mukhopadhyay, McGraw Hills 2<sup>nd</sup> Edition.
5. Principles of Information Security- Michael E. Whiteman, Herbert J Mattoral, CENGAGE Learning 4<sup>th</sup> Edition.
6. Kimberly Graves: CEH-official Ethical Hacker Guide, Wiley Publishing Inc. 2007, ISBN: 978-0-7821-4437-6.
7. Shakeel Ali & Tedi Heriyanto” Backtrack-4 Assuring Security by penetration testing PACKT Publishing, 2011, ISBN: 978-1-849513-94-4.
8. Understanding Laws- Cyber laws and Cyber-crimes (Lexip Nexis)
9. Cyber Crime Manual by Bibhas Catterjee, Lawman Publication.

**Course Outcomes (COs):**

Upon the completion of course, the student should be able:

CO No.	CO	Cognitive level
1	To understand different types of networks	2
2	To acquire skill to use Hash function, digital signature	3

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**M. Sc. Part-II Organic Chemistry**  
**Semester-III Audit Course (w.e.f. 2022-23)**  
**AC-301 (C): Molecular Docking**

**Credit: 02**

**Hours of instruction/week: 02**

**Marks: 100**

**Total hours of instruction: 60**

**Course Objectives:**

CO-1. Student will be able to know about natural products.

CO-2. Students will understand structure-based drug design.

CO-3. Student will learn about the docking method.

1	<p><b>Introduction drug design and discovery</b>                      Introduction: - Natural product, Drugs; principles of drug Development.                      Bioinformatics in drug development, Chemoinformatics and Pharmacoinformatics.                      Applications of Drug Discovery and In-Silico Drug Designing, Area influencing drug discovery; Molecular Biology, pharmacogenomics and pharmacoproteomics</p>	20 L
2	<p><b>Structure-based drug designing</b>                      Introduction, Structure-based drug designing approaches: - Target Identification and Validation, homology modeling and protein folding, receptor mapping, active site analysis and pharmacophore mapping, Grid maps.</p>	20 L
3	<p><b>Ligand-based drug designing and docking</b>                      4.1 Introduction, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, High Throughput Screening (HTS), QSAR, Database generation and Chemical libraries, ADME property. 4.2 Introduction to docking methods to generate new structure; Tools and Molecular docking programs: Auto Dock, Dock, HEX  <b>References:</b>                      1. The Pharmacological Basis of Therapeutics, Louis S. Goodman, Alfred Gilman Sr., Edited by Laurence L. Brunton, John S.L., K.L. Parkar, McGraw Hill Education, 11<sup>th</sup> Edition (2005).                      2. Oxford Textbook of Clinical Pharmacology and Drug Therapy, D.G. Grahame-Smith and J.K. Aronson, Oxford University Press, 3<sup>rd</sup> Edition (2002).                      3. Organic Chemistry of drug design and drug action, R.B. Silverman, Academic Press, 2<sup>nd</sup> Edition (2004).                      4. Statistical Methods in Biology, Bailey M. A., Norman T. J., Cambridge University Press, 3<sup>rd</sup> Edition (1995).                      5. A Text book of Drug design and development, Povl. Krogsgaard-Larsen Tommy L. and U Madsen, CRC Press, 2<sup>nd</sup> Edition (1996).</p>	20 L

**Course Outcomes (COs):**

Upon the completion of course, the student should be able:

CO No.	CO	Cognitive level
1	To understand the principle of drug development.	2
2	To identify target and its validation, in case of structure based drug design	3

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**Syllabus under CBCS**

**M. Sc. Part-II Organic Chemistry**

**Semester-IV Audit Course (w.e.f. 2022-23)**

**AC-301 (D): Technical Report Writing**

**Credit: 02**

**Hours of instruction/week: 02**

**Marks: 100**

**Total hours of instruction: 60**

	<p><b>Course Objectives:</b> To make the students familiar with the,</p> <p>CO-1. Student will be able to understand various types of literature resources, technical reports.</p> <p>CO-2. Student will be able to make a technically sound presentation.</p> <p>CO-3. To learn the Ethics and plagiarism precautions to be taken while doing research.</p> <p>CO-4. To understand the process of writing research project report and research proposal.</p> <p>CO-5. At the end of this course, Student will be able to write a technically effective report.</p>	
	<b>Course Contents (Topics and subtopics)</b>	
	Literature Resources, Writing Scientific Reports, Scientific Paper and Writing a Scientific Paper	
1	<p><b>Literature Resources:</b></p> <p>Introduction of Print and Digital Literature Resources, Sources of Information, Types of Literature: Primary, Secondary, and tertiary sources of Information, Types of Journals, Literature Review, Need for Literature Review, Writing a Literature Review, Conference Proceedings, Journal Impact Factor, <i>h</i>-index, and Citation Index. Seminar Conference and Workshop. Shodhganga: a reservoir of Indian Theses.</p> <p><b>Ref.: Ref. - 1: Pages: 149-177; Ref. – 2.</b></p>	<b>20 L</b>
2	<p><b>Writing Scientific Reports:</b></p> <p>Introduction, Types of Scientific Reports, General Rules for Scientific Writing, Synopsis Writing, Progress Report, Formats for Report Writing, Reporting Practical and Project work, Research Proposal, Referencing. Introduction of Plagiarism, Reading Research Paper. Scientific work presentation, Organizing a Poster display, Oral Presentation, Resume, Curriculum Vitae, A Comparison between a Resume, Curriculum Vitae.</p> <p>Ref.: Ref. - 1: Relevant Pages; Ref. – 3: Pages: 85-107, 209-232, Ref. 5: 344-360.</p>	<b>20 L</b>
3	<p><b>Scientific Paper and Writing a Scientific Paper:</b></p> <p>Introduction of Scientific Paper, Title, Abstract, Keywords, Introduction, Materials and Methods, Result and Discussion, Conclusion, Acknowledge and References.</p> <p>Introduction to writing a scientific paper, Importance of Scientific Writing, Characteristics of Scientific Writing, Duties and Responsibilities of Authors, Communicating to a Journal,</p>	<b>20 L</b>

	<p>Submission Methods, Peer Review: Single Blind Review, Double Blind Review and Open Review.</p> <p><b>Ref.: Ref. – 1: Pages: 180-208.; Ref. – 4: 325-354, Ref. 5: 344-360.</b></p>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Research Methodology for Scientific Research, K. Prathapan, I. K. International Pvt. Ltd., New Delhi (2019).</li> <li>2. <a href="https://shodhganga.inflibnet.ac.in/">https://shodhganga.inflibnet.ac.in/</a></li> <li>3. Advanced Manual for Communication Laboratories and Technical Report Writing, D. Sudha Rani, Dorling Kindersley (India) Pvt. Ltd, Pearson Education in South Asia, New Delhi 110 017, India (2012).</li> <li>4. Practical Skills in Chemistry, 2nd Ed, Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. and Jones, A. Prentice-Hall, Harlow (2011).</li> <li>5. Research Methodology: Methods and Techniques, 3rd edition, Kothari, C.R. Published by New Age International (P) Ltd., Publishers (2004).</li> <li>6. APPENDIX A: The Literature of Organic Chemistry March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Seventh Edition, by Michael B. Smith and Jerry March Copyright John Wiley &amp; Sons, Inc. (2013).</li> <li>7. Research Methodology, G. H. Sonawane, H. A. Mahajan, H. R. Talele, S. S. Rajput, S. D. Yeole, S. L. Sonawane, Prashant Publications (2020).</li> </ol>	

<b>Course Outcomes (COs):</b>		
Upon the completion of course, the student should be able:		
<b>CO No.</b>	<b>CO</b>	<b>Cognitive level</b>
<b>1</b>	To be able to write comprehensive literature review, project or scientific reports on a given research topic.	<b>2</b>
<b>2</b>	To follow the ethical guidelines while doing research avoid plagiarism in thesis and research publications.	<b>3</b>
<b>3</b>	To be able to present and communicate their scientific work as well as ideas to scientific community.	<b>2</b>
<b>4</b>	To utilize the gained knowledge or skills in the scientific research and build his/her career in chemistry research field	<b>2</b>

	<b>KAVAYITRI BAHINABAI CHAUDHARI</b> <b>NORTH MAHARASHTRA UNIVERSITY, JALGAON</b> <b>(For Affiliated Colleges of KBC NMU)</b> <b>Syllabus under CBCS</b> <b>M. Sc. Part-II Organic Chemistry</b> <b>Semester-IV Audit Course (w.e.f. 2022-23)</b> <b>AC-401 (A): Human Rights</b>	
	<b>Credit: 02</b> <b>Marks: 100</b>	<b>Hours of instruction/week: 02</b> <b>Total hours of instruction: 60</b>
	<b>Course Objective</b> To impart the basic ideas about Human Rights at post graduations level. This paper provides different aspects of human rights which includes children and women. Students can learn not only their basic rights bus also can understand the duties to be carried out in the days to come.	
1	<b>An Introduction to Human Rights</b> 1.1: Values – Dignity, Liberty, Equality, Justice, Unity in Diversity 1.2: Human Rights – Meaning and features; Significance of the study 1.3: Classification of Human Rights 1.4: Rights and Duties – Correlation	10 L
2	<b>Human Rights of Vulnerable Groups:</b> 2.1: Women’s Rights 2.2: Rights of the Child 2.3: The Rights of Persons Belonging to Minorities 2.4: Rights of Refugees and Migrant Workers 2.5: Indigenous People and Human Rights 2.6: Human Rights of Prisoners 2.7: Rights of Physically Disabled	14 L
3	<b>Human Rights in India</b> 3.1: Human Rights and Fundamental Rights 3.2: Fundamental Rights and Fundamental Duties 3.3: Directive Principles 3.4: Role of Judiciary in the protection of Human Rights	12 L
4	<b>Protection and promotion of Human Rights in India</b> 4.1: National Human Rights Commission – Composition and functions 4.2: Human Rights and NGOs 4.3: Human Rights and Media	12 L
5	<b>Issues and concerns in Human Rights</b> 5.1: Changing dimensions of Human Rights 5.2: Challenges to Human Rights promotion in India-Poverty, Illiteracy, Communal and caste conflicts, patriarchal values, lack of inclusive development 5.3: Human Rights and Terrorism 5.4: Human Rights and problems of health and environment	12 L
	<b>References :</b> 1. “Protect Human Rights”, <a href="http://www.un.org/en/sections/what-we-do/protect-human-rights/index.html">http://www.un.org/en/sections/what-we-do/protect-human-rights/index.html</a> 2. Aftab Alam, ed., Human Rights in India: Issues and Challenges, Delhi; Raj Publications., 2012 3. D.D. Basu, Human Rights in Constitutional Law, Gurgaon; Lexis Nexis, 2008 4. Upendra Baxi, The Future of Human Rights, New Delhi; OUP India, 2012 5. Andrew Clapham, Human Rights A Very Short Introduction, Oxford; OUP, 2015	

	<p>6. Human Rights by S. Subrahmanyam</p> <p>7. M.P.Dube and Neeta Bora, eds., Perspectives on Human Rights, Delhi; Anamika Pub., 2000</p> <p>8. Manisha Priyam, Krishna Menon and Madhulikea Banerjee, Human Rights, Gender and the Environment, Chennai; Pearson Education, 2009</p> <p>9. K.P. Saksena, ed., Human Rights and the Constitution: Vision and Reality,, New Delhi; Gyan Pub., 2003</p> <p>10. K.S. Pavithran, Human Rights in India: Discourses and Contestations, New Delhi; Gyan Pub., 2018</p> <p>11. H.O. Agarwal, Human Rights, Allahabad: Central Law Pub., 2016</p> <p>12. Baradat Sergio and Swaronjali Ghosh. Teaching of Human Rights : Dominant Publishers and distributors, New Delhi,2009.</p> <p>13. Asish Kumar Das and Prasant Kumar Mohanty, Human Rights in India, New Delhi; Sarup &amp; Sons, 2007</p> <p>14. C.J. Nirmal, Human Rights in India, Historical, Social and Political Perspectives, New Delhi, OUP, 2002</p>	
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**Course Outcomes (COs):**

Upon the completion of course, the student should be able:

CO No.	CO	Cognitive level
1	Understand the importance and different approaches to Human rights.	2
2	Understand the different Constitutional provisions and legislation to protect Human rights in India.	3
3	Examine the challenges to Human Rights of different vulnerable sections.	2
4	Understand the issues concerning the rights of citizens in general.	2

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**Syllabus under CBCS**  
**M. Sc. Part-II Organic Chemistry**  
**Semester-IV Audit Course (w.e.f. 2022-23)**

**AC-401 (B): Seminar on Review of Research Paper**

**Credit: 02**  
**Marks: 100**

**Hours of instruction/week: 02**  
**Total hours of instruction: 60**

	<b>Course Objectives:</b> CO-1. Students will learn how to do the referencing. CO-2. Students will understand how to write the review of literature.	
1	Select a topic for research duly in consultation with his/her guide.	10L
2	Identify the appropriate databases for literature survey and compile a working bibliography adopting standard referencing style.	20L
3	Prepare a comprehensive and critical review of the literature highlighting the growth, development, evolution and landmarks in the area of research. The review should result in identification of gaps in the existing literature and should form the basis to present the novelty, significance and need for the study. The objective, methodology and findings of the earlier studies shall be examined in the context of the research topic chosen by the researcher.	20L
4	Present the literature review report in the form of a seminar and submit the same to be evaluated by the Department Council.	10L
	<b>Suggested Studies:</b> 1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) 2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press Model Curriculum of Engineering & Technology PG Courses [Volume -II] 3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book. 4. Adrian Wall work , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011	

**Course Outcomes (COs):**

Upon the completion of course, the student should be able:

CO No.	CO	Cognitive level
1	To select the topic for research in consultation with guide.	2
2	To present the literature review in the form of seminar.	3

<b>KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON</b> (For Affiliated Colleges of KBC NMU) <b>Syllabus under CBCS</b> <b>M. Sc. Part-II Organic Chemistry</b> <b>Semester-IV Audit Course (w.e.f. 2022-23)</b> <b>AC-401 (C): Current Affairs</b>		
<b>Credit: 02</b> <b>Marks: 100</b>	<b>Hours of instruction/week: 02</b> <b>Total hours of instruction: 60</b>	
<b>Course Objective:</b> Students will be expected to display general knowledge of history, politics and International Affairs, as deemed necessary to interpret current affairs.		
<ul style="list-style-type: none"> <li>• <b>Current Affairs: Global Issues</b> <ul style="list-style-type: none"> <li>○ International Security</li> <li>○ International Political Economy</li> <li>○ Human Rights</li> <li>○ Environment: Global Warming, Kyoto Protocol, Copenhagen Accord</li> <li>○ Population: world population trends, world population policies</li> <li>○ Terrorism and Counter Terrorism</li> <li>○ Global Energy Politics</li> <li>○ Nuclear Proliferation and Nuclear Security</li> <li>○ Nuclear Politics in South Asia</li> <li>○ Millennium Development Goals, Current Status,</li> <li>○ Globalization</li> <li>○ Middle East Crisis</li> <li>○ Kashmir Issue</li> <li>○ Palestine Issue</li> </ul> </li> </ul>		60 L

<b>Course Outcomes (COs):</b>		
Upon the completion of course, the student should be able:		
CO No.	CO	Cognitive level
1	Understand effect of greenhouse gases.	2
2	To understand the reasons of Crisis and the solutions.	3

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Syllabus under CBCS  
M. Sc. Part-II Organic Chemistry  
Semester-IV Audit Course (w.e.f. 2022-23)  
AC-401 (D): Intellectual Property Rights**

**Credit: 02  
Marks: 100**

**Hours of instruction/week: 02  
Total hours of instruction: 60**

**Course Objectives:**

- ❖ To acquaint the learners with the basic concepts of Intellectual Property Rights.
- ❖ To develop expertise in the learners in IPR related issues and sensitize the learners with the emerging issues in IPR and the rationale for the protection of IP

1	<p><b>Introduction</b></p> <p>Introduction to IPRs, Basic concepts and need for Intellectual Property – Meaning and practical aspects of Patents, Copyrights, Geographical Indications, IPR in India and Abroad. Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.</p>	12 L
2	<p><b>Intellectual Property Rights</b></p> <p>The IPR tool kit, Patents, the patenting process, Patent cooperation treaties: International Treaties and conventions on IPRs: Trade Related Aspects of Intellectual Property Rights Agreement, Patent Cooperation Treaty, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act</p>	12 L
3	<p><b>Intellectual Property Protections</b></p> <p>IPR of Living Species, protecting inventions in biotechnology, protections of traditional knowledge, biopiracy and documenting traditional knowledge, Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection. Case studies: The basmati rice issue, revocations of turmeric patent, revocation of neem patent.</p>	12 L
4	<p><b>Exercising and Enforcing of Intellectual Property Rights</b></p> <p>Rights of an IPR owner, licensing agreements, criteria for patent infringement. Case studies of patent infringement, IPR – contract, unfair competitions and control, provisions in TRIPS,</p>	12 L
5	<p><b>Role of Patents in Product Development &amp; Commercialization</b></p> <p>Recent changes in IPR laws impacting patents and copy rights, intellectual cooperation in the</p>	12 L

	science and allied industry. Patentable and non-patentable research. Case studies	
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. P.B. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy. Tata Mc Graw Hill, 2001.</li> <li>2. Steve Smith, The Quality Revolution. 1st ed., Jaico Publishing House, 2002.</li> <li>3. Kompal Bansal and Praishit Bansal. Fundamentals of IPR for Engineers, 1st Edition, BS Publications, 2012.</li> <li>4. Prabuddha Ganguli. Intellectual Property Rights. 1st Edition, TMH, 2012.</li> <li>5. R Radha Krishnan &amp; S Balasubramanian. Intellectual Property Rights. 1st Edition, Excel Books, 2012.</li> <li>6. M Ashok Kumar &amp; Mohd. Iqbal Ali. Intellectual Property Rights. 2nd Edition, Serial Publications, 2011.</li> <li>7. Vinod V. Scople, Managing Intellectual Property. Prentice Hall of India Pvt Ltd, 2012.</li> <li>8. Deborah E. Bouchoux. Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets. Cengage Learning, 3rd</li> <li>9. Prabuddha Ganguli. Intellectual Property Rights: Unleashing the Knowledge Economy. McGraw Hill Education, 2011.</li> <li>10. Edited by Derek Bosworth and Elizabeth Webster. The Management of Intellectual Property. Edward Elgar Publishing Ltd., 2013.</li> <li>11. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House</li> </ol>	

<b>Course Outcomes (COs):</b>		
Upon the completion of course, the student should be able:		
<b>CO No.</b>	<b>CO</b>	<b>Cognitive level</b>
<b>1</b>	to understand the concept of intellectual property Rights, its protection.	<b>2</b>
<b>2</b>	To know the latest changes made in Intellectual Property Rights.	<b>2</b>