



**MARUDHAR KESARI JAIN COLLEGE FOR WOMEN  
(AUTONOMOUS)**

Vaniyambadi – 635 751

**PG Department of Chemistry**

**for**

**Postgraduate Programme  
Master of Science in Chemistry**

**From the Academic Year 2024-25**

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# LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION

## 1. Preamble

Chemistry plays a pivotal role in all aspects of physical & biological sciences, engineering, agriculture, medicine, and allied health disciplines. The knowledge of chemistry is essential for student to make the sustainable development and face the upcoming societal change. To impart the basic knowledge of science to young women community, the Department of Chemistry started B.Sc. Programme in the year 2017 followed by M.Sc. Chemistry Programme at 2020. The department offers Chemistry program with the aim of producing chemists with high professional competence, in carrying out both basic and applied chemistry research. The department has well equipped with the latest instruments required to carry out practical experiments in the laboratories and separate library with all needed books.

The faculty members have contributed research towards publication of several research papers in national and international conferences and peer reviewed journals. The research has been carried out in frontier areas of chemistry such as environmental chemistry, electrochemistry, nano materials, coordination chemistry, synthetic organic chemistry, photochemistry, polymer chemistry, and green chemistry. As extension activities, our faculty members and students visit remote villages and various industries in training them to develop entrepreneurial skills and competencies.

In the forthcoming academic year, B.Sc. & M.Sc. Chemistry syllabus provides an integrated and unified approach towards chemical sciences covering all branches of chemistry and following Choice Based Credit System with Outcome Based Education. The curriculum is rigorous in accord to international standards and covers theory and practical courses with full emphasis to construct intellectual assets. In the final semester, the PG students are encouraged to carry out research project in reputed research institutions to enhance their exposure level and placement abilities.

## 2. PROGRAMME OUTCOMES (PO)

<b>Programme</b>	M.Sc., Chemistry
<b>Programme Code</b>	24PCH
<b>Duration</b>	2 years [PG]
<b>Programme Outcomes</b>	<p><b>PO1: Disciplinary Knowledge:</b> Acquire knowledge in chemistry and apply the knowledge in their day-to-day life for betterment of self and society.</p> <p><b>PO2: Cognitive and Problem-Solving Skills:</b> Develop critical, analytical thinking and problem-solving skills.</p> <p><b>PO3: Societal and Environmental Impact:</b> Address and develop solutions for societal and environmental needs at local, regional, and national levels.</p> <p><b>PO4: Research-Related Skills:</b> Develop research skills in defining problems, formulating and testing hypotheses, analyzing, interpreting, and drawing conclusions from data.</p> <p><b>PO5: Employability and Entrepreneurship:</b> Enhance employability and entrepreneurship among students, along with ethical and communication skills.</p> <p><b>PO6: Self-Directed Learning:</b> Work independently and engage in lifelong learning and continuous professional development.</p> <p><b>PO7: Moral and Ethical Awareness/Reasoning:</b> Understand the importance of ethical behavior in professional contexts and be able to recognize and address ethical dilemmas.</p> <p><b>PO8: Lifelong Learning and Adaptability:</b> Be prepared for lifelong learning and professional development, including the ability to adapt to changes in technology, business practices, and economic conditions.</p>

### 3. PROGRAMME SPECIFIC OUTCOMES (PSO)

<b>Programme Specific Outcomes:</b>	<p><b>PSO1: Placement:</b> Apply principles of organic, inorganic, and physical chemistry to design and synthesize novel compounds, contributing to advancements in pharmaceuticals, materials science, and sustainable industries.</p> <p><b>PSO2: Research and Development:</b> Develop expertise in Nano Science and Green Chemistry to design and implement sustainable, pollution-free technologies with high accuracy, fostering innovation in environmental protection, industrial applications, and entrepreneurship.</p> <p><b>PSO3: Contribution to the Society:</b> Integrate practical expertise in compound analysis to ensure precision in quality control, research, and innovation, contributing to industrial growth and societal well-being.</p>
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#### 4. Eligibility for Admission:

Candidate for admission to the first year of M.Sc., Chemistry shall be required to have passed the UG with Chemistry.

## 5. Methods of Evaluation and Assessments

<b>Methods of Evaluation</b>		
Internal Evaluation		25 Marks
External Evaluation	End Semester Examination	75 Marks
	<b>Total</b>	<b>100 Marks</b>
<b>Methods of Assessment</b>		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview	
Application (K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate Between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Semester – I						
Code	Course Title	Hours Distribution				C
		L	T	P	S	
24PCHC11	CC-1 Organic Reaction Mechanism-I	3	1	2	0	4
24PCHC12	CC –2 Structure and Bonding in Inorganic Compounds	3	1	2	0	4
24PCHC13P	CC - 3 Practical-I - Organic Chemistry	0	0	4	0	3
24PCHE11	EC - 1 Nanomaterials and Nanotechnology	3	1	1	0	3
24PCHE12	EC – 2 Molecular Spectroscopy	3	1	1	0	3
24PCHA11	AEC – 1 Chemistry in Consumer Products	1	1	0	0	2
24PCHR11	VE - 1 Human Rights	1	1	0	0	2
					<b>30</b>	<b>21</b>

Semester – III						
Code	Course Title	Hours Distribution				C
		L	T	P	S	
24PCHC31	CC – 8 Organic Synthesis and Photochemistry	3	1	2	0	5
24PCHC32	CC – 9 Coordination Chemistry – I	3	1	2	0	5
24PCHC33P	CC - 10 Practical-III-Physical Chemistry	0	0	5	0	4
24PCHC34P	CC – 11 Practical-IV - Analytical Instrumentation Techniques	0	0	5	0	3
24PCHE31	EC – 5 Polymer Chemistry	2	1	1	0	3
24PCHE32	Pharmacognosy and Phytochemistry					
24PCHS31P	SEC – 2 Practical-V - Chemistry in Everyday Life	0	0	2	0	2
24PCHIN31	Internship	0	0	2	0	2
					<b>30</b>	<b>24</b>

Semester - II						
Code	Course Title	Hours Distribution				C
		L	T	P	S	
24PCHC21	CC – 4 Organic Reactions Mechanism-II	3	1	2	0	4
24PCHC22	CC – 5 Physical Chemistry – I	3	1	2	0	4
24PCHC23P	CC - 6 Practical - II - Inorganic Chemistry	0	0	4	0	3
24PCHC24	CC – 7 Bio-Inorganic Chemistry	2	1	1	0	3
24PCHE21	EC – 3 Medicinal Chemistry	2	1	1	0	3
24PCHE22	Green Chemistry					
24PCHE23	EC – 4 Industrial Chemistry	2	1	1	0	3
24PCHE24	Materials Science					
24PCHS21	SEC - 1 (NME) Renewable Energy and Energy Harvesting	1	0	1	0	2
					<b>30</b>	<b>22</b>

Semester - IV						
Code	Course Title	Hours Distribution				C
		L	T	P	S	
24PCHC41	CC – 12 Coordination Chemistry –II	3	1	2	0	5
24PCHC42	CC – 13 Physical Chemistry – II	3	1	2	0	5
24PCHC43P	CC - 14 Project	0	0	6	0	5
24PCHE41	EC – 6 Chemistry of Natural Products	4	1	1	0	4
24PCHE42	Electrochemistry					
24PCHP41	PEC – 1 Research Tools and Techniques	1	1	0	0	2
24PCHL41	SLC – 1 Biomolecules and Heterocyclic Chemistry	0	0	1	3	2
					<b>30</b>	<b>23</b>
	<b>Total Credits</b>				<b>90+2*</b>	

Students must complete at least one online course (MOOC) from platforms like SWAYAM, NPTEL, or Nanmulvan within the fifth semester. Additionally, engaging in a specified Self-learning Course is mandatory to qualify for the degree, and successful participation will be acknowledged with an extra credit of 2\*.

CC	Core Course	14
EC	Elective Paper	6
SEC	Skill Enhancement Course	2
AEC	Ability Enhancement Compulsory Courses	1
VE	Value Educations	1
	Internship	1
PEC	Professional Enhancement Course	1
SLC	Self-Learning Course	1

**1<sup>ST</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC11	<b>Core Course 1 - Organic Reaction Mechanism – I</b>	Core	3	1	2	0	5	6	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the feasibility and the mechanism of various organic reactions.										
LO2	To comprehend the techniques in the determination of reaction mechanisms.										
LO3	To understand the concept of stereochemistry involved in organic compounds.										
LO4	To correlate and appreciate the differences involved in the various types of organic reaction mechanisms.										
LO5	To design feasible synthetic routes for the preparation of organic compounds.										
Unit	Content									Hours	
1	<b>Methods of Determination of Reaction Mechanism:</b> Reaction intermediates. The transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions: Hammond postulate. Methods of determining mechanism: non-kinetic methods – product analysis, determination of intermediates - isolation, detection, and trapping. Effect of structure on reactivity: Hammett and Taft equations.									18	
2	<b>Aromatic and Aliphatic Electrophilic Substitution:</b> Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation;									18	

	Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions. Aliphatic electrophilic substitution Mechanisms: $SE_2$ and $SE_i$ , $SE_1$ - Mechanism and evidences.	
3	<b>Aromatic and Aliphatic Nucleophilic Substitution:</b> Aromatic nucleophilic substitution: Mechanisms - $SN_{Ar}$ , $SN_i$ and Benzyne mechanisms - Evidences. Reactivity of nucleophile, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur - nucleophiles, Bucherer and Rosenmund reactions, Von Richter, Sommelet-Hauser and Smiles rearrangements. $SN_1$ and $SN_2$ mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.	18
4	<b>Stereochemistry-I:</b> Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D, L system, Cram's and Prelog's rules: R, S notations, proR, proS, absolute and relative configurations. Chiral shift reagents and chiral solvating reagents. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations and asymmetric synthesis. Stereoselective and stereospecific synthesis.	18
5	<b>Stereochemistry-II:</b> Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and poly substituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule. Optical rotation and ORD curves, Cotton effect.	18

CO	Course Outcomes
CO1	To recall the basic principles of organic chemistry.
CO2	To understand the formation and detection of reaction intermediates of organic reactions.
CO3	To predict the reaction mechanism of organic reactions and stereochemistry of organic compounds.
CO4	To apply the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.
CO5	To design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.
<b>Textbooks:</b>	
1	March J. and Smith M. "Advanced Organic Chemistry", John-Wiley and Sons. 5 <sup>th</sup> ed., 2001.
2	Gould E. S. "Mechanism and Structure in Organic Chemistry", Holt, Rinehart and Winston Inc., 5 <sup>th</sup> ed., 1959.
3	Kalsi P. S. "Stereochemistry of Carbon Compounds", NewAge International Publishers, 8 <sup>th</sup> ed., 2015.
4	Bruice P. Y. "Organic Chemistry", Prentice Hall, 7 <sup>th</sup> ed., 2013.
5	Clayden J, Greeves N. and Warren S. "Organic Compounds", Oxford University Press, 2 <sup>nd</sup> ed., 2014.
<b>Reference Books:</b>	
1	Carey F. A. and Sundberg R. J. "Advanced Organic Chemistry Part-A and B", Kluwer Academic / Plenum Publishers, 5 <sup>th</sup> ed., 2007.
2	Morris D. G. "Stereochemistry", RSC Tutorial Chemistry Text 1, 2001.
3	Isaacs N. S. "Physical Organic Chemistry", ELBS, Longman, UK, 1987.
4	Eliel E. L. "Stereochemistry of Carbon Compounds", Tata-McGrawHill, 2000.
5	Finar I. L. "Organic chemistry", Vol-1 & 2, 6 <sup>th</sup> ed., Pearson Education Asia, 2004.
<b>Web resources:</b>	
1	<a href="https://www.masterorganicchemistry.com/reaction-guide/">https://www.masterorganicchemistry.com/reaction-guide/</a>
2	<a href="https://www.khanacademy.org/science/organic-chemistry/aromatic-compounds/reactions-benzene/v/electrophilic-aromatic-substitution">https://www.khanacademy.org/science/organic-chemistry/aromatic-compounds/reactions-benzene/v/electrophilic-aromatic-substitution</a>
3	<a href="https://m.youtube.com/watch?v=Efh5GkVbhEc">https://m.youtube.com/watch?v=Efh5GkVbhEc</a>
4	<a href="https://chem.libretexts.org/Courses/Sacramento_City_College/SCC%3A_Chem_420_-_Organic_Chemistry_I/Text/06%3A_Stereochemistry_at_Tetrahedral_Centers/6.01%3A_Chirality">https://chem.libretexts.org/Courses/Sacramento_City_College/SCC%3A_Chem_420_-_Organic_Chemistry_I/Text/06%3A_Stereochemistry_at_Tetrahedral_Centers/6.01%3A_Chirality</a>
5	<a href="https://www.masterorganicchemistry.com/">https://www.masterorganicchemistry.com/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	3	2	3	3	3	3	3	3
<b>CO2</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO3</b>	3	3	2	3	3	3	3	2	3	3	3
<b>CO4</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO5</b>	2	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>ST</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
<b>24PCHC12</b>	<b>Core Course 2 - Structure and Bonding in Inorganic Compounds</b>	<b>Core</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>0</b>	<b>3</b>	<b>6</b>	<b>25</b>	<b>75</b>	<b>100</b>
<b>Learning Objectives</b>											
LO1	To understand the Structural properties of main group compounds and clusters.										
LO2	To gain fundamental knowledge on structural aspects of ionic crystals.										
LO3	To familiarize various diffraction and microscopic techniques.										
LO4	To understand the effect of point defects and line defects in ionic crystals.										
LO5	To evaluate the structural aspects of solids.										
Unit	Content										Hours
1	<b>Molecular Geometry:</b> Structure of main group compounds and clusters: VB theory – Effect of lone pair and electronegativity of atoms (Bent’s rule) on the geometry of the molecules; Structure of silicates - applications of Pauling’s rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates.										18
2	<b>Boron Compounds and Clusters:</b> Chemistry of boron – Preparation, properties and structure of boranes, higher boranes - types of boranes closo, nido, arachno. ( $B_2H_6$ , $B_4H_{10}$ , $B_5H_{11}$ , $B_6H_{10}$ , $B_{10}H_{14}$ ) linear and cyclic borazines ( $B_3N_3H_6$ ), boron nitrides $(BN)_x$ and borates ions — STYX numbers, Wade’s rules. Metal clusters: Chemistry of low molecularity metal clusters only – Structure of $Re_2C_{18}$ ; multiple metal – metal bonds.										18

3	<p><b>Solid State Chemistry:</b> Structural features of the crystal systems: Rock salt, Zinc blende &amp; Wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide and nickel arsenide; Spinel - normal and inverse types and perovskite structures.</p>	18
4	<p><b>Techniques in Solid State Chemistry:</b> X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation; Electron microscopy – difference between optical and electron microscopy, theory, principle, instrumentation, sampling methods and applications of SEM and TEM.</p>	18
5	<p><b>Band Theory and Defects in Solids:</b> Band theory – features and its application of conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects due to dislocations.</p>	18

CO	Course Outcomes
CO1	Predict the geometry of main group compounds and clusters.
CO2	Explain about the packing of ions in crystals and apply the radius ratio rule to predict the coordination number of cations.
CO3	Understand the various types of ionic crystal systems and analyze their structural features.
CO4	Explain the crystal growth methods.
CO5	To understand the principles of diffraction techniques and microscopic techniques.
<b>Textbooks:</b>	
1	West A. R, "Solid state Chemistry and its Applications", 2 <sup>nd</sup> ed., (Students Edition), John Wiley & Sons Ltd., 2014.
2	Bhagi A. K. and Chatwal G. R, "A Textbook of Inorganic Polymers", Himalaya Publishing House, 2001.
3	Smart L. and Moore E, "Solid State Chemistry – An Introduction", 4 <sup>th</sup> ed., CRC Press, 2012.
4	Purcell K. F. and Kotz J. C, "Inorganic Chemistry", W.B. Saunders Company, Philadelphia, 1977.
5	Huheey J. E, Keiter E. A. and Keiter R. L, "Inorganic Chemistry", 4 <sup>th</sup> ed., Harper and Row, New York, 1983.
<b>Reference Books:</b>	
1	Douglas D. E, McDaniel D. H. and Alexander J. J, "Concepts and Models in Inorganic Chemistry", 3 <sup>rd</sup> ed., John Wiley, 1994.
2	Tilley R. J. D, "Understanding Solids - The Science of Materials", 2 <sup>nd</sup> ed., Wiley Publication, 2013.
3	Rao C. N. R. and Gopalakrishnan J, "New Directions in Solid State Chemistry", 2 <sup>nd</sup> ed., Cambridge University Press, 1986.
4	Moeller T, "Inorganic Chemistry: A Modern Introduction", John Wiley & Sons Ltd., New York, 1982.
5	Shriver D. F, Atkins P. W. and Langford C. H, "Inorganic Chemistry", 3 <sup>rd</sup> ed., Oxford University Press, London, 2001.
<b>Web resources:</b>	
1	<a href="https://webbook.nist.gov/chemistry/">https://webbook.nist.gov/chemistry/</a>
2	<a href="https://ocw.mit.edu/courses/3-091sc-introduction-to-solid-state-chemistry-fall-2010/">https://ocw.mit.edu/courses/3-091sc-introduction-to-solid-state-chemistry-fall-2010/</a>
3	<a href="https://nptel.ac.in/courses/104104101">https://nptel.ac.in/courses/104104101</a>
4	<a href="https://foundry.lbl.gov/about/facilities/the-national-center-for-electron-microscopy-ncem/">https://foundry.lbl.gov/about/facilities/the-national-center-for-electron-microscopy-ncem/</a>
5	<a href="https://ocw.mit.edu/courses/3-185-transport-phenomena-in-materials-engineering-fall-2003/">https://ocw.mit.edu/courses/3-185-transport-phenomena-in-materials-engineering-fall-2003/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	3	2	3	3	3	3	3	3
<b>CO2</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO3</b>	3	3	2	3	3	3	3	2	3	3	3
<b>CO4</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO5</b>	2	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>ST</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
<b>24PCHC13P</b>	<b>Core Course 3 - Organic Chemistry Practical</b>	<b>Core</b>	<b>0</b>	<b>0</b>	<b>4</b>	<b>0</b>	<b>3</b>	<b>4</b>	<b>25</b>	<b>75</b>	<b>100</b>
<b>Learning Objectives</b>											
LO1	To understand the concept of separation, qualitative analysis and preparation of organic compounds.										
LO2	To develop analytical skill in the handling of chemical reagents for separation of binary and ternary organic mixtures.										
LO3	To analyze the separated organic components systematically and derivative them suitably.										
LO4	To construct suitable experimental setup for the organic preparations involving two stages.										
LO5	To experiment different purification and drying techniques for the compound processing.										
Unit	Content									Hours	
1	<b>Separation and analysis:</b> a) Two component mixtures. Ternary component (Demo)									12	
2	<b>Estimations:</b> a) Estimation of Phenol (Bromination) b) Estimation of Aniline (Bromination)									12	
3	<b>Estimations:</b> a) Estimation of Glucose (Redox) b) Estimation of Glycine (Acidimetry) c) Estimation of Amino group (Acetylation)									12	

4	<p><b>Preparation of Organic Compounds (Single stage):</b></p> <ul style="list-style-type: none"> <li>a) Methyl-m-nitro benzoate from ethyl benzoate (nitration)</li> <li>b) Benzo phenone oxime from benzophenone (addition)</li> <li>c) o-Chlorobenzoic acid from anthranilic acid (Sand mayer reaction)</li> <li>d) p-Benzoquinone from hydroquinone (oxidation)</li> <li>e) Phenylazo-2-naphthol from aniline (diazotization)</li> </ul>	12
5	<p><b>Preparation of Organic Compounds (Two stages):</b></p> <ul style="list-style-type: none"> <li>a) p-Bromoacetanilide from aniline</li> <li>b) p-Nitroaniline from acetanilide</li> <li>c) Acetyl salicylic acid from methyl salicylate</li> <li>d) Benzilic acid from benzoin</li> <li>e) m-Nitrobenzoic acid from methyl benzoate</li> </ul>	12

**SCHEME OF VALUATION**  
**24PCHC13P - ORGANIC CHEMISTRY PRACTICAL**

Internal assessment	: 25 Marks
External assessment	: 75 Marks
Total	: 100 Marks
Max. Marks	: 75 Marks
Estimation	: 30 Marks
Preparation of Organic Compounds	: 30 Marks
Record	: 10 Marks
Viva voce	: 5 Marks

CO	Course Outcomes
CO1	To recall the basic principles of organic separation, qualitative analysis and preparation.
CO2	To explain the method of separation and analysis of separated organic mixtures and convert them as derivatives by suitable preparation method.
CO3	To determine the characteristics of separation of organic compounds by various chemical reactions.
CO4	To develop strategies to separate, analyze and prepare organic compounds.
CO5	To formulate a method of separation, analysis of organic mixtures and design suitable procedure for organic preparations.
<b>Textbooks:</b>	
1	Mohan, "Organic Analytical Chemistry: Theory and Practice", Narosa, 2003.
2	Ahluwalia V. K, Bhagat ., and Agarwal R, "Laboratory Techniques in Organic Chemistry", I. K. International, 2005.
3	Gnanaprakasam N. S. and Ramamurthy G, "Organic Chemistry Lab Manual", S. V. Printers, 1987.
4	Vogel A. I, Tatchell A. R, Furniss B. S, Hannaford A. J. and Smith P. W. G, "Vogel's Textbook of Practical Organic Chemistry", 5 <sup>th</sup> ed., Prentice Hall, 1989.
5	Jonathan Clayden, Nick Greeves and Stuart Warren, "Organic Practical: Techniques and Transformations", Oxford University Press, 2014.
<b>Reference Books:</b>	
1	Tatchell A. R, Furniss B. S, Hannaford A. J, Smith P. W. G. and Tatchell A. R, "Vogel's Textbook of Practical Organic Chemistry", Pearson Education Ltd., 2009.
2	Hayden-McNeil, "Organic Chemistry Laboratory Notebook", Hayden-McNeil Publishing, 2010.
3	John C. Gilbert and Stephen F. Martin, "Experimental Organic Chemistry: A Miniscale & Microscale Approach", Cengage Learning, 2015.
4	Jerry R. Mohrig, David Alberg, Gretchen Hofmeister, and Paul F. Schatz, "Techniques in Organic Chemistry", W. H. Freeman, 2010.
5	James W. Zubrick, "Organic Chemistry: A Laboratory Manual", Wiley, 2001.
<b>Web resources:</b>	
1	<a href="https://www.ncbi.nlm.nih.gov/books/NBK547700/">https://www.ncbi.nlm.nih.gov/books/NBK547700/</a>
2	<a href="https://webbook.nist.gov/chemistry/">https://webbook.nist.gov/chemistry/</a>
3	<a href="https://www.nist.gov/publications/certification-standard-reference-materialr-917d-d-glucose-dextrose">https://www.nist.gov/publications/certification-standard-reference-materialr-917d-d-glucose-dextrose</a>
4	<a href="https://chem.libretexts.org/Courses/Sonoma_State_University/SSU_Chem_335B/Material_for_Exam_3/Chapter_18%3A_Electrophilic_Aromatic_Substitution/18.4_Nitration_and_Sulfonation">https://chem.libretexts.org/Courses/Sonoma_State_University/SSU_Chem_335B/Material_for_Exam_3/Chapter_18%3A_Electrophilic_Aromatic_Substitution/18.4_Nitration_and_Sulfonation</a>
5	<a href="https://www.masterorganicchemistry.com/">https://www.masterorganicchemistry.com/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	3	2	3	3	3	3	3	3
<b>CO2</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO3</b>	3	3	2	3	3	3	3	2	3	3	3
<b>CO4</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO5</b>	2	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>ST</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
<b>24PCHE11</b>	<b>Elective Course 1 - Nanomaterials and Nanotechnology</b>	<b>Elective</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>5</b>	<b>25</b>	<b>75</b>	<b>100</b>
<b>Learning Objectives</b>											
LO1	To learn about the synthesis and chemical process of nanoscience.										
LO2	To understand the various types of nano materials and their properties.										
LO3	To analyse the various application of nanotechnology in remediation of pollution.										
LO4	To apply principles and characterization of nanoscience by XRD, SEM, EDAX, TEM.										
LO5	To understand the applications of synthetically important nano materials.										
Unit	Content									Hours	
1	<b>Synthesis of Nanomaterials by Chemical Processes:</b> Introduction to nanomaterials and nanotechnologies. Chemical precipitation and co-precipitation, polyol – borohydride reduction methods – Sol-Gel synthesis; Microemulsions synthesis – Hydrothermal – Solvothermal synthesis methods – Microwave assisted synthesis – Sonochemical assisted synthesis – Core-Shell nanostructure – Quantum dot (QDs) synthesis.									15	
2	<b>Structural Properties of Nanomaterials:</b> Bonding and structure of the nano materials, predicting the type of bonding in a substance crystal structure. Metallic nano particles, surfaces of materials, nanoparticle Size. Techniques to study the following properties of nanomaterials - Thermal, mechanical and electrical properties.									15	
3	<b>Nanotechnology - Environmental and Health Effects:</b> Environmental pollutants in air, water, soil, hazardous and toxic wastes – application of nanotechnology in remediation of pollution									15	

	<p>– The challenge to occupational health and hygiene – toxicity of nanoparticles – effects of inhaled nanosized particles – skin exposure to nanoparticles – impact of CNTs on respiratory systems – hazards and risks of exposure to nanoparticles – monitoring nanoparticles in workplace and sensors.</p>	
4	<p><b>Nanostructured Materials Characterization Techniques:</b> X-ray diffraction (XRD) – SEM – EDAX – TEM – Elemental mapping – FTIR – UV Visible spectrophotometer – Laser Raman Spectroscopy – Thermo gravimetric Analysis (TGA), Differential Scanning Calorimeter (DSC) – Differential Thermal Analyzer (DTA) – X-ray Photoelectron Spectroscopy (XPS).</p>	15
5	<p><b>Nanocomposite Materials and Nanolubricants</b></p> <p><b>Nanocomposites</b> - Types of nanocomposites - Organic and Inorganic hybrid nanocomposites -Polymer matrix composites, metal matrix composites, ceramic matrix composites; Applications of composites in drug delivery, automobiles and aerospace industries.</p> <p><b>Nanolubricants</b> - Classification, properties and mechanism of different types of nanolubricants.</p>	15

CO	Course Outcomes
CO1	To explain methods of fabricating nanostructures.
CO2	To relate the unique properties of nanomaterials to reduce dimensionality of the material.
CO3	To understand the health and safety related to nanomaterials.
CO4	To familiar with analytical techniques used to characterize nanomaterials, such as SEM, TEM, XRD), and spectroscopic methods (UV-Vis, FTIR, Raman).
CO5	To discuss applications of nanocomposites and nanolubricants
<b>Textbooks:</b>	
1	Sanjay Mathur and Mrityunjay Singh, “Nanostructured Materials and Nanotechnology”, 2 <sup>nd</sup> ed., Willey, 2008.
2	Carl C. Koch, “Nanostructured Materials”, Noyes Publications, New York, 2002.
3	Nazri G. A. and Pistoia G, “Science and Technology”, Kulwer Academic Publishers, Dordrecht, Netherlands, 2004.
4	Brown P. and Stevens K, “Nanofibers and Nanotechnology in Textiles”, Woodhead publication London, 2006.
5	Altmann J. and Routledge, “Military Nanotechnology: Potential Applications and Preventive Arms Control”, Taylor and Francis Group, 2006.
<b>Reference Books:</b>	
1	Chattopadhyay K, “An Introduction to Nanoscience and Nanotechnology”, Prentice Hall Learning Pvt. Ltd, 2009.
2	Shi D, Aktas B, Pust L. and Mikailov F, “Nanostructured Magnetic Materials and their Applications”, Springer, 2002.
3	Victor E. Borisenko, “A Handbook on Nanoscience and Nanotechnology”, Wiley VCH, 2008.
4	Pradeep T, “A Textbook of Nanoscience and Nanotechnology”, McGraw Hill Education, 2017.
5	Hari Singh Nalwa, “Encyclopedia of Nanoscience and Nanotechnology”, American Scientific Publishers, 2004.
<b>Web resources:</b>	
1	<a href="https://www.nano.gov/">https://www.nano.gov/</a>
2	<a href="https://ocw.mit.edu/courses/3-091sc-introduction-to-solid-state-chemistry-fall-2010/">https://ocw.mit.edu/courses/3-091sc-introduction-to-solid-state-chemistry-fall-2010/</a>
3	<a href="https://pubmed.ncbi.nlm.nih.gov/">https://pubmed.ncbi.nlm.nih.gov/</a>
4	<a href="https://www.thermofisher.com/us/en/home/materials-science/learning-center/scanning-electron-microscopy.html">https://www.thermofisher.com/us/en/home/materials-science/learning-center/scanning-electron-microscopy.html</a>
5	<a href="https://www.asminternational.org/asm-handbook-volume-21-composites/results/-/journal_content/56/06781G/PUBLICATION/">https://www.asminternational.org/asm-handbook-volume-21-composites/results/-/journal_content/56/06781G/PUBLICATION/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	3	2	3	3	3	3	3	3
<b>CO2</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO3</b>	3	3	2	3	3	3	3	2	3	3	3
<b>CO4</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO5</b>	2	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3 – Strong, 2- Medium, 1- Low**

1<sup>ST</sup> YEAR: FIRST SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHE12	Elective Course – 2 Molecular Spectroscopy	Elective	3	1	1	0	3	5	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules.										
LO2	Understand the principles of vibrational spectroscopy.										
LO3	To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions.										
LO4	Gain knowledge of the NMR, fine structure of ESR absorption, Hyperfine structure, double resonance in ESR and techniques of ESR spectroscopy.										
LO5	To carry out the structural elucidation of molecules using different spectral techniques.										
Unit	Content									Hours	
1	<b>Rotational and Raman Spectroscopy:</b> Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion.									15	
2	<b>Vibrational Spectroscopy:</b> Vibrations of molecules, harmonic and anharmonic oscillators - vibrational energy expression, energy level diagram. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies.									15	

3	<p><b>Electronic Spectroscopy:</b> Electronic spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and pre-dissociation spectra. <math>\pi \rightarrow \pi^*</math>, <math>n \rightarrow \pi^*</math> transitions and their selection rules. Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules. Lasers: Laser action, population inversion properties of laser radiation, examples of simple laser systems.</p>	15
4	<p><b>NMR and ESR Spectroscopy:</b> Spin-spin interactions: Homonuclear coupling interactions - AX, AX<sub>2</sub>, AB types. <sup>13</sup>C NMR and structural correlations, Satellites. ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; The g value and the hyperfine coupling parameter. Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling.</p>	15
5	<p><b>Mass Spectrometry, EPR and Mossbauer Spectroscopy:</b> Ionization techniques- Electron ionization (EI), chemical ionization (CI), fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation. EPR spectra of anisotropic systems - anisotropy in g value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei.</p> <p><b>Practice:</b> Structural elucidation of simple organic molecules by UV-Visible, FT-IR, NMR, and Mass spectral data.</p>	15

CO	Course Outcomes
CO1	To understand the importance of rotational and Raman spectroscopy.
CO2	To apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.
CO3	To evaluate different electronic spectra of simple molecules using electronic spectroscopy.
CO4	To perform the most commonly used NMR and ESR spectroscopy to interpret the chemical compounds and their characteristics.
CO5	To develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass, EPR and Mossbauer Spectroscopy.
<b>Textbooks:</b>	
1	Banwell C. N. and McCash E. M, "Fundamentals of Molecular Spectroscopy", 4 <sup>th</sup> Ed., Tata McGraw Hill, New Delhi, 2000.
2	Silverstein R. M. and Webster F. X, "Spectroscopic Identification of Organic Compounds", 6 <sup>th</sup> ed., John Wiley & Sons, New York, 2003.
3	Kemp W, "Applications of Spectroscopy", English Language Book Society, 1987.
4	Williams D. H. and Fleming I, "Spectroscopic Methods in Organic Chemistry", 4 <sup>th</sup> ed., Tata McGraw-Hill Publishing Company, New Delhi, 1988.
5	Straughan B. P. and Walker S, "Spectroscopy", Vol.3, Halstead Press, Sydney, 1978.
<b>Reference Books:</b>	
1	Barrow G. M, "Introduction to Molecular Spectroscopy", McGraw Hill, New York, 1964.
2	Sharma Y. R, "Elementary Organic Spectroscopy–Principles and Chemical Applications, S.Chand, New Delhi, 1992.
3	Rahman A, "Nuclear Magnetic Resonance-Basic Principles", Springer-Verlag, New York, 1986.
4	Nakamoto K, "Infrared and Raman Spectra of Inorganic and Coordination Compounds - PartB", 5 <sup>th</sup> ed., John Wiley & Sons Inc., New York, 1997.
5	Weil J. A, Bolton J. R. and Wertz J. E, "Electron Paramagnetic Resonance", Wiley Interscience, 1994.
<b>Web resources:</b>	
1	<a href="https://www.nist.gov/spectroscopy">https://www.nist.gov/spectroscopy</a>
2	<a href="https://cccbdb.nist.gov/">https://cccbdb.nist.gov/</a>
3	<a href="https://webbook.nist.gov/chemistry/">https://webbook.nist.gov/chemistry/</a>
4	<a href="https://nationalmaglab.org/user-facilities/nmr-mri-s/">https://nationalmaglab.org/user-facilities/nmr-mri-s/</a>
5	<a href="https://acsanalytical.org/">https://acsanalytical.org/</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	3	2	3	3	3	3	3	3
<b>CO2</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO3</b>	3	3	2	3	3	3	3	2	3	3	3
<b>CO4</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO5</b>	2	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3 – Strong, 2- Medium, 1- Low**

1<sup>ST</sup> YEAR: FIRST SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHA11	Ability Enhancement Compulsory Course 1 - Chemistry in Consumer Products	AEC	1	1	0	0	2	2	25	75	100
<b>Learning Objectives</b>											
LO1	To learn step-by-step process of various types of soap manufacturing.										
LO2	To explore the formulation and development of detergent products.										
LO3	To gain knowledge of common raw materials used in cosmetics, including oils, waxes, colors, preservatives and fragrances.										
LO4	To understand the cosmetic formulation principles, including the selection of active ingredients, excipients, and additives to achieve desired skincare effects.										
LO5	To identify common toxic chemical ingredients found in skincare and toiletries products.										
Unit	Content										Hours
1	<b>Soaps:</b> Types of Soaps, manufacture of soaps, formulation of toilet soaps – different ingredients used - soft soaps, shaving soaps, herbal soaps and antibacterial soaps.										6
2	<b>Detergents:</b> Types of detergents - anionic detergents and cationic detergents – manufactures and applications; detergent performance; Green detergents - sustainable alternatives.										6
3	<b>Cosmetics:</b> Cosmetics - Introduction about raw materials in cosmetics - (oil, waxes, color, preservative and fragrance). Shampoo - different kinds shampoo – anti-dandruff, anti-lice, herbal and baby shampoo, hair dye – manufacture of conditioners (raw materials and uses only).										6
4	<b>Skin Care Products:</b> Preparation of cosmetics - skin and hair - skin lighteners, sun screen lotions - skin toners anti wrinkling creams. Lip care - lip gloss – lipsticks - lip liners, moisturizers - crack creams, Sun cream and UV rays protecting cream.										6
5	<b>Toxicity:</b> Toxic chemical ingredients – skincare products – toiletries products – carcinogens; preservatives - parabens, formaldehyde-releasing agents, fragrances - phthalates, surfactants - sodium lauryl sulfate, and colorants - coal tar dyes.										6

<b>CO</b>	<b>Course Outcomes</b>
CO1	To learn about various soap making techniques.
CO2	To understand the structure-property relationships of surfactants in detergents.
CO3	To apply the knowledge to develop cosmetic products with desired properties.
CO4	To understand the cosmetic formulation principles, including the selection of active ingredients, excipients, and additives to achieve desired skincare effects for both skin and hair products.
CO5	To explore the adverse health effects associated with harmful chemicals found in skincare and toiletries products.
<b>Textbooks:</b>	
1	David A. Katz and Richard A. Lawton, "Chemistry of Household Products", Thomson Learning, 2001.
2	Richard J. Farn, "Chemistry and Technology of Surfactants", Blackwell Publishing, 2006.
3	NIIR Board, "Modern Technology of Cosmetics", Asia Pacific Business Press Inc., New Delhi, 2004.
4	Ernest W. Flick, "Cosmetic and Toiletry Formulations", Noyes Publications, 2001.
5	D. F. Williams and W. H. Schmitt, "Chemistry and Technology of Cosmetics and Toiletries", Blackie Academic & Professional, 1992.
<b>Reference Books:</b>	
1	André O. Barel, Marc Paye, and Howard I. Maibach, "Handbook of Cosmetic Science and Technology", CRC Press, 2001.
2	Charles S. Sell, "Chemistry of Fragrances: From Perfumer to Consumer", Royal Society of Chemistry, 2006.
3	Michael Showell, "Handbook of Detergents, Part F: Production", CRC Press, 2009.
4	Romanowski P. and Schueller R, "Beginning Cosmetic Chemistry: Practical Knowledge for the Cosmetic Industry", Allured Books, 3 <sup>rd</sup> ed., 2009.
5	John Toedt, Darrell Koza, and Kathleen Van Cleef-Toedt, "Chemical Composition of Everyday Products", Greenwood, 2005.
<b>Web resources:</b>	
1	<a href="https://www.gutenberg.org/">https://www.gutenberg.org/</a>
2	<a href="https://openlibrary.org/">https://openlibrary.org/</a>
3	<a href="https://www.cleaninginstitute.org/">https://www.cleaninginstitute.org/</a>
4	<a href="https://www.aad.org/">https://www.aad.org/</a>
5	<a href="https://www.ewg.org/">https://www.ewg.org/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	3	2	3	3	3	3	3	3
<b>CO2</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO3</b>	3	3	2	3	3	3	3	2	3	3	3
<b>CO4</b>	2	3	3	3	3	2	3	3	3	3	3
<b>CO5</b>	2	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3 – Strong, 2- Medium, 1- Low**

1<sup>ST</sup> YEAR: SECOND SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC21	Organic Reaction Mechanism - II	Core	3	1	2	0	4	6	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the concept of aromaticity in benzenoid, non-benzenoid, heterocyclic and annulene compounds.										
LO2	To understand the mechanism involved in various types of organic reactions with evidences.										
LO3	To understand the applications of synthetically important reagents.										
LO4	To correlate the reactivity between aliphatic and aromatic compounds.										
LO5	To design synthetic routes for synthetically used organic reactions.										
Unit	Content										Hours
1	<p><b>Elimination and Free Radical Reactions:</b> Mechanisms: E<sub>2</sub>, E<sub>1</sub>, and E<sub>1cB</sub> mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Long lived and short-lived radicals – Production of radicals by thermal and photochemical reactions, Detection and stability of radicals, characteristics of free radical reactions - Reactions of radicals: Polymerization, addition, halogenations, aromatic substitutions, rearrangements. Reactivity: Reactivity on aliphatic, aromatic substrates, reactivity in the attacking radical, effect of solvent.</p>										18
2	<p><b>Oxidation and Reduction Reactions:</b> Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, ferricyanide, permanganate, osmium tetroxide, oxidation of saturated hydrocarbons, alcohols, halides and amines. Reactions involving cleavage of C-C bonds - oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCCD). Mechanism of reduction reactions: Wolff-Kishner, Clemmenson, Rosenmund, McFadyen-Steven's reduction, Hydroboration with cyclic systems, MPV and Bouveault- Blanc reduction.</p>										18

3	<p><b>Rearrangements:</b> Rearrangements to electron deficient carbon: Pinacol - pinacolone and semi-pinacolone rearrangements - applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Baker-Venkataraman, Benzilic acid and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann rearrangements. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements. Rearrangements to electron rich atom: Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement. Intramolecular rearrangements – Claisen, Cope, Oxy-Cope, Benzidine rearrangements.</p>	18
4	<p><b>Addition to Carbon Multiple Bonds:</b> Mechanisms: (a) Addition to carbon-carbon multiple bonds- Addition reactions involving electrophiles, nucleophiles, free radicals, Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen; (b) Addition to carbon-hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, Wittig reaction, Prins reaction. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates – Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.</p>	18
5	<p><b>Reagents and Modern Synthetic Reactions:</b> Lithium diisopropylamine (LDA), Sodium cyanoborohydride (NaBH<sub>3</sub>CN), <i>meta</i>-Chloroperbenzoic acid (m-CPBA), Dimethyl aminopyridine (DMAP), Triethylamine (TEA), Diazobicyclo[5.4.0]undec-7-ene (DBU), Diisopropylazodicarboxylate (DIAD), Diethylazodicarboxylate (DEAD), <i>N</i>-bromosuccinimide (NBS), Trifluoroacetic acid (TFA), Tetramethyl piperiridin-1-oxyl (TEMPO), Phenyltrimethylammonium tribromide (PTAB). Diazomethane and Zn-Cu, Diethyl maleate (DEM), TiCl<sub>3</sub>, NaIO<sub>4</sub>, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Meisenheimer complex. Heck reaction, Negishi reaction, Baylis-Hillman reaction.</p>	18

CO	Course Outcomes
CO1	To recall the basic principles of aromaticity of organic and heterocyclic compounds.
CO2	To understand the mechanism of various types of organic reactions.
CO3	To predict the suitable reagents for the conversion of selective organic compounds.
CO4	To correlate the principles of substitution, elimination, and addition reactions.
CO5	To design new routes to synthesis organic compounds.
<b>Textbooks:</b>	
1.	J. March and M. Smith, " <i>Advanced Organic Chemistry</i> ", 5 <sup>th</sup> ed., John-Wiley and Sons. 2001.
2.	E. S. Gould, " <i>Mechanism and Structure in Organic Chemistry</i> ", 1 <sup>st</sup> ed., Holt, Rinehart and Winston Inc., 1959.
3.	P. S. Kalsi, " <i>Stereochemistry of carbon compounds</i> ", 8 <sup>th</sup> ed., New Age International Publishers, 2015.
4.	P. Y. Bruice, " <i>Organic Chemistry</i> ", 7 <sup>th</sup> ed., Prentice Hall, 2013.
5.	R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, " <i>Organic Chemistry</i> ", 7 <sup>th</sup> ed., Pearson Education, 2010.
<b>Reference Books:</b>	
1.	S. H. Pine, " <i>Organic Chemistry</i> ", 5 <sup>th</sup> ed, McGraw Hill International Edition, 1987.
2.	L. F. Fieser and M. Fieser, " <i>Organic Chemistry</i> ", 4 <sup>th</sup> ed., Asia Publishing House, Bombay, 2000.
3.	O. P. Agarwal, " <i>Organic Chemistry: Reactions &amp; Reagents</i> ", 53 <sup>rd</sup> ed., Krishna Prakashan Media (P) Ltd., 2015.
4.	T. L. Gilchrist, " <i>Heterocyclic Chemistry</i> ", 2 <sup>nd</sup> ed., Longman Press, 1989.
5.	J. A. Joule and K. Mills, " <i>Heterocyclic Chemistry</i> ", 4 <sup>th</sup> ed., John-Wiley, 2010.
<b>Web resources:</b>	
1.	<a href="https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic">https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic</a>
2.	<a href="https://www.organic-chemistry.org/">https://www.organic-chemistry.org/</a>
3.	<a href="https://www.masterorganicchemistry.com/">https://www.masterorganicchemistry.com/</a>
4.	<a href="https://onlinecourses.nptel.ac.in/">https://onlinecourses.nptel.ac.in/</a>
5.	<a href="https://www.masterorganicchemistry.com/">https://www.masterorganicchemistry.com/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	3	3	3	2	3	3	3	3	3	3
<b>CO 2</b>	2	3	3	3	3	2	3	3	2	3	3
<b>CO 3</b>	3	3	2	3	3	3	3	2	3	3	2
<b>CO 4</b>	3	2	3	3	3	2	3	3	2	3	3
<b>CO 5</b>	2	3	2	3	3	3	3	2	3	3	3
<b>Total</b>	13	14	13	15	14	12	15	13	13	15	14
<b>Average</b>	<b>2.6</b>	<b>2.8</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.6</b>	<b>3.0</b>	<b>2.6</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>

**3 – Strong, 2 – Medium, 1 - Low**

1<sup>ST</sup> YEAR: SECOND SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC22	Physical Chemistry - I	Core	3	1	2	0	4	6	25	75	100
<b>Learning Objectives</b>											
LO1	To recall the fundamentals of thermodynamics and the composition of partial molar quantities.										
LO2	To understand the classical and statistical approach of the functions.										
LO3	To compare the significance of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein.										
LO4	To correlate the theories of reaction rates for the evaluation of thermodynamic parameters.										
LO5	To study the mechanism and kinetics of reactions.										
Unit	Content										Hours
1	<b>Classical Thermodynamics:</b> Partial molar properties - Chemical potential, Gibb's- Duhem equation-binary and ternary systems. Determination of partial molar quantities. Thermodynamics of real gases - Fugacity- determination of fugacity by graphical and equation of state methods. Thermodynamics of ideal and non-ideal binary mixtures, Duhem - Margulus equation applications of ideal and non-ideal mixtures. Activity and activity coefficients-standard states.										18
2	<b>Statistical thermodynamics:</b> Concepts of thermodynamic and mathematical probabilities. Assemblies, ensembles, canonical particles. Maxwell - Boltzmann, Fermi Dirac & Bose-Einstein Statistics-comparison and applications. Partition functions - evaluation of translational, vibrational and rotational partition functions for monoatomic ideal gases. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function, residual entropy, equilibrium constants and equipartition principle.										18
3	<b>Irreversible Thermodynamics:</b> Theories of conservation of mass and energy, entropy production in open systems by heat, matter and current flow, force and flux concepts. Onsager theory-validity and verification-Onsager reciprocal relationships. Electro kinetic and thermomechanical effects-Applications of irreversible thermodynamics to biological systems.										18

4	<b>Kinetics of Reactions:</b> Theories of reactions, collision theory of reaction rates, Effect of temperature on reaction rates, Unimolecular reactions-Lindeman reactions, Transition state theory--applications of ARRT to reactions between atoms and molecules - primary salt effect and secondary salt effect, homogeneous catalysis- acid- base catalysis-mechanism of acid base catalyzed reactions- Bronsted catalysis law, enzyme catalysis-Michelis-Menton catalysis.	<b>18</b>
5	<b>Kinetics of complex and fast reactions:</b> Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. Chain reactions-chain length, kinetics of $H_2 - Cl_2$ & $H_2 - Br_2$ reactions (Thermal and Photochemical reactions). Study of fast reactions-relaxation methods- temperature and pressure jump methods electric and magnetic field jump methods - stopped flow flash photolysis methods and pulse radiolysis.	<b>18</b>

CO	Course Outcomes
CO1	To explain the classical and statistical concepts of thermodynamics.
CO2	To compare and correlate the thermodynamic concepts to study the kinetics of chemical reactions.
CO3	To discuss the various thermodynamic and kinetic determination.
CO4	To evaluate the thermodynamic methods for real gases and mixtures.
CO5	To compare and correlate the thermodynamic concepts to study the kinetics of chemical reactions.
<b>Textbooks:</b>	
1.	J. Rajaram and J. C. Kuriacose, " <i>Thermodynamics for Students of Chemistry</i> ", 2 <sup>nd</sup> ed., S.L.N.Chand and Co., Jalandhar, 1986.
2.	I. M. Klotz and R. M. Rosenberg, " <i>Chemical thermodynamics</i> ", 6 <sup>th</sup> ed., W.A. Benjamin Publishers, California, 1972.
3.	M. C. Gupta, " <i>Statistical Thermodynamics</i> ", 1 <sup>st</sup> ed., New Age International Pvt. Ltd., New Delhi, 1995.
4.	K. J. Laidler, " <i>Chemical Kinetics</i> ", 3 <sup>rd</sup> ed., Pearson, Reprint - 2013.
5.	J. Rajaram and J. C. Kuriokose, " <i>Kinetics and Mechanisms of chemical transformation</i> ", 1 <sup>st</sup> ed., Macmillan India Ltd, Reprint - 2011.
<b>Reference Books:</b>	
1.	D. A. Mcqurie And J. D. Simon, " <i>Physical Chemistry - A Molecular Approach</i> ", 2 <sup>nd</sup> ed., Viva Books Pvt. Ltd., New Delhi, 1999.
2.	R. P. Rastogi and R. R. Misra, " <i>Classical Thermodynamics</i> ", 3 <sup>rd</sup> ed., Vikas Publishing, Pvt. Ltd., New Delhi, 1990.
3.	S. H. Maron and J. B. Lando, " <i>Fundamentals of Physical Chemistry</i> ", 5 <sup>th</sup> ed., Macmillan Publishers, New York, 1974
4.	L. B. Ytsiimiriski, " <i>Kinetic Methods of Analysis</i> ", 2 <sup>nd</sup> ed., Pergamom Press, 1996.
5.	Gurdeep Raj, " <i>Phase rule</i> ", 1 <sup>st</sup> ed., Goel Publishing House, 2011.
<b>Web resources:</b>	
1.	<a href="https://nptel.ac.in/courses/104/103/104103112/">https://nptel.ac.in/courses/104/103/104103112/</a>
2.	<a href="https://nptel.ac.in/courses/112103016">https://nptel.ac.in/courses/112103016</a>
3.	<a href="https://onlinecourses.nptel.ac.in/noc24_ch34/preview">https://onlinecourses.nptel.ac.in/noc24_ch34/preview</a>
4.	<a href="https://www.youtube.com/watch?v=zVEKh_mCGqw">https://www.youtube.com/watch?v=zVEKh_mCGqw</a>
5.	<a href="https://nptel.ac.in/courses/112103016">https://nptel.ac.in/courses/112103016</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	3	3	3	2	3	3	3	3	3	3
<b>CO 2</b>	2	3	3	3	3	2	3	3	3	2	3
<b>CO 3</b>	3	3	2	3	3	3	3	2	3	2	3
<b>CO 4</b>	2	3	3	3	3	2	3	3	2	3	3
<b>CO 5</b>	2	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	12	15	13	15	14	12	15	13	14	13	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>2.8</b>	<b>2.6</b>	<b>3.0</b>

**3 – Strong, 2 – Medium, 1 - Low**

1<sup>ST</sup> YEAR: SECOND SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC23P	Inorganic Chemistry Practical	Core	0	0	4	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	To understand and enhance the visual observation as an analytical tool for the quantitative estimation of ions.										
LO2	To recall the principle and theory in preparing standard solutions.										
LO3	To train the students for improving their skill in estimating the amount of ion accurately present in the solution.										
LO4	To estimate metal ions, present in the given solution accurately without using instruments.										
LO5	To determine the amount of ions, present in a binary mixture accurately.										
Unit	Content									Hours	
1, 2 & 3	<p><b>Analysis of Mixture of Cations:</b> Analysis of a mixture of four cations containing two common cations and two rare cations. Cations to be tested.</p> <p>Group-I : W and Pb</p> <p>Group-II : Mo, Cu, Bi and Cd</p> <p>Group-III : Ce, Zr, V, Cr, Fe and Ti</p> <p>Group-IV : Zn, Ni, Co and Mn</p> <p>Group-V : Ca, Ba and Sr</p> <p>Group-VI : Li and Mg</p>									36	
4 & 5	<p><b>Quantitative Analysis of the following Mixtures (by Volumetric/Gravimetric method)</b></p> <ol style="list-style-type: none"> <li>1. Estimation of Zinc and Magnesium in a mixture</li> <li>2. Estimation of Copper and Nickel in a mixture</li> <li>3. Determination of Nickel in the presence of Iron</li> <li>4. Determination of Magnesium in the presence of Iron</li> </ol>									24	

**SCHEME OF VALUATION**  
**24PCHC23P - INORGANIC CHEMISTRY PRACTICAL**

Internal assessment	: 25 Marks
External assessment	: 75 Marks
Total	: 100 Marks
Max. Marks	: 75 Marks
Analysis of Mixture of Cations	: 40 Marks
Estimation	: 20 Marks
Record	: 10 Marks
Viva voce	: 5 Marks

CO	Course Outcomes
CO1	To identify the anions and cations present in a mixture of salts.
CO2	To apply the principles of semi micro qualitative analysis to categorize acid radicals and basic radicals.
CO3	To acquire the qualitative analytical skills by selecting suitable confirmatory tests and spot tests.
CO4	To choose the appropriate chemical reagents for the detection of anions and cations.
CO5	To synthesize coordination compounds in good quality.
<b>Textbooks:</b>	
1	A. JeyaRajendran, “ <i>Microanalytical Techniques in Chemistry: Inorganic Qualitative Analysis</i> ”, 1 <sup>st</sup> ed., United Global Publishers, 2021.
2	V. V. Ramanujam, “ <i>Inorganic Semimicro Qualitative Analysis</i> ”, 3 <sup>rd</sup> ed., The National Publishing Company, Chennai, 1974.
3	G. Svehla, “ <i>Vogel’s Text book of Inorganic Qualitative Analysis</i> ”, 4 <sup>th</sup> ed., ELBS, London.
4	G. H. Jeffery, J. Bassett, J. Mendham, and R. C. Denney, “ <i>Vogel’s Textbook of Quantitative Inorganic Analysis</i> ”, 6 <sup>th</sup> ed., Wiley, 2002.
5	Gary D. Christian, “ <i>Analytical Chemistry: Principles and Techniques</i> ”, 9 <sup>th</sup> ed., Wiley, 2021.
<b>Reference Books:</b>	
1	G. Pass, and H. Sutcliffe, “ <i>Practical Inorganic Chemistry</i> ”, 1 <sup>st</sup> ed., Chapman Hall, 1965.
2	W. G. Palmer, “ <i>Experimental Inorganic Chemistry</i> ”, 1 <sup>st</sup> ed., Cambridge University Press, 1954.
3	A. I. Vogel, “ <i>Qualitative Inorganic Analysis</i> ”, 3 <sup>rd</sup> ed., Longmans, 1961.
4	F. A. Cotton and G. Wilkinson, “ <i>Advanced Inorganic Chemistry</i> ”, 6 <sup>th</sup> ed., Wiley-Interscience, 1988.
5	Gary L. Miessler and Donald A. Tarr, “ <i>Inorganic Chemistry</i> ”, 5 <sup>th</sup> ed., Pearson Prentice Hall, 2010.
<b>Web resources:</b>	
1	<a href="https://www.masterorganicchemistry.com/">https://www.masterorganicchemistry.com/</a>
2	<a href="https://nptel.ac.in/">https://nptel.ac.in/</a>
3	<a href="https://ocw.mit.edu/">https://ocw.mit.edu/</a>
4	<a href="https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.jstor.org/">https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.jstor.org/</a>
5	<a href="https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.sciencedirect.com/">https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.sciencedirect.com/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	3	3	3	2	3	3	3	3	3	3
<b>CO 2</b>	2	3	3	3	3	2	3	3	3	3	2
<b>CO 3</b>	3	3	2	2	3	3	3	2	2	3	3
<b>CO 4</b>	3	3	3	2	3	2	3	3	3	3	3
<b>CO 5</b>	3	3	2	3	3	2	3	2	2	3	3
<b>Total</b>	14	15	13	13	14	12	15	13	13	15	14
<b>Average</b>	<b>2.8</b>	<b>3.0</b>	<b>2.6</b>	<b>2.6</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>

**3 – Strong, 2 – Medium, 1 - Low**

1<sup>ST</sup> YEAR: SECOND SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC24	Bio-Inorganic Chemistry	Core	2	1	1	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the role of essential trace elements in biological systems.										
LO2	To understand the structure, function, and properties of oxygen carriers and other transport proteins.										
LO3	To study the process of nitrogen fixation and photosynthesis.										
LO4	To assess the toxicity and therapeutic applications of metals in medicine.										
LO5	To apply the properties, kinetics, and factors affecting enzyme activity.										
Unit	Content										Hours
1	<b>Essential Trace Elements:</b> Selective transport and storage of metal ions: Ferritin, Transferrin and siderophores; Sodium and potassium transport, Calcium signaling proteins. Metalloenzymes: Zinc enzymes–carboxypeptidase and carbonic anhydrase. Iron enzymes–catalase, peroxidase. Copper enzymes – superoxide dismutase, Plastocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B <sub>12</sub> coenzymes.										12
2	<b>Transport Proteins:</b> Oxygen carriers -Hemoglobin and myoglobin - Structure and oxygenation Bohr Effect. Binding of CO, NO, CN– to Myoglobin and Hemoglobin. Biological redox system: Cytochromes-Classification, Cytochrome P-450. Non-heme oxygen carriers-Hemerythrin and hemocyanin. Iron-sulphur proteins- Rubredoxin and Ferredoxin- Structure and classification.										12
3	<b>Nitrogen Fixation:</b> Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase redox property - Dinitrogen complexes - transition metal complexes of dinitrogen - nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Photosynthesis: photosystem-I and photosystemII-chlorophylls structure and function.										12
4	<b>Metals in Medicine:</b> Metal Toxicity of Hg, Cd, Zn, Pb, As, Sb. Therapeutic compounds: Vanadium-based diabetes drugs; Platinum-Containing anticancer agents. Chelation therapy: Cancer treatment. Diagnostic agents: Technetium imaging agents, Gadolinium MRI imaging agents. Temperature and critical magnetic field.										12
5	<b>Enzymes:</b> Introduction and properties -nomenclature and classification. Enzyme kinetics, free energy of activation and the effects of catalysis. Michelis - Menton equation - Effect of pH, temperature on enzyme reactions. Factors contributing to the efficiency of enzyme.										12

CO	Course Outcomes
CO1	To explain the role of essential trace elements in biological systems, including their transport, storage, and function in metalloenzymes.
CO2	To describe the structure, function, and properties of oxygen carriers and other transport proteins involved in redox reactions.
CO3	To understand the process of nitrogen fixation and photosynthesis, including the role of nitrogenase enzymes and photosystems.
CO4	To evaluate the toxicity and therapeutic applications of metals in medicine, such as chelation therapy and diagnostic agents.
CO5	To explain the properties, kinetics, and factors affecting enzyme activity, as well as the Michaelis-Menten equation.
<b>Textbooks:</b>	
1	I. Bertini, A. Sigel, and H. Sigel, " <i>Metal Ions in Biological Systems: Volume 42: Transport and Storage of Metal Ions: Ferritins, Transferrins, and Siderophores</i> ", 1 <sup>st</sup> ed., Springer, 2004.
2	R. E. Dickerson and I. Geis, " <i>Emoglobin: Structure, Function, and Evolution</i> ", 1 <sup>st</sup> ed., Benjamin/Cummings Publishing Company, 1983.
3	B. K. Burgess and D. J. Lowe, " <i>Nitrogenase: A Molybdenum-Iron Enzyme</i> ", 1 <sup>st</sup> ed., Wiley-VCH, 1996.
4	C. F. Meares, " <i>Metal Ions in Biological Systems: Volume 28: Chemistry and Biological Applications of Vanadium</i> ", 1 <sup>st</sup> ed., Springer, 1990.
5	A. Fersht, " <i>Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Engineering</i> ", 3 <sup>rd</sup> ed., W. H. Freeman, 2003.
<b>Reference Books:</b>	
1	J. J. R. Fraústo da Silva and R. J. P. Williams, " <i>The Biological Chemistry of Elements: The Inorganic Chemistry of Life</i> ", 2 <sup>nd</sup> ed., Oxford University Press, 2009.
2	L. Stryer, " <i>Biochemistry</i> ", 5 <sup>th</sup> ed., W. H. Freeman, 2002.
3	R. H. Burris, " <i>Nitrogen Fixation: Principles and Practice</i> ", 1 <sup>st</sup> ed., Chapman & Hall, 1990.
4	E. A. Liberles, " <i>Medicinal Inorganic Chemistry: A Bioinorganic Approach</i> ", 2 <sup>nd</sup> ed., John Wiley & Sons, 2009.
5	D. E. Koshland Jr., " <i>Enzyme Catalysis</i> ", 1 <sup>st</sup> ed., W. H. Freeman, 1970.
<b>Web resources:</b>	
1	<a href="https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://pubchem.ncbi.nlm.nih.gov/">https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://pubchem.ncbi.nlm.nih.gov/</a>
2	<a href="https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.rcsb.org/">https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.rcsb.org/</a>
3	<a href="https://www.britannica.com/summary/nitrogen-fixation">https://www.britannica.com/summary/nitrogen-fixation</a>
4	<a href="https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3584006/">https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3584006/</a>
5	<a href="https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.enzyme.com/">https://www.google.com/url?sa=E&amp;source=gmail&amp;q=https://www.enzyme.com/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	3	3	3	2	3	3	3	2	3	3
<b>CO 2</b>	2	3	3	3	3	2	3	3	3	2	3
<b>CO 3</b>	3	3	2	3	3	3	3	2	3	2	3
<b>CO 4</b>	2	3	3	3	3	2	3	3	2	3	3
<b>CO 5</b>	2	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	12	15	13	15	14	12	15	13	13	13	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>2.6</b>	<b>2.6</b>	<b>3.0</b>

**3 – Strong, 2 – Medium, 1 - Low**

1<sup>ST</sup> YEAR: SECOND SEMESTER

Course Code	Course name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHE21	Medicinal Chemistry	Elective 3	2	1	1	0	3	4	25	75	100
<b>Learning objectives</b>											
LO1	To study the chemistry behind the development of pharmaceutical materials.										
LO2	To gain knowledge on mechanism and action of drugs.										
LO3	To understand the need of antibiotics and usage of drugs.										
LO4	To apply knowledge of CNS pharmacology to the treatment of various disorders.										
LO5	To identify and apply the action of various antibiotics.										
Unit	Content										Hours
1	<b>Introduction to receptors:</b> Introduction, targets, Agonist, antagonist, partial agonist. Receptors, Receptor types, Theories of Drug receptor interaction, Drug synergism, Drug resistance, physicochemical factors influencing drug action.										12
2	<b>Antibiotics:</b> Introduction, Targets of antibiotics action, classification of antibiotics, enzyme-based mechanism of action, SAR of penicillins and tetracyclins, clinical application of penicillins, cephalosporin. Current trends in antibiotic therapy.										12
3	<b>Antihypertensive agents and diuretics:</b> Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride.										12
4	<b>Central Nervous System (CNS) Drugs:</b> Introduction to the CNS, CNS Disorders - Anxiety, depression, schizophrenia, Parkinson's disease, Alzheimer's disease, epilepsy. Classes of CNS Drugs - Antidepressants, Antipsychotics, Anxiolytics, Anticonvulsants, Analgesics, Stimulants. Mechanisms of action, Drug metabolism and Pharmacokinetics, Therapeutic applications, various adverse effects.										12
5	<b>Analgesics, Antipyretics and Anti-inflammatory Drugs:</b> Introduction, mechanism of inflammation, classification and mechanism of action - Paracetamol, Ibuprofen, Diclofenac, Naproxen, Indomethacin, Phenylbutazone and Meperidine. Medicinal chemistry of antidiabetic agents - Introduction, types of diabetics, drugs used for the treatment, chemical classification, mechanism of action, treatment of diabetic mellitus. Chemistry of insulin and sulfonyl urea.										12

CO	Course Outcomes
CO1	To predict a drugs properties based on its structure.
CO2	To describe the factors that affect its absorption, distribution, metabolism, and excretion, and hence the considerations to be made in drug design.
CO3	To explain the relationship between drug's chemical structure and its therapeutic properties.
CO4	To critically evaluate the mechanisms of action, therapeutic applications, and potential adverse effects of various CNS drugs.
CO5	To identify different targets for the development of new drugs for the treatment of infectious and GIT.
<b>Textbooks:</b>	
1	Jayashree Ghosh, " <i>A text book of Pharmaceutical Chemistry</i> ", 1 <sup>st</sup> ed., S. Chand and Co. Ltd, 1999.
2	Wilson, Charles Owens; Beale, John Marlowe; Block, John H, Lippincott William, " <i>Wilson's Comprehensive Textbook of Ophthalmology</i> ", 12 <sup>th</sup> ed., Lippincott Williams & Wilkins, 2011.
3	Graham L. Patrick, " <i>An Introduction to Medicinal Chemistry</i> ", 5 <sup>th</sup> ed., Oxford University Press, 2013.
4	O. LeRoy, " <i>Natural and synthetic organic medicinal compounds</i> ", 1 <sup>st</sup> ed., Ealemi, 1976.
5	S. Ashutosh Kar, " <i>Medicinal Chemistry</i> ", 1 <sup>st</sup> ed., Wiley Eastern Ltd, New Delhi, 1993.
<b>Reference Books:</b>	
1	Lippincott Williams, " <i>Foye's Principles of Medicinal Chemistry</i> ", 7 <sup>th</sup> ed., 2012.
2	Donald J. Abraham, David P. Rotella, Alfred Burger, " <i>Burger's Medicinal Chemistry, Drug Discovery and Development</i> ", 6 <sup>th</sup> ed., Academic press, 2010.
3	John M. Beale Jr and John M. Block, " <i>Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry</i> ", 12 <sup>th</sup> ed., Wolters Kluwer, 2011.
4	P. Parimoo, " <i>A Textbook of Medical Chemistry</i> ", 1 <sup>st</sup> ed., CBS Publishers, New Delhi, 1995.
5	S. Ramakrishnan, K. G. Prasanna and R. Rajan, " <i>Textbook of Medical Biochemistry</i> ", 3 <sup>rd</sup> ed., Orient Longman. Hyderabad, 1993.
<b>Web resources:</b>	
1	<a href="https://www.ncbi.nlm.nih.gov/books/NBK482447/">https://www.ncbi.nlm.nih.gov/books/NBK482447/</a>
2	<a href="https://reference.medscape.com/drugs/antimicrobials">https://reference.medscape.com/drugs/antimicrobials</a>
3	<a href="https://www.classcentral.com/course/swayam-medicinal-chemistry-">https://www.classcentral.com/course/swayam-medicinal-chemistry-</a>
4	<a href="https://www.webmd.com/drugs/2/drug-15964-3/analgesic-oral/aspirin-oral/details">https://www.webmd.com/drugs/2/drug-15964-3/analgesic-oral/aspirin-oral/details</a>
5	<a href="https://hopkinsdiabetesinfo.org/type-2-meds/">https://hopkinsdiabetesinfo.org/type-2-meds/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	2	3	3	2	3	3	3	3	3	3
<b>CO 2</b>	3	3	3	3	3	2	2	3	3	3	3
<b>CO 3</b>	3	2	2	3	3	3	2	2	3	3	3
<b>CO 4</b>	3	2	3	3	2	2	3	3	3	3	3
<b>CO 5</b>	3	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	15	12	13	15	13	12	13	13	13	12	13
<b>Average</b>	<b>3.0</b>	<b>2.4</b>	<b>2.6</b>	<b>3.0</b>	<b>2.6</b>	<b>2.4</b>	<b>2.6</b>	<b>2.6</b>	<b>2.6</b>	<b>2.4</b>	<b>2.6</b>

**3 – Strong, 2 – Medium, 1 - Low**

1<sup>ST</sup> YEAR: SECOND SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHE22	Green Chemistry	Elective 4	2	1	1	0	3	4	25	75	100
<b>Learning objectives</b>											
LO1	To discuss the principles of green chemistry.										
LO2	To propose green solutions for chemical energy storage and conversion.										
LO3	To understand soil properties and microbial roles in soil processes.										
LO4	Propose solutions for pollution prevention in Industrial chemical and fuel production, Automotive industry and Shipping industries.										
LO5	Propose green solutions for industrial production of Surfactants, Organic and Inorganic chemicals.										
Unit	Content										Hours
1	<b>Introduction to Green Chemistry:</b> Introduction - Need, Goals and Limitations Green Chemistry - Chemical accidents, terminologies, International green chemistry organizations - Twelve principles of Green Chemistry with examples.										12
2	<b>Green Synthesis and Reagents:</b> Choice of starting materials - reagents, catalysts and solvents - Green chemistry in everyday life - Designing green synthesis - Green reagents - Green solvents - Criteria, general methods of preparation, effect on organic reaction - Supercritical carbon dioxide - Green synthesis.										12
3	<b>Soil Chemistry:</b> Soil - Classification, properties, soil texture, soil water, soil temperature, soil minerals, buffering of soil, soil fertility and soil formation - Types of soil enzymes - Dehydrogenases, phosphatases, ureases - Role of enzymes in soil processes - Nutrient cycling, organic matter decomposition.										12
4	<b>Phase Transfer Catalysis and Green Synthesis:</b> Phase transfer catalysis in green synthesis - Oxidation using hydrogen peroxide, crown ethers, esterification, saponification, anhydride formation, elimination reaction and displacement reaction.										12
5	<b>Green Synthesis Using Advanced Techniques:</b> Microwave induced green synthesis - Principle, Instrumentation and applications - Sonochemistry – Instrumentation - Cavitation theory - Combined microwave and sonochemical synthesis - Environmental and economic benefits of green synthesis.										12

CO	Course Outcomes
CO1	To recall the basic chemical techniques used in conventional industrial preparations and in green innovations.
CO2	To understand the various techniques used in chemical industries and in laboratory.
CO3	To gain knowledge of soil chemistry for agricultural and environmental management.
CO4	To apply the principles of PTC, microwave and ultrasonic assisted organic synthesis.
CO5	To design and synthesize new organic compounds by green methods.
<b>Textbooks:</b>	
1	V. K. Ahluwalia and M. R. Kidwai, " <i>New Trends in Green Chemistry</i> ", 1 <sup>st</sup> ed., Anamalaya Publishers, 2005.
2	W. L. McCabe, J. C. Smith and P. Harriott, " <i>Unit Operations of Chemical Engineering</i> ", 7 <sup>th</sup> ed., McGraw-Hill, New Delhi, 2005.
3	J. M. Swan and D. St. C. Black, " <i>Organometallics in Organic Synthesis</i> ", 1 <sup>st</sup> ed., Chapman Hall, 1974.
4	V. K. Ahluwalia and R. Aggarwal, " <i>Organic Synthesis: Special Techniques</i> ", 1 <sup>st</sup> ed., Narosa Publishing House, New Delhi, 2001.
5	A. K. De, " <i>Environmental Chemistry</i> ", 1 <sup>st</sup> ed., New Age Publications, 2017.
<b>Reference Books:</b>	
1	P. T. Anastas and J. K. Warner, " <i>Oxford Green Chemistry -Theory and Practical</i> ", 1 <sup>st</sup> ed., University Press, 1998.
2	A. S. Matlack, " <i>Introduction to Green Chemistry</i> ", 1 <sup>st</sup> ed., Marcel Dekker, 2001.
3	M. C. Cann and M. E. Connely, " <i>Real-World Cases in Green Chemistry</i> ", 1 <sup>st</sup> ed., American Chemical Society, Washington, 2000.
4	M. A. Ryan and M. Tinnesand, " <i>Introduction to Green Chemistry</i> ", 1 <sup>st</sup> ed., American Chemical Society Washington, 2002.
5	Chandrakanta Bandyopadhyay, " <i>An Insight into Green Chemistry</i> ", 1 <sup>st</sup> ed., Books and Allied (P) Ltd, 2019.
<b>Web resources:</b>	
1	<a href="https://www.acs.org/greenchemistry.html">https://www.acs.org/greenchemistry.html</a>
2	<a href="https://www.rsc.org/journals-books-databases/about-journals/green-chemistry/">https://www.rsc.org/journals-books-databases/about-journals/green-chemistry/</a>
3	<a href="https://www.acs.org/greenchemistry.html">https://www.acs.org/greenchemistry.html</a>
4	<a href="https://www.nsf.gov/div/index.jsp?div=CHE">https://www.nsf.gov/div/index.jsp?div=CHE</a>
5	<a href="https://chemistry.berkeley.edu/topics/green-chemistry">https://chemistry.berkeley.edu/topics/green-chemistry</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	3	3	2	2	3	3	3	3	3	3
<b>CO 2</b>	2	3	3	3	2	2	2	3	3	3	3
<b>CO 3</b>	3	2	2	3	3	3	3	3	3	3	2
<b>CO 4</b>	2	3	2	3	2	2	2	3	3	3	3
<b>CO 5</b>	2	2	2	3	3	2	3	3	3	3	3
<b>Total</b>	12	13	12	14	12	12	13	15	15	15	14
<b>Average</b>	<b>2.4</b>	<b>2.6</b>	<b>2.4</b>	<b>3.0</b>	<b>2.4</b>	<b>2.4</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>2.8</b>

**3 – Strong, 2 – Medium, 1 - Low**

1<sup>ST</sup> YEAR: SECOND SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHE23	Industrial Chemistry	Elective 5	2	1	1	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	To recall basic statistical concepts, control chart types, and quality assurance principles.										
LO2	To explain the concept of relative volatility in distillation.										
LO3	To calculate the material balance for a filtration process.										
LO4	To break down the steps involved in extracting a metal from its ore.										
LO5	To judge the effectiveness of different personal protective equipment.										
Unit	Content										Hours
1	<b>Statistical Quality Control Techniques:</b> Statistical treatment of data - Control charts. Quality Assurance: Elements of quality Assurance, Quality Management System: ISO 9001:2000 QMS and ISO 14000 Series of Standards. Six Sigma Approach to Quality: Applying Six Sigma to chemical Industries. Good Laboratory Practices: Principles of GLP, GMP in Chemical and Pharmaceutical Industries.										12
2	<b>Distillation Unit Process:</b> Types of distillation processes, concept of batch and continuous distillation, simple steam distillation - advantages, disadvantages and application. Evaporation and Drying - factors affecting the rate of evaporation and choice of evaporators, application of evaporation, equipment- climbing film evaporator, drying process, free moisture, bound moisture and equilibrium moisture content, purpose of drying, equipment- rotary dryer.										12
3	<b>Purification and Filtration:</b> Filter media and filter aids, characteristics of ideal filter aids, factors affecting the rate of filtration and choice of filter media, equipment - bag filters and candle filters. Material Balance - steady and unsteady state of flow processes, material balance equation, flow/block diagrams for various industrially important chemical engineering operations - distillation and crystallization.										12

4	<p><b>Metallurgical Operations:</b> Crushing and pulverization, concentration methods, gravity separation, magnetic concentration, froth flotation process, chemical methods - calcination and roasting, reduction using carbon and carbon monoxide, Alumino thermite reduction, auto reduction, refining methods - polling, parting and electrolyte refining. Metallurgical Extraction - Lead from galena, Aluminum from bauxite and Zinc from Zinc blende.</p>	<b>12</b>
5	<p><b>Industrial Hygiene &amp; Safety:</b> Personal protective equipments. Industrial hazards and Safety: Process hazards checklists, hazard surveys, safety program, Hazop safety reviews. Industrial pollution: Classification of hazardous chemicals, storage, transportation, handling, risk assessments, challenges/solutions. Eco-friendly effluents disposal: advanced waste water treatment, effluent quality standards and laws. Sensors: Concept of molecular sensors its properties and applications.</p>	<b>12</b>

CO	Course Outcomes
CO1	Able to use statistical tools to analyze process data and identify quality issues.
CO2	To design and optimize distillation processes for various applications.
CO3	To select appropriate purification and filtration techniques for different materials.
CO4	To evaluate the feasibility of extracting metals from different ores.
CO5	To implement effective industrial hygiene and safety practices.
<b>Textbooks:</b>	
1	Douglas C. Montgomery, “ <i>Statistical Quality Control: A Modern Introduction</i> , 9 <sup>th</sup> ed., John Wiley & Sons, 2018.
2	J. D. Perry, “ <i>Distillation: Principles and Applications</i> ”, 5 <sup>th</sup> ed., McGraw-Hill Education, 2015.
3	Warren L. McCabe, Julian C. Smith, and Peter Harriott, “ <i>Unit Operations of Chemical Engineering</i> ”, 8 <sup>th</sup> ed., McGraw-Hill Education, 2016.
4	J. C. Agarwal, “ <i>The Extractive Metallurgy of Copper</i> ”, 3 <sup>rd</sup> ed., Elsevier, 2013.
5	Kenneth R. Holness and David H. Slone, “ <i>Industrial Hygiene: Principles and Practices</i> ”, 3 <sup>rd</sup> ed., John Wiley & Sons, 2015.
<b>Reference Books:</b>	
1	George E. P. Box, William G. Hunter, and J. Stuart Hunter, “ <i>Statistical Methods for Engineers and Scientists</i> ”, 3 <sup>rd</sup> ed., John Wiley & Sons, 2005.
2	J. M. Coulson and J.F. Richardson, “ <i>Separation Processes in Chemical Engineering</i> ”, 3 <sup>rd</sup> ed., Pergamon Press, 1991.
3	Robert H. Perry, Don W. Green, and James O. Maloney, “ <i>Perry's Chemical Engineers' Handbook</i> ”, 9 <sup>th</sup> ed., McGraw-Hill Education, 2019.
4	A. K. Biswas and W.G. Davenport, “ <i>Extractive Metallurgy: Principles and Practice</i> ”, 4 <sup>th</sup> ed., Elsevier, 2013.
5	Clayton W. Hoyle, Jr., and Kenneth R. Holness, “ <i>Industrial Hygiene: A Comprehensive Textbook</i> ”, 4 <sup>th</sup> ed., John Wiley & Sons, 2013.
<b>Web resources:</b>	
1	<a href="https://www.projectmanager.com/blog/quality-assurance-and-testing">https://www.projectmanager.com/blog/quality-assurance-and-testing</a>
2	<a href="https://www.britannica.com/summary/distillation">https://www.britannica.com/summary/distillation</a>
3	<a href="https://www.britannica.com/dictionary/filtration">https://www.britannica.com/dictionary/filtration</a>
4	<a href="https://en.wikipedia.org/wiki/Metallurgy">https://en.wikipedia.org/wiki/Metallurgy</a>
5	<a href="https://www.osha.gov/">https://www.osha.gov/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	2	3	3	2	3	2	3	3	3	2
<b>CO 2</b>	3	3	3	2	3	2	2	3	3	3	3
<b>CO 3</b>	3	2	2	3	3	3	3	3	3	3	3
<b>CO 4</b>	3	3	3	3	3	2	2	3	2	3	3
<b>CO 5</b>	3	3	2	3	3	2	2	3	3	3	3
<b>Total</b>	15	13	13	14	14	12	11	15	14	15	14
<b>Average</b>	<b>3.0</b>	<b>2.6</b>	<b>2.6</b>	<b>2.8</b>	<b>2.8</b>	<b>2.4</b>	<b>2.2</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3 – Strong, 2 – Medium, 1 - Low**

1<sup>ST</sup> YEAR: SECOND SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHE24	Materials Science	Elective 6	2	1	1	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the crystal structure, growth methods and X-ray scattering.										
LO2	To explain the optical, dielectric and diffusion properties of crystals.										
LO3	To recognize the basis of semiconductors, superconductivity materials and magnets.										
LO4	To study the synthesis, classification and applications of nanomaterials.										
LO5	To learn about the importance of materials used for renewable energy conversion.										
Unit	Content										Hours
1	<p><b>Crystallography:</b> Symmetry - unit cell and Miller indices - crystal systems - Bravais lattices - point groups and space groups - X-ray diffraction-Laue equations-Bragg's law-reciprocal lattice and its application to geometrical crystallography. Crystal structure–powder and single crystal applications. Electron charge density maps, neutron diffraction-method and applications.</p>										12
2	<p><b>Crystal Growth Methods:</b> Nucleation–equilibrium stability and metastable state. Single crystal –Low and high temperature, solution growth– Gel and sol-gel. Crystal growth methods- nucleation–equilibrium stability and metastable state. Melt growth - Bridgeman-Stockbarger, Czochralski methods. Flux technique, physical and chemical vapour transport. Lorentz and polarization factor - primary and secondary extinctions.</p>										12
3	<p><b>Properties of Crystals:</b> Optical studies - Electromagnetic spectrum (qualitative) refractive index – reflectance – transparency, translucency and opacity. Types of luminescence – photo-, electro-, and injection luminescence, LEDs – organic, Inorganic and polymer LED materials - Applications. Dielectric studies- Polarisation - electronic, ionic, orientation, and space charge polarisation. Effect of temperature, dielectric constant, dielectric loss. Types of dielectric breakdown–intrinsic, thermal, discharge, electrochemical and defect breakdown.</p>										12

4	<p><b>Special Materials:</b> Superconductivity: Meissner effect, Critical temperature and critical magnetic Field, Type I and II superconductors, BCS theory-Cooper pair, Applications. Soft and hard magnets – Domain theory Hysteresis Loop-Applications. Magneto and giant magnetoresistance. Ferro, ferri and antiferromagnetic materials applications, magnetic parameters for recording applications. Ferro-, Piezo-, and pyro electric materials – properties and applications. Shape memory Alloys-characteristics and applications, Non-linear optics Second Harmonic Generators.</p>	12
5	<p><b>Materials for Renewable Energy Conversion:</b> Solar Cells: Organic, bilayer, bulk heterojunction, polymer, perovskite based. Solar energy conversion: lamellar solids and thin films, dye-sensitized photo voltaic cells, coordination compounds anchored onto semiconductor surfaces - Ru(II) and Os(II) polypyridyl complexes. Photochemical activation and splitting of water, CO<sub>2</sub> and N<sub>2</sub>. Manganese based photo systems for water-splitting. Complexes of Rh, Ru, Pd and Pt - photochemical generation of hydrogen from alcohol.</p>	12

CO	Course Outcomes
CO1	To understand and recall the synthesis and characteristics of crystal structures, semiconductors, magnets, nanomaterials and renewable energy materials.
CO2	To integrate and assess the structure of different materials and their properties.
CO3	To analyse and identify new materials for energy applications.
CO4	To explain the importance of crystal structures, piezoelectric and pyroelectric materials, nanomaterials, hard and soft magnets, superconductors, solar cells, electrodes, LED uses, structures and synthesis.
CO5	To design and develop new materials with improved property for energy applications.
<b>Textbooks:</b>	
1	S. Mohan and V. Arjunan, " <i>Principles of Materials Science</i> ", 2 <sup>nd</sup> ed., MJP Publishers, 2016.
2	Arumugam, " <i>Materials Science</i> ", 2 <sup>nd</sup> ed., Anuradha Publications, 2007.
3	Giacavazzo et. al., " <i>Fundamentals of Crystallography</i> ", 2 <sup>nd</sup> ed., International Union of Crystallography, Oxford Science Publications, 2010.
4	Woolfson, " <i>An Introduction to Crystallography</i> ", 3 <sup>rd</sup> ed., Cambridge University Press, 2012.
5	James F. Shackelford and Madanapalli K. Muralidhara, " <i>Introduction to Materials Science for Engineers</i> ", 6 <sup>th</sup> ed., Pearson Press, 2007.
<b>Reference Books:</b>	
1	M. G. Arora, " <i>Solid State Chemistry</i> ", 2 <sup>nd</sup> ., Anmol Publications, New Delhi, 2001.
2	Q. K. Puri and V. K. Babbar, " <i>Solid State Physics</i> ", 5 <sup>th</sup> ed., S Chand and Company Ltd, 2001.
3	C. Kittel, " <i>Solid State Physics</i> ", 5 <sup>th</sup> ed., John-Wiley and Sons, NY, 1966.
4	E. P. Meyers, " <i>Introductory Solid State Physics</i> ", 1 <sup>st</sup> ed., Viva Books Private Ltd., 1998.
5	A. R. West, " <i>Solid State Chemistry and Applications</i> ", 2 <sup>nd</sup> ed., John-Wiley and Sons, 1987.
<b>Web resources:</b>	
1	<a href="https://en.wikipedia.org/wiki/Crystal_structure">https://en.wikipedia.org/wiki/Crystal_structure</a>
2	<a href="https://en.wikipedia.org/wiki/Czochralski_method">https://en.wikipedia.org/wiki/Czochralski_method</a>
3	<a href="https://en.wikipedia.org/wiki/Dielectric">https://en.wikipedia.org/wiki/Dielectric</a>
4	<a href="https://en.wikipedia.org/wiki/Superconductivity">https://en.wikipedia.org/wiki/Superconductivity</a>
5	<a href="https://en.wikipedia.org/wiki/Solar_cell">https://en.wikipedia.org/wiki/Solar_cell</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	3	3	2	2	3	3	2	2	3	2
<b>CO 2</b>	2	2	3	3	3	3	3	3	3	3	3
<b>CO 3</b>	3	3	2	2	3	3	3	2	3	3	3
<b>CO 4</b>	3	3	3	2	3	3	2	3	3	3	2
<b>CO 5</b>	2	2	2	3	3	3	3	3	3	3	3
<b>Total</b>	13	13	13	12	14	15	14	13	14	15	13
<b>Average</b>	<b>2.6</b>	<b>2.6</b>	<b>2.6</b>	<b>2.4</b>	<b>2.8</b>	<b>3.0</b>	<b>2.8</b>	<b>2.6</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>

**3 – Strong, 2 – Medium, 1 - Low**

1<sup>ST</sup> YEAR: SECOND SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHS21	Cosmetic Chemistry	SEC-1 (NME)	1	0	1	0	2	2	25	75	100
<b>Learning Objectives</b>											
LO1	To understand formulations of various types of cosmetics.										
LO2	To understand the makeup preparations and personal grooming.										
LO3	To knowledge about regulatory bodies and rules governing personal care products.										
LO4	To understand the importance and health benefits of essential oils in cosmetic industries.										
LO5	To understand beauty treatments.										
Unit	Content										Hours
1	<p><b>Skin Care:</b> Nutrition of the skin, skincare and cleansing of the skin; face powder – ingredients; creams and lotions – cleansing, moisturizing all purpose, shaving and sunscreen (formulation only); Gels – formulation and advantages.</p> <p>Lab Practice: Prepare a hand sanitizer.</p>										6
2	<p><b>Hair Care and Dental Care:</b> Shampoos – types – powder, cream, liquid, gel – ingredients; conditioner – types – ingredients. Toothpastes – ingredients – mouthwash.</p> <p>Lab Practice: Formulate a basic Shampoos, prepare a basic toothpaste and mouthwash.</p>										6
3	<p><b>Make Up:</b> Base – foundation – types – ingredients; lipstick, eyeliner, mascara, eye shadow, concealers, rouge.</p> <p>Lab Practice: Synthesize a basic lip balm.</p>										6
4	<p><b>Perfumes:</b> Classification of perfumes - Natural – plant origin – parts of the plant used, chief constituents; synthetic – classification emphasizing characteristics – esters – alcohols – aldehydes – ketones.</p> <p>Lab Practice: Prepare a customized perfume of body spray.</p>										6
5	<p><b>Beauty Treatments:</b> Facials - types – advantages – disadvantages; facemasks – types; bleach - types – advantages – disadvantages; shaping the eyebrows; hair coloring and dyeing; pedicure, manicure - advantages – disadvantages.</p> <p>Lab Practice: Prepare a clay-based face mask.</p>										6

CO	Course Outcomes
CO1	Know about the composition of various cosmetic products.
CO2	Understand chemical aspects and applications of hair care and dental care and skincare products.
CO3	Understand chemical aspects and applications of perfumes and skincare products.
CO4	To understand the methods of beauty treatments their advantages and disadvantage.
CO5	Understand the hazards of cosmetic products.
<b>Textbooks:</b>	
1	Thankamma Jacob, “ <i>Foods, Drugs and Cosmetics – A consumer guide</i> ”, Macmillan Publication, London, 1997.
2	Zoe Diana Draelos (Editor) and Lauren Thaman (Editor), “ <i>Cosmetic Formulation of Skin Care Products</i> ”, CRC Press, 2 <sup>nd</sup> ed., 2006.
3	Meyer R and Rosen (Editor), “ <i>Harry's Cosmeticology</i> ”, Chemical Publishing Company, 9 <sup>th</sup> ed., 2019.
4	André O, Barel (Editor), Marc Paye (Editor), Howard I and Maibach (Editor), “ <i>Handbook of Cosmetic Science and Technology</i> ”, CRC Press, 3 <sup>rd</sup> ed., 2014.
5	Maison G and deNavarre, “ <i>The Chemistry and Manufacture of Cosmetics</i> ”, Van Nostrand Reinhold, 2 <sup>nd</sup> ed., 2009.
<b>Reference Books:</b>	
1	Wilkinson J. B. E. and Moore R. J, “ <i>Harry's Cosmeticology</i> ”, 7 <sup>th</sup> ed., Chemical Publishers, London, 1997.
2	George Howard, “ <i>Principles and Practice of Perfumes and Cosmetics</i> ”, 1987.
3	Milady, “ <i>Milady Standard Cosmetology</i> ”, Cengage Learning Publishers, 13 <sup>th</sup> ed., 2016.
4	Hiroshi Iwata, “ <i>Formulas, Ingredients and Production of Cosmetics: Technology of Skin- and Hair-Care Products in Japan</i> ”, Springer, 1 <sup>st</sup> ed., 2016.
5	Zoe Diana Draelos, “ <i>Cosmetic Dermatology: Products and Procedures</i> ”, Wiley-Blackwell Co., 2 <sup>nd</sup> ed., 2016.
<b>Web resources:</b>	
1	<a href="https://www.paulaschoice.com/ingredient-dictionary">https://www.paulaschoice.com/ingredient-dictionary</a>
2	<a href="https://www.thespruce.com/about-us-4776800">https://www.thespruce.com/about-us-4776800</a>
3	<a href="https://www.makeupalley.com/categories/foundation-makeup">https://www.makeupalley.com/categories/foundation-makeup</a>
4	<a href="https://perfumesociety.org/">https://perfumesociety.org/</a>
5	<a href="https://www.aad.org/public/everyday-care">https://www.aad.org/public/everyday-care</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	3	3	3	3	3	3	2	2	3	3
<b>CO 2</b>	2	3	3	3	2	3	3	2	2	3	3
<b>CO 3</b>	3	3	3	2	3	3	3	2	3	2	3
<b>CO 4</b>	3	3	3	3	3	3	3	2	3	3	3
<b>CO 5</b>	3	2	3	3	3	3	3	2	3	2	3
<b>Total</b>	14	14	15	14	14	15	15	10	13	13	15
<b>Average</b>	<b>2.8</b>	<b>2.8</b>	<b>3.0</b>	<b>2.8</b>	<b>2.8</b>	<b>3.0</b>	<b>3.0</b>	<b>2.0</b>	<b>2.6</b>	<b>2.6</b>	<b>3.0</b>

**3 – Strong, 2 – Medium, 1 - Low**

2<sup>ND</sup> YEAR: THIRD SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC31	Organic Synthesis and Photochemistry	Core	3	1	2	0	5	6	25	75	100
<b>Learning Objectives</b>											
LO1	To design, evaluate, and retrosynthesize organic routes, using key concepts and calculating yields.										
LO2	To design routes for functionalized compounds, using and managing protecting groups.										
LO3	To predict outcomes and explain mechanisms of pericyclic reactions.										
LO4	To describe excitation principles and predict excited ketone reactions.										
LO5	To explain and predict the various photochemical reactions.										
Unit	Content										Hours
1	<b>Planning an Organic Synthesis and Control Elements:</b> Linear Vs convergent synthesis. synthesis based on Umpolung concepts of Seebeck effect, regiospecific control elements. Use of protective groups, activating groups and bridging elements. Examples on retrosynthetic approach, calculation of yield, advantages of convergent synthesis.										18
2	<b>Organic Synthetic Methodology:</b> Retrosynthetic analysis: Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach, disconnection approach for small carbocyclic rings. Protection of hydroxyl, carboxyl, carbonyl, and amino groups by retrosynthetic approach. Protection and deprotection in synthesis.										18
3	<b>Pericyclic Reactions:</b> Woodward Hoffmann rules; The FMO, PMO method and correlation diagrams. Cycloaddition and retrocycloaddition reactions: [2+2], [2+4], Cationic, anionic, and 1,3-dipolar cycloadditions. Cheletropic reactions. Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigmatropic rearrangements: (1,3), (1,5), (3,3) and (5,5)-carbon migrations.										18
4	<b>Organic Photochemistry-I:</b> Photochemical excitation: Experimental techniques, electronic transitions, Jablonskii diagrams, intersystem crossings, energy transfer processes, Stern-Volmer equation. Reactions of electronically excited ketones: triplets; Norrish type-I and type-II cleavage reactions, photo reductions, Paterno-Buchi reactions.										18
5	<b>Organic Photochemistry-II:</b> Cis-trans isomerisation, Photon energy transfer reactions, Photo cycloadditions, Barton's reactions. Photochemical oxidation photosensitization of butadiene, photodimerization. Photolysis of cyclic ketones and aldehydes, Photo induced reactions of $\alpha$ , $\beta$ -unsaturated ketones.										18

CO	Course Outcomes
	<b>Students will be able to</b>
CO1	Design efficient synthetic routes for target molecules, utilizing retrosynthetic analysis, key synthetic strategies, and yield calculations.
CO2	Assess and execute synthetic strategies for complex molecules, employing appropriate protecting groups and reaction conditions.
CO3	Predict the stereochemical outcomes and explain the mechanisms of pericyclic reactions using relevant theoretical frameworks.
CO4	Describe the principles of photochemical excitation and predict the reactions of electronically excited ketones.
CO5	Explain and predict the mechanisms and products of a range of photochemical reactions.
<b>Textbooks:</b>	
1.	J. March and M. Smith, " <i>Advanced Organic Chemistry</i> ", 5 <sup>th</sup> ed., John-Wiley and Sons, 2007.
2.	Clayden, Greeves and Warren, " <i>Organic Chemistry</i> ", 2 <sup>nd</sup> ed., Oxford University Press, 2016.
3.	M. B. Smith, " <i>Organic Synthesis</i> ", 3 <sup>rd</sup> ed., Mc Graw Hill International, 2011.
4.	S. Warren, " <i>Designing Organic Syntheses</i> ", 2 <sup>nd</sup> ed., John Wiley & Sons, 2008.
5.	N. J. Turro, V. Ramamurthy, and J.C. Scaiano, " <i>Modern Molecular Photochemistry</i> ", 2 <sup>nd</sup> ed., University Science Books, 2010.
<b>Reference Books:</b>	
1.	Stuart Warren & Paul Wyatt, " <i>Organic Synthesis: The Disconnection Approach</i> ", 2 <sup>nd</sup> ed., Wiley, 2008.
2.	J.A. Joule, G.F. Smith, " <i>Heterocyclic Chemistry</i> ", 2 <sup>nd</sup> ed., Garden City Press, Great Britain, 2004.
3.	Nicholas J. Turro, " <i>Modern Molecular Photochemistry of Organic Molecules</i> ", University Science Books, 1991.
4.	H. O. House, " <i>Modern Synthetic reactions</i> ", 9 <sup>th</sup> ed., W.A. Benjamin Inc, 1972.
5.	Jagdamba Singh and Jaya Singh, " <i>Photochemistry and Pericyclic Reactions</i> ", 7 <sup>th</sup> ed., New Age International Publishers, New Delhi, 2012.
<b>Web Resources:</b>	
1.	<a href="https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Logic_of_Organic_Synthesis_%28Rao%29/04%3A_The_Logic_of_Synthesis?utm_source=chatgpt.com">https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Logic_of_Organic_Synthesis_%28Rao%29/04%3A_The_Logic_of_Synthesis?utm_source=chatgpt.com</a>
2.	<a href="https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCYA5101.pdf?utm_source=chatgpt.com">https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCYA5101.pdf?utm_source=chatgpt.com</a>
3.	<a href="https://en.wikipedia.org/wiki/Woodward%E2%80%93Hoffmann_rules?utm_source=chatgpt.com">https://en.wikipedia.org/wiki/Woodward%E2%80%93Hoffmann_rules?utm_source=chatgpt.com</a>
4.	<a href="https://www.msuniv.ac.in/images/distance%20education/learning%20materials/ug%20pg%202023/pg%202021/Msc%20chemistry%202023/SCHM31_III_Sem_Organic_Synthesis_and_Photochemistry.pdf?utm_source=chatgpt.com">https://www.msuniv.ac.in/images/distance%20education/learning%20materials/ug%20pg%202023/pg%202021/Msc%20chemistry%202023/SCHM31_III_Sem_Organic_Synthesis_and_Photochemistry.pdf?utm_source=chatgpt.com</a>
5.	<a href="https://www.youtube.com/watch?v=mxkJFGfO1UQ&amp;utm_source=chatgpt.com">https://www.youtube.com/watch?v=mxkJFGfO1UQ&amp;utm_source=chatgpt.com</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO 1	3	3	3	2	3	2	2	2	3	3	3
CO 2	3	3	3	2	2	2	2	3	2	3	3
CO 3	3	3	3	2	3	2	2	3	3	2	3
CO 4	3	3	3	2	3	2	2	2	3	3	3
CO 5	3	3	3	2	2	2	2	2	3	3	3
Total	15	15	15	10	13	10	10	12	14	14	14
<b>Average</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>2.0</b>	<b>2.6</b>	<b>2.0</b>	<b>2.0</b>	<b>2.4</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>

**3– Strong, 2 – Medium, 1 - Low**

2<sup>ND</sup> YEAR: THIRD SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC32	Coordination Chemistry-I	Core	3	1	2	0	5	6	25	75	100
<b>Learning Objectives</b>											
LO1	To explain the bonding and properties of coordination compounds using CFT and MOT, including the factors that influence these properties.										
LO2	To interpret electronic spectra of coordination complexes, including band origins and transitions.										
LO3	To analyze complex stability, determine constants, and explain magnetic properties.										
LO4	To explain the mechanisms of substitution reactions in octahedral and square planar complexes.										
LO5	To develop the mechanisms of electron transfer reactions and photochemical reactions in coordination complexes, and describe their applications.										
Unit	Content										Hours
1	<b>Modern Theories of Coordination Compounds:</b> Crystal field theory - splitting of d orbitals in octahedral, tetrahedral and square planar symmetries - measurement of $10Dq$ - factors affecting $10Dq$ - spectrochemical series - crystal field stabilisation energy for high spin and low spin complexes - evidences for crystal field splitting - site selections in spinels and antispinel - Jahn Teller distortions and its consequences. Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields, Sigma and pi bonding in octahedral, square planar and tetrahedral complexes.										18
2	<b>Spectral Characteristics of Complexes:</b> Term states for d ions - characteristics of d-d transitions - charge transfer spectra - selection rules for electronic spectra - Orgel correlation diagrams - Sugano-Tanabe energy level diagrams - nephelauxetic series - Racha parameter and calculation of inter-electronic repulsion parameter.										18
3	<b>Stability and Magnetic Property of the Complexes:</b> Stability of complexes: Factors affecting stability of complexes, Thermodynamic aspects of complex formation, Stepwise and overall formation constants, Stability correlations, statistical factors and chelate effect, Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method, Potentiometric method, Spectrophotometric method, Ion exchange method, Polarographic method and Continuous variation method (Job's method); Magnetic property of complexes: Spin-orbit coupling, effect of spin-orbit coupling on magnetic moments, quenching of orbital magnetic moments.										18
4	<b>Kinetics and Mechanisms of Substitution Reactions of Octahedral and Square Planar Complexes:</b> Inert and Labile complexes; Associative, Dissociative and SNCB mechanistic pathways for										18

	substitution reactions; Acid and base hydrolysis of octahedral complexes; Classification of metal ions based on the rate of water replacement reaction and their correlation to Crystal Field Activation Energy; Substitution reactions in square planar complexes: Trans effect, theories of trans effect and applications of trans effect in synthesis of square planar compounds; Kurnakov test.	
5	<b>Electron Transfer Reactions in Octahedral Complexes:</b> Outer sphere electron transfer reactions and Marcus-Hush theory; Inner sphere electron transfer reactions; Nature of the bridging ligand in inner sphere electron transfer reactions. Photo-redox, photo-substitution and photo-isomerisation reactions in complexes and their applications.	<b>18</b>

<b>Course Outcomes</b>	
<b>CO</b>	<b>Students will be able to</b>
CO1	Predict and explain the structure, bonding, and properties of coordination compounds using Crystal Field Theory and Molecular Orbital Theory.
CO2	Analyze and interpret the electronic spectra of coordination complexes, assigning transitions and calculating relevant parameters.
CO3	Evaluate the stability of coordination complexes using various methods and explain their magnetic behavior.
CO4	Propose and explain the mechanisms of ligand substitution reactions in coordination complexes.
CO5	Describe and explain the mechanisms of electron transfer and photochemical reactions in coordination complexes, and discuss their applications in various fields.
<b>Textbooks:</b>	
1.	J.E. Huheey, E.A. Keiter, R.L. Keiter, and O.K. Medhi, "Inorganic Chemistry: Principles of Structure and Reactivity", 4 <sup>th</sup> ed., Pearson Education, Delhi, 2006.
2.	B. N. Figgis and M. A. Hitchman, "Ligand Field Theory and Its Applications", Wiley-VCH, 2000.
3.	R. G. Wilkins, "Kinetics and Mechanism of Reactions of Transition Metal Complexes", 2 <sup>nd</sup> ed., VCH, 1991.
4.	F. Basolo and R. G. Pearson, "Mechanisms of Inorganic Reactions", 2 <sup>nd</sup> ed., John Wiley & Sons, 1967.
5.	Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr, "Inorganic Chemistry", 5 <sup>th</sup> ed., Pearson, 2013.
<b>Reference Books:</b>	
1.	F. A. Cotton, G. Wilkinson, and P. L. Gaus, "Advanced Inorganic Chemistry", 8 <sup>th</sup> ed., John Wiley & Sons, 2009.
2.	K. Nakamoto, "Infrared and Raman Spectra of Inorganic and Coordination Compounds", 5 <sup>th</sup> ed., John Wiley & Sons, 1997.
3.	James E. House and Kathleen A. House, "Inorganic Chemistry", 3 <sup>rd</sup> ed., Academic Press, 2018.
4.	Catherine E. Housecroft and Alan G. Sharpe, "Inorganic Chemistry", 5 <sup>th</sup> ed., Pearson, 2018.
5.	Konrad Sandner, "Inorganic Photochemistry", Topics in Organometallic Chemistry 65, Springer, 2019.
<b>Web resources:</b>	
1.	<a href="https://chem.libretexts.org/Courses/Inorganic_Chemistry/Inorganic_Chemistry_I">https://chem.libretexts.org/Courses/Inorganic_Chemistry/Inorganic_Chemistry_I</a>
2.	<a href="https://ocw.mit.edu/">https://ocw.mit.edu/</a>
3.	<a href="https://chem.libretexts.org/Courses/Inorganic_Chemistry/Inorganic_Chemistry_I/06%3A_Coordination_Chemistry">https://chem.libretexts.org/Courses/Inorganic_Chemistry/Inorganic_Chemistry_I/06%3A_Coordination_Chemistry</a>
4.	<a href="http://www.webmo.net">www.webmo.net</a>
5.	<a href="https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall-008/pages/syllabus/">https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall-008/pages/syllabus/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO 1	3	3	3	2	3	2	2	2	3	3	3
CO 2	3	3	3	2	2	2	2	3	2	3	3
CO 3	3	3	3	2	3	2	2	3	3	2	3
CO 4	3	3	3	2	3	2	2	2	3	3	3
CO 5	3	3	3	2	2	2	2	2	3	3	3
Total	15	15	15	10	13	10	10	12	14	14	14
Average	3.0	3.0	3.0	2.0	2.6	2.0	2.0	2.4	2.8	2.8	2.8

3 – Strong, 2 – Medium, 1 - Low

2<sup>ND</sup> YEAR: THIRD SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC33P	Physical Chemistry Practical	Core	0	0	5	0	4	5	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the principle of conductivity experiments through conductometric titrations.										
LO2	To experimentally determine the equivalent conductance of a strong electrolyte and relate it to the DHO equation and to verify Ostwald's Dilution Law and calculate the pK <sub>a</sub> of a weak acid.										
LO3	To evaluate the order of the reaction, temperature coefficient, and activation energy of the reaction by following pseudo first order kinetics.										
LO4	To construct the phase diagram of two component system forming congruent melting solid and find its eutectic temperatures and compositions.										
LO5	To determine the isotherm of adsorption of oxalic acid on charcoal.										
Unit	Content										Hours
1 & 2	<b>Conductivity Experiments:</b> <ol style="list-style-type: none"> <li>Determination of equivalent conductance of a strong electrolyte &amp; the verification of DHO equation.</li> <li>Verification of Ostwald's Dilution Law &amp; Determination of pK<sub>a</sub> of a weak acid.</li> <li>Determination of solubility of a sparingly soluble salt.</li> <li>Acid-base titration (strong acid and weak acid vs NaOH).</li> <li>Precipitation titrations (BaCl<sub>2</sub> Vs Na<sub>2</sub>SO<sub>4</sub> only).</li> </ol>										30
3	<b>Kinetics</b> <ol style="list-style-type: none"> <li>Study the kinetics of acid hydrolysis of an ester, determine the temperature coefficient and also the activation energy of the reaction.</li> <li>Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect to iodine and acetone.</li> </ol>										15
4 & 5	<b>Phase diagram</b> Construction of phase diagram for a simple binary system <ol style="list-style-type: none"> <li>Naphthalene - biphenyl</li> <li>Benzophenone - diphenyl amine</li> </ol> <b>Adsorption</b> Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).										30

**SCHEME OF VALUATION**  
**24PCHC33P - PHYSICAL CHEMISTRY PRACTICAL**

<b>Content</b>	<b>Mark Allocation</b>
Internal assessment	25 Marks
External assessment	75 Marks
Total	100 Marks
Max. Marks	75 Marks
Short Procedure	15 Marks
Experiment	35 Marks
Calculation	10 Marks
Record	10 Marks
Viva voce	5 Marks

<b>Course Outcomes</b>	
<b>CO</b>	<b>Students will be able to</b>
CO1	Apply principles of conductivity to perform and interpret conductometric titrations.
CO2	Determine the equivalent conductance of strong electrolytes and relate it to the Debye-Hückel-Onsager (DHO) equation and Verify Ostwald's Dilution Law and calculate the pKa of weak acids using conductivity measurements.
CO3	Evaluate reaction order, temperature coefficient, and activation energy using pseudo-first-order kinetics.
CO4	Construct phase diagrams for two-component systems with congruent melting solids and identify eutectic temperatures and compositions.
CO5	Determine adsorption isotherms for a given adsorbate/adsorbent system.
<b>Textbooks:</b>	
1.	B. Viswanathan and P.S.Raghavan, " <i>Practical Physical Chemistry</i> ", Viva Books, New Delhi, 2009.
2.	Sundaram, Krishnan and Raghavan, " <i>Practical Chemistry (Part II)</i> ", S. Viswanathan Co. Pvt., 1996.
3.	V.D. Athawale and Parul Mathur, " <i>Experimental Physical Chemistry</i> ", 3 <sup>rd</sup> ed., New Age International (P) Ltd., New Delhi, 2008.
4.	A. Findley, " <i>Practical Physical Chemistry</i> ", 12 <sup>th</sup> ed., Longman, Green and Co., London, 1951.
5.	D. P. Shoemaker, C. W. Garland, and J. W. Nibler, " <i>Experiments in Physical Chemistry</i> ", 7 <sup>th</sup> ed., McGraw-Hill,
<b>Reference Books:</b>	
1.	J. B. Yadav, " <i>Advanced Practical Physical Chemistry</i> ", 2 <sup>nd</sup> ed., Goel Publishing House, 2001.
2.	G.W. Garland, J.W. Nibler, D.P. Shoemaker, " <i>Experiments in Physical Chemistry</i> ", 8 <sup>th</sup> ed., McGraw Hill, 2009.
3.	J. N. Gurthu and R. Kapoor, " <i>Advanced Experimental Chemistry</i> ", S. Chand and Co., 1987.
4.	Shailendra K Sinha, " <i>Physical Chemistry: A laboratory Manual</i> ", Narosa Publishing House Pvt, Ltd., New Delhi, 2014.
5.	M. Satish Kumar, " <i>Practical Physical Chemistry</i> ", 2 <sup>nd</sup> ed., Sankalp Publication, 2019.
<b>Web resources:</b>	
1.	<a href="https://web.iitd.ac.in/~nukur/2015-16/Isem/cmp511/lab_handout_new.pdf">https://web.iitd.ac.in/~nukur/2015-16/Isem/cmp511/lab_handout_new.pdf</a>
2.	<a href="http://chemlab.dartmouth.edu/">http://chemlab.dartmouth.edu/</a>
3.	<a href="https://ocw.mit.edu/">https://ocw.mit.edu/</a>
4.	<a href="http://www.khanacademy.org">www.khanacademy.org</a>
5.	<a href="https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Surface_Chemistry/Adsorption/Adsorption_Isotherms">https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Surface_Chemistry/Adsorption/Adsorption_Isotherms</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO 1	2	3	3	3	2	3	3	3	3	3	2
CO 2	3	3	3	3	3	2	3	2	3	2	3
CO 3	3	2	2	3	2	3	3	3	3	3	3
CO 4	3	3	2	2	3	3	3	2	3	3	3
CO 5	3	3	3	3	3	3	2	3	2	3	3
Total	14	14	13	14	13	13	13	13	14	14	14
Average	2.8	2.8	2.6	2.8	2.6	2.6	2.6	2.6	2.8	2.8	2.8

3 – Strong, 2 – Medium, 1 - Low

2<sup>ND</sup> YEAR: THIRD SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC34P	Analytical Instrumentation Techniques (Practical)	Core	0	0	5	0	3	5	25	75	100
<b>Learning Objectives</b>											
LO1	To determine the pKa of weak acids and measure the pH of various samples, including soil and water, using a pH meter.										
LO2	To perform and interpret potentiometric titrations involving acid-base, redox, and other reaction types to determine unknown concentrations.										
LO3	To quantify the concentration of metal ions, such as iron, copper, and nickel, in solution using colorimetric methods.										
LO4	To analyze water quality by measuring dissolved oxygen (DO) and chemical oxygen demand (COD) using titrimetric techniques.										
LO5	To interpret and identify organic compounds based on their UV-Visible, IR, and NMR spectra.										
Unit	Content										Hours
1	<b>pH metry</b> 1. Determination of pKa of weak acid by pH metry. 2. Determination of pH of a soil sample and water samples from different sources.										15
2	<b>Potentiometry</b> 3. Potentiometric titration of strong acid Vs strong base. 4. Potentiometric titration of FAS Vs K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> . 5. Potentiometric titration of KI Vs KMnO <sub>4</sub> .										15
3	<b>Colorimetry</b> 6. Estimation of Iron by Colorimetric method. 7. Estimation of Copper by Colorimetric method. 8. Estimation of Nickel by Colorimetric method.										15
4	<b>Titrimetry</b> 9. Analysis of water quality through DO measurements. 10. Analysis of water quality through COD measurements.										15
5	<b>Spectral Interpretation</b> Interpretation and identification of the given spectra of various organic compounds arrived at from the following instruments: 1. UV-Visible 2. IR 3. NMR										15

**SCHEME OF VALUATION**  
**24PCHC34P - ANALYTICAL INSTRUMENTATION TECHNIQUES**  
**(PRACTICAL)**

<b>Content</b>	<b>Mark Allocation</b>
Internal assessment	25 Marks
External assessment	75 Marks
Total	100 Marks
Max. Marks	75 Marks
Short Procedure	15 Marks
Experiment	35 Marks
Spectral interpretation	10 Marks
Record	10 Marks
Viva voce	5 Marks

CO	Course Outcomes Students will be able to
CO1	Apply pH metry to determine pKa values and measure pH in diverse samples.
CO2	Perform and interpret potentiometric titrations for various reaction types.
CO3	Quantify metal ion concentrations using colorimetric techniques.
CO4	Analyze water quality through DO and COD titrations.
CO5	Interpret and identify organic compounds using spectroscopic data (UV-Vis, IR, NMR).
<b>Textbooks:</b>	
1.	Vogel, " <i>Text book of Practical Organic Chemistry</i> ", 5 <sup>th</sup> ed., ELBS/Longman, England, 2003.
2.	G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, " <i>Vogel's Textbook of Quantitative Chemical Analysis</i> ", 6 <sup>th</sup> ed., ELBS, 1989.
3.	J. D. Woollins, " <i>Inorganic Experiments</i> ", VCH: Weinheim, 1995.
4.	B. Viswanathan and P. S. Raghavan, " <i>Practical Physical Chemistry</i> ", Viva Books, New Delhi, 2009.
5.	Robert M. Silverstein, Francis X. Webster, David J. Kiemle and David L. Bryce, " <i>Spectrometric Identification of Organic Compounds</i> ", 8 <sup>th</sup> ed., Wiley India Pvt. Ltd, 2019.
<b>Reference Books:</b>	
1.	N. S. Gnanapragasam and G. Ramamurthy, " <i>Organic Chemistry –Lab Manual</i> ", S. Viswanathan Co. Pvt. Ltd, 2009.
2.	J. N. Gurtu and R. Kapoor, " <i>Advanced Experimental Chemistry</i> ", S.Chand and Co., 2011.
3.	J. B. Yadav, " <i>Advanced Practical Physical Chemistry</i> ", Goel Publishing House, 2001.
4.	G.W. Garland, J.W. Nibler and D.P. Shoemaker, " <i>Experiments in Physical Chemistry</i> ", 8 <sup>th</sup> ed., McGraw Hill, 2009.
5.	J. N. Gurthu and R. Kapoor, " <i>Advanced Experimental Chemistry</i> ", S.Chand and Co., 1987.
<b>Web resources:</b>	
1.	<a href="https://nie.lk/pdf/files/other/eALOM%20Chemistry%20Practical%20Handbook.pdf">https://nie.lk/pdf/files/other/eALOM%20Chemistry%20Practical%20Handbook.pdf</a>
2.	<a href="https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf">https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf</a>
3.	<a href="https://chem.libretexts.org/Bookshelves/Analytical_Chemistry">https://chem.libretexts.org/Bookshelves/Analytical_Chemistry</a>
4.	<a href="https://edu.rsc.org/">https://edu.rsc.org/</a>
5.	<a href="https://www.vmi.vt.edu/">https://www.vmi.vt.edu/</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO 1	2	3	2	3	2	3	3	2	3	2	3
CO 2	3	3	2	3	3	2	3	2	3	3	2
CO 3	3	3	3	2	3	2	3	3	3	3	3
CO 4	2	3	3	3	3	3	3	3	3	3	3
CO 5	3	2	3	3	3	3	3	3	3	3	3
Total	13	14	13	14	14	13	15	13	15	14	14
<b>Average</b>	<b>2.6</b>	<b>2.8</b>	<b>2.6</b>	<b>2.8</b>	<b>2.8</b>	<b>2.6</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.8</b>

**3 – Strong, 2 – Medium, 1 - Low**

2<sup>ND</sup> YEAR: THIRD SEMESTER

Course Code	Course name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHE31	Polymer Chemistry	Elective 7	2	1	1	0	3	4	25	75	100
<b>Learning objectives</b>											
LO1	To analyze polymer properties including bonding, structure, T <sub>g</sub> , molecular weight, and stability.										
LO2	To explain chain-growth polymerization including cationic, anionic, and free radical polymerization, and Ziegler-Natta catalysis.										
LO3	To compare polymerization techniques and explain polymer degradation types and photostabilization.										
LO4	To describe preparation and properties of key industrial polymers including fibers, elastomers, thermoplastics, and thermosets.										
LO5	To explain polymer compounding with additives and processing techniques including calendaring, and vanadium catalysis.										
Unit	Content										Hours
1	<b>Characterization, Molecular Weight and its Determination:</b> Primary and secondary bond forces in polymers, cohesive energy, molecular structure, chemical tests, thermal methods, T <sub>g</sub> , molecular distribution, stability.										12
2	<b>Mechanism and kinetics of Polymerization:</b> Chain growth polymerization: Cationic, anionic, free radical polymerization; Stereo regular polymers: Ziegler-Natta polymerization.										12
3	<b>Techniques of Polymerization and Polymer Degradation:</b> Bulk, Solution, Emulsion, Suspension, Solid, Interfacial and Gas phase polymerization. Types of Polymer Degradation, Thermal degradation, mechanical degradation, photo degradation, Photostabilizers.										12
4	<b>Industrial Polymers:</b> Preparation of fibre forming polymers, elastomeric material. Thermoplastics: Polyethylene, Polypropylene, Polystyrene, Polyacrylonitrile, Polyvinyl chloride, Poly tetrafluoro ethylene, Nylon and Polyester. Thermosetting Plastics: Phenol formaldehyde. Elastomers: Natural rubber and Synthetic rubber, Polyurethanes, Polyureas, Polyethylene.										12
5	<b>Polymer Processing:</b> Compounding of Polymer, Additives: Fillers, Plasticizers, antioxidants, thermal stabilizers, fire retardants and colourants. Processing Techniques: Calendaring, Polymerization catalysis, Vanadium-based heterogeneous catalysis and active centers.										12

CO	Course Outcomes
	<b>Students will be able to</b>
CO1	Analyze polymer bonding, structure, T <sub>g</sub> , molecular weight, and stability.
CO2	Explain chain-growth polymerization viz. cationic, anionic, free radical and Ziegler-Natta catalysis.
CO3	Compare polymerization techniques and explain polymer degradation and photostabilization.
CO4	Describe synthesis, properties, and applications of industrial polymers such as fibers, elastomers, thermoplastic and thermosets.
CO5	Explain polymer compounding with additives and processing techniques including calendaring and vanadium catalysis.
<b>Textbooks:</b>	
1.	V.R. Gowariker, V.N. Viswanathan, and J. Sridhar, " <i>Polymer Science</i> ", 4 <sup>th</sup> ed., New Age International (Pvt) Ltd, New Delhi, 2021.
2.	G.S. Misra, " <i>Introductory Polymer Chemistry</i> ", 1 <sup>st</sup> ed., New Age International (Pvt) Limited, New Delhi, 1993.
3.	M.S. Bhatnagar, " <i>A Text Book of Polymers</i> ", 4 <sup>th</sup> ed., Vols. I & II, S. Chand & Company, New Delhi, 2004.
4.	H. G. Elias, " <i>An Introduction to Polymer Science</i> ", 5 <sup>th</sup> ed., VCH, Weinheim, 1997.
5.	J. M. McKelvey, " <i>Polymer Processing</i> ", 2 <sup>nd</sup> ed., John Wiley & Sons, New York, 1979.
<b>Reference Books:</b>	
1.	F. N. Billmeyer, " <i>Textbook of Polymer Science</i> ", 3 <sup>rd</sup> ed., Wiley Interscience, 1984.
2.	A. Kumar and S. K. Gupta, " <i>Fundamentals and Polymer Science and Engineering</i> ", 1 <sup>st</sup> ed., Tata McGraw-Hill, 1978.
3.	G. Odian, " <i>Principles of Polymerization</i> ", 4 <sup>th</sup> ed., John Wiley & Sons, Hoboken, NJ, 2004.
4.	R. J. Young and P. A. Lovell, " <i>Introduction to Polymers</i> ", 3 <sup>rd</sup> ed., CRC Press, Boca Raton, FL, 2011.
5.	L. Mascia, " <i>The Role of Additives in Plastics</i> ", 3 <sup>rd</sup> ed., Edward Arnold, London, 1993.
<b>Web resources:</b>	
1.	<a href="https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000661/M019111/ET/1515650810CHE_P6_M32_etext.pdf">https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000661/M019111/ET/1515650810CHE_P6_M32_etext.pdf</a>
2.	<a href="https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000661/M019110/ET/1515650790CHE_P6_M31_e-Text.pdf">https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000661/M019110/ET/1515650790CHE_P6_M31_e-Text.pdf</a>
3.	<a href="https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000831ME/P001678/M030964/ET/1526886039Module8_2.pdf">https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000831ME/P001678/M030964/ET/1526886039Module8_2.pdf</a>
4.	<a href="https://chem.libretexts.org/Bookshelves/Macromolecular_Chemistry/Polymer_Chemistry">https://chem.libretexts.org/Bookshelves/Macromolecular_Chemistry/Polymer_Chemistry</a>
5.	<a href="https://www.nypic.org/">https://www.nypic.org/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO 1	3	3	3	2	3	2	2	2	3	3	3
CO 2	3	3	3	2	2	2	2	3	2	3	3
CO 3	3	3	3	2	3	2	2	3	3	2	3
CO 4	3	3	3	2	3	2	2	2	3	3	3
CO 5	3	3	3	2	2	2	2	2	3	3	3
Total	15	15	15	10	13	10	10	12	14	14	14
<b>Average</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>2.0</b>	<b>2.6</b>	<b>2.0</b>	<b>2.0</b>	<b>2.4</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>

**3 – Strong, 2 – Medium, 1 - Low**

2<sup>ND</sup> YEAR: THIRD SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHE32	Pharmacognosy and Phytochemistry	Elective 8	2	1	1	0	3	4	25	75	100
<b>Learning objectives</b>											
LO1	To understand principles, classify drugs, perform pharmacognostic studies, and apply standardization guidelines.										
LO2	To explain and compare extraction methods; select appropriate techniques.										
LO3	To classify terpenoids, apply the isoprene rule, describe properties and uses, and understand camphor oil.										
LO4	To evaluate function and uses, describe isolation, identification, and structure, and discuss morphine.										
LO5	To describe glycoside structure and classification, understand activity, and discuss marine drugs and toxins.										
Unit	Content										Hours
1	<b>Pharmacognosy and Standardization of Herbal drugs:</b> Introduction, definition, development, classification and source of drugs: Biological, mineral, marine, and plant tissue cultures. Study of pharmacognostic of a crude drug. Standardization of Herbal drugs. WHO guidelines, Sampling of crude drug.										12
2	<b>Extraction Techniques:</b> General methods of extraction, types – maceration, Decoction, percolation, Immersion and soxhlet extraction. Factors affecting the choice of extraction process.										12
3	<b>Drugs containing Terpenoids and Volatile Oils:</b> Terpenoids: Classification, Isoprene rule, General properties Camphor, Menthol, Eucalyptol. Volatile Oils or Essential Oils: Method of Preparations, Classifications of Volatile oils, Camphor oil - Structure and pharmacological applications.										12
4	<b>Drugs containing alkaloids:</b> Function of alkaloids in plants, pharmaceutical applications. Isolation, Preliminary Qualitative tests, General methods of structural elucidation. Morphine - chemical properties, structure and uses.										12
5	<b>Plant Glycosides and Marine Drugs:</b> Glycosides: Basic ring system, classification, Pharmacological activity of Senna glycosides, Cardiac glycosides - Digoxin, Digitoxin, Steroidal saponins glycosides - Marine drugs - Selected Drug Molecules, Cardiovascular active substances, Marine toxins.										12

CO	Course Outcomes
	<b>Students will be able to</b>
CO1	Understand fundamental pharmacological principles, drug classifications, and pharmacognosy.
CO2	Apply appropriate extraction and standardization techniques for natural products.
CO3	Analyze the structure, properties, and applications of terpenoids, including camphor oil, applying the isoprene rule.
CO4	Evaluate the function, uses, isolation, identification, and structure of alkaloids, using morphine as a specific example.
CO5	Describe glycoside structure, classification, and biological activity, including an understanding of marine drugs and toxins.
<b>Textbooks:</b>	
1.	Gurdeep R. Chatwal, " <i>Organic Chemistry of Natural Products</i> ", Vols. I & II, 5 <sup>th</sup> ed., Himalaya Publishing House, Mumbai, 2016.
2.	Subhash C. Mandal, Vivekananda Mandal, and Anup Kumar Das, " <i>Essentials of Botanical Extraction: Principles and Applications</i> ", 1 <sup>st</sup> ed., Academic Press, London, 2015.
3.	Michael Heinrich, Joanne Barnes, Simon Gibbons, and Elizabeth M. Williamson, " <i>Fundamentals of Pharmacognosy and Phytotherapy</i> ", 3 <sup>rd</sup> ed., Elsevier, Edinburgh, 2017.
4.	S.V. Bhat, B.A. Nagasampagi, and M. Sivakumar, " <i>Chemistry of Natural Products</i> ", Revised ed., Narosa Publishers, New Delhi, 2014.
5.	Robert J. Krueger and David G. Stevenson, " <i>Pharmacognosy and Phytochemistry: Principles, Techniques, and Applications</i> ", 1 <sup>st</sup> ed., Wiley, Hoboken, NJ, 2025.
<b>Reference Books:</b>	
1.	Vinod D. Rangari, " <i>Pharmacognosy and Phytochemistry</i> ", Vols. I & II, 3 <sup>rd</sup> ed., Career Publications, Nashik, 2009.
2.	Sukhdev Swami Handa, " <i>Extraction Technologies for Medicinal and Aromatic Plants</i> ", 1 <sup>st</sup> ed., International Centre for Science and High Technology, Trieste, 2008.
3.	Thomas S. S. Li, " <i>Medicinal Plants: Culture, Utilization, and Phytopharmacology</i> ", 1 <sup>st</sup> ed., CRC Press, Boca Raton, FL, 2000.
4.	Trevor Robinson, " <i>The Organic Constituents of Higher Plants: Their Chemistry and Interrelationships</i> ", 6 <sup>th</sup> ed., Cordus Press, North Amherst, MA, 1991.
5.	William C. Evans, " <i>Trease and Evans' Pharmacognosy</i> ", 16 <sup>th</sup> ed., Saunders Ltd., London, 2009.
<b>Web resources:</b>	
1.	<a href="https://www.who.int/publications/i/item/9789241594448?utm_source=chatgpt.com">https://www.who.int/publications/i/item/9789241594448?utm_source=chatgpt.com</a>
2.	<a href="https://www.slideshare.net/slideshow/methods-of-extraction-pharmacognosy-types-of-extraction-for-herbal-drugs/232414018?utm_source=chatgpt.com">https://www.slideshare.net/slideshow/methods-of-extraction-pharmacognosy-types-of-extraction-for-herbal-drugs/232414018?utm_source=chatgpt.com</a>
3.	<a href="https://pubmed.ncbi.nlm.nih.gov/">https://pubmed.ncbi.nlm.nih.gov/</a>
4.	<a href="https://en.wikipedia.org/wiki/Alkaloid?utm_source=chatgpt.com">https://en.wikipedia.org/wiki/Alkaloid?utm_source=chatgpt.com</a>
5.	<a href="https://iponline.ipc.gov.in/">https://iponline.ipc.gov.in/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO 1	3	3	3	2	3	2	2	2	3	3	3
CO 2	3	3	3	2	2	2	2	3	3	3	3
CO 3	3	3	3	2	3	2	2	3	3	3	3
CO 4	3	3	3	2	3	2	2	2	3	3	3
CO 5	3	3	3	2	2	2	2	2	3	3	3
Total	15	15	15	10	13	10	10	12	15	15	15
<b>Average</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>2.0</b>	<b>2.6</b>	<b>2.0</b>	<b>2.0</b>	<b>2.4</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3 – Strong, 2 – Medium, 1 - Low**

2<sup>ND</sup> YEAR: THIRD SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHS31	Chemistry in Everyday Life	SEC-2	0	0	2	0	2	2	25	75	100
<b>Learning Objectives</b>											
LO1	To analyze chemical processes in food and test for specific components.										
LO2	To formulate and evaluate cleaning solutions, understand household chemical processes.										
LO3	To create cosmetics, understand ingredient functions, and analyze product properties.										
LO4	To investigate environmental issues, understand human impact, and apply chemistry to solutions.										
LO5	To synthesize and characterize polymers, relate structure to properties, and explain applications.										
Unit	Content										Hours
1	<b>Food Chemistry:</b> <ol style="list-style-type: none"> <li><b>The Browning of Food:</b> Investigate the Maillard reaction and enzymatic browning in fruits and vegetables.</li> <li><b>Gluten in Wheat Flour:</b> Extract and observe gluten, exploring its role in bread making.</li> <li><b>Homemade Yogurt:</b> Explore the fermentation process and the role of bacteria in yogurt production.</li> <li><b>Testing for Starch:</b> Use iodine to test various foods for the presence of starch.</li> <li><b>Emulsification:</b> Make mayonnaise or salad dressing to understand how emulsifiers work.</li> <li><b>Preserving Food:</b> Explore different food preservation techniques like pickling or drying.</li> </ol>										6
2	<b>Household Chemistry:</b> <ol style="list-style-type: none"> <li><b>Homemade Cleaners:</b> Create and test natural cleaning solutions using vinegar, baking soda, and lemon juice.</li> <li><b>Soap Making:</b> Explore the saponification process and make your own soap.</li> <li><b>Laundry Science:</b> Investigate the effectiveness of different laundry detergents on various stains.</li> <li><b>Water Hardness:</b> Test the hardness of your local water using a soap test.</li> <li><b>Rust Removal:</b> Explore different methods for removing rust from metal objects.</li> <li><b>Homemade Air Fresheners:</b> Create natural air fresheners using essential oils and other ingredients.</li> </ol>										6

3	<p><b>Cosmetic Chemistry:</b></p> <ol style="list-style-type: none"> <li>1. <b>Lip Balm Creation:</b> Make your own lip balm using natural ingredients like beeswax and oils.</li> <li>2. <b>Natural Dyes:</b> Extract natural dyes from plants and use them to dye fabric or paper.</li> <li>3. <b>Homemade Face Masks:</b> Create face masks using ingredients like honey, oatmeal, or clay.</li> <li>4. <b>Testing pH of Cosmetics:</b> Test the pH of different cosmetic products using a pH indicator.</li> <li>5. <b>Exploring Sunscreen:</b> Investigate the effectiveness of different sunscreens in blocking UV rays.</li> <li>6. <b>Perfume Blending:</b> Experiment with blending essential oils to create your own perfume.</li> </ol>	6
4	<p><b>Environmental Chemistry:</b></p> <ol style="list-style-type: none"> <li>1. <b>Water Purification:</b> Build a simple water filter using sand, gravel, and charcoal.</li> <li>2. <b>Testing Soil pH:</b> Test the pH of different soil samples to understand their suitability for plant growth.</li> <li>3. <b>Acid Rain Simulation:</b> Simulate acid rain and observe its effects on plants or materials.</li> <li>4. <b>Biodegradable Plastics:</b> Investigate the biodegradability of different types of plastics.</li> <li>5. <b>Carbon Footprint Calculation:</b> Calculate personal carbon footprint and explore ways to reduce it.</li> <li>6. <b>Pollution Detection:</b> Investigate local water or air quality using simple tests or kits.</li> </ol>	6
5	<p><b>Polymer Chemistry:</b></p> <ol style="list-style-type: none"> <li>1. <b>Making Slime:</b> Explore the properties of polymers by making different types of slime.</li> <li>2. <b>Homemade Glue:</b> Make own glue using milk or other household ingredients.</li> <li>3. <b>Exploring Plastics:</b> Investigate the properties of different types of plastics and their uses.</li> <li>4. <b>Tie-Dyeing:</b> Explore the chemistry of fabric dyes and create tie-dye designs.</li> <li>5. <b>Making Paper:</b> Recycle paper and make own paper sheets.</li> <li>6. <b>Investigating Fibers:</b> Examine different types of natural and synthetic fibers under a microscope.</li> </ol>	6

**NOTE: Integrating IPR and Soft Skills:**

- **IPR (Intellectual Property Rights):**

- For each experiment, encourage students to consider the potential for innovation and commercialization.
- Discuss patents, copyrights, and trademarks related to the products they create (e.g., homemade cleaners, cosmetics, polymers).

- Have students document their experimental processes and formulations, emphasizing the importance of keeping detailed records for potential IPR protection.
  - Include assignments where students research existing patents or trademarks related to the chemicals or products they are working with.
- **Soft Skills:**
    - ❖ **Communication:**
      - Require students to present their experimental findings and project ideas clearly and concisely.
      - Encourage group work and peer review to develop communication and collaboration skills.
    - ❖ **Problem-solving:**
      - Present students with real-world problems related to the experiments (e.g., troubleshooting a failed soap-making attempt).
      - Assess their ability to analyze problems and develop solutions.
    - ❖ **Critical thinking:**
      - Encourage students to evaluate the environmental and ethical implications of the chemicals and products they are working with.
      - Promote discussions about sustainability and responsible consumption.
    - ❖ **Teamwork:**
      - Have the students work in teams for many of the experiments.

### SCHEME OF VALUATION

#### 24PCHS31 - CHEMISTRY IN EVERYDAY LIFE

#### (SEC 2)

Content	Mark Allocation
Internal assessment	25 Marks
External assessment	75 Marks
Total	100 Marks
Max. Marks	75 Marks
Experiment Execution	15 Marks
Preparation of Products	35 Marks
Presentation of Product Outcome	10 Marks
Record	10 Marks
Viva voce	5 Marks

CO	Course Outcomes
	<b>Students will be able to</b>
CO1	Analyze chemical processes relevant to food science and perform qualitative tests for specific food components.
CO2	Formulate and evaluate cleaning solutions, demonstrating an understanding of common household chemical processes.
CO3	Formulate cosmetic products, explaining the function of individual ingredients and analyzing the properties of the final product.
CO4	Investigate environmental issues, explaining the impact of human activities and applying chemical principles to propose solutions.
CO5	Synthesize and characterize polymers, relating their structure to observed properties and explaining their diverse applications.
<b>Textbooks:</b>	
1.	H.D. Belitz, W. Grosch, and P. Schieberle, " <i>Food Chemistry</i> ", 4 <sup>th</sup> ed., Springer, Berlin, 2009.
2.	John W. Hill and Doris K. Kolb, " <i>Chemistry for Changing Times</i> ", 13 <sup>th</sup> ed., Pearson, Boston, 2013.
3.	J. Barel, M. Paye, and H.I. Maibach, " <i>Handbook of Cosmetic Science and Technology</i> ", 3 <sup>rd</sup> ed., CRC Press, Boca Raton, 2009.
4.	Stanley E. Manahan, " <i>Environmental Chemistry</i> ", 9 <sup>th</sup> ed., CRC Press, Boca Raton, 2009.
5.	Paul C. Hiemenz and Timothy P. Lodge, " <i>Polymer Chemistry</i> ", 2 <sup>nd</sup> ed., CRC Press, Boca Raton, 2007.
<b>Reference Books:</b>	
1.	Theodore Gray, " <i>Mad Science: 50 Essential Experiments for Every Thinker</i> ", Black Dog & Leventhal Publishers, 2020.
2.	David W. Ball, " <i>The Basics of General, Organic, and Biological Chemistry</i> ", 1 <sup>st</sup> ed., Flat World Knowledge, Washington, 2011.
3.	Randy Schueller and Perry Romanowski, " <i>Beginning Cosmetic Chemistry</i> ", 3 <sup>rd</sup> ed., Allured Publishing Corporation, Carol Stream, 2009.
4.	Colin Baird and Michael Cann, " <i>Environmental Chemistry</i> ", 5 <sup>th</sup> ed., W.H. Freeman and Company, New York, 2012.
5.	Richard G. Kline, " <i>The Inventor's Handbook: How to Develop, Protect, and Market Your Invention</i> ", 3 <sup>rd</sup> ed., Dover Publications, 2007.
<b>Web resources:</b>	
1.	<a href="https://link.springer.com/content/pdf/10.1007/978-3-540-69934-7.pdf">https://link.springer.com/content/pdf/10.1007/978-3-540-69934-7.pdf</a>
2.	<a href="https://www.sciencebuddies.org/">https://www.sciencebuddies.org/</a>
3.	<a href="https://www.exploratorium.edu/">https://www.exploratorium.edu/</a>
4.	<a href="https://www.acs.org/">https://www.acs.org/</a>
5.	<a href="https://www.eng.uc.edu/~beaucag/IntrotoPolySci/StyreneandothersSYnthesis.pdf">https://www.eng.uc.edu/~beaucag/IntrotoPolySci/StyreneandothersSYnthesis.pdf</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	3	3	2	3	3	3
CO 2	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	2	3	3	3	2	3	3	3
CO 5	3	3	3	2	2	2	3	2	3	3	3
Total	15	15	15	13	13	15	15	12	15	15	15
<b>Average</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>2.6</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>2.4</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

3 – Strong, 2 – Medium, 1 - Low

2<sup>nd</sup> YEAR: FOURTH SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC41	Coordination Chemistry-II	Core	3	1	2	0	5	6	25	75	100
<b>Learning Objectives</b>											
LO1	To recognize the fundamental concepts and structural aspects of organometallic compounds.										
LO2	To learn reactions of organometallic compounds and their catalytic behaviour.										
LO3	To identify or predict the structure of coordination compounds using spectroscopic tools.										
LO4	To analyze the structure and bonding in coordination complexes.										
LO5	To evaluate the spectral characteristics of selected complexes.										
Unit	Content										Hours
1	<b>Chemistry of Organometallic Compounds:</b> Classification of organometallic compounds based on M-C bond – 18 and 16 electron rule; Bonding in metal-olefin complexes (example: Ziese's salt), metal-acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes—Examples and MO approach to bonding in metallocenes. Metal – carbonyl complexes: MO diagram of CO; Structure and bonding – bonding modes, MO approach of M-CO bonding, synergistic effect (stabilization of lower oxidation states of metals); Carbonyl clusters: Low nuclearity and high nuclearity carbonyl clusters—Structures based on polyhedral skeleton electron pair theory or Wade's rule.										18
2	<b>Reactions and Catalysis of Organometallic Compounds:</b> Reactions of organometallic compounds: Oxidative addition, reductive elimination ( $\alpha$ and $\beta$ eliminations). Organo-metallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt or rhodium catalysts (oxo process), oxidation of olefin (Wacker process), olefin isomerisation, Cyclo-oligomerisation of Acetylenes using Reppe's catalysts, Monsanto process.										18
3	<b>Inorganic Spectroscopy-I:</b> Applications of UV-Visible and IR spectroscopy: Selection rules, isosbestic points, Geometrical isomerism using UV-Visible Spectroscopy. IR spectroscopy: Effect of coordination on the stretching frequency-sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea and DMSO complexes; IR spectroscopy of carbonyl compounds. NMR spectroscopy- Applications of $^1\text{H}$ , $^{15}\text{N}$ , $^{19}\text{F}$ , $^{31}\text{P}$ -NMR spectroscopy in structural identification of inorganic complexes, fluxional molecules and quadrupolar nuclei- effect.										18
4	<b>Inorganic Spectroscopy-II:</b> Introductory terminologies: g and A parameters-definition, explanation and factors affecting g and A; Applications of ESR to coordination compounds with one and more than one unpaired electrons – hyperfine and secondary hyperfine splitting and Kramer's doublets; ESR spectra of V(II), Mn(II), Fe(II), Co(II), Ni(II), Cu(II) complexes. Mossbauer spectroscopy – Mossbauer effect, Recoil energy, Mossbauer active nuclei, Doppler shift, Isomer shift, quadrupole splitting and magnetic interactions. Applications of Mössbauer										18

	spectra to Fe and Sn compounds.	
<b>5</b>	<b>Photo Electron Spectroscopy:</b> PES of homonuclear diatomic molecules (N <sub>2</sub> , O <sub>2</sub> ) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H <sub>2</sub> O, CO <sub>2</sub> , CH <sub>4</sub> , NH <sub>3</sub> ) – evaluation of vibrational constants of the above molecules. Koopman's theorem- applications and limitations. Optical Rotatory Dispersion – Principle of CD and ORD; $\Delta$ and $\lambda$ isomers in complexes, Assignment of absolute configuration using CD and ORD techniques.	<b>18</b>

CO	Course Outcomes
	<b>Students will be able to</b>
CO1	Understand and apply 18 and 16 electron rule for organometallic compounds.
CO2	Understand the structure and bonding in olefin, allyl, cyclopentadienyl and carbonyl containing organometallic compounds.
CO3	Understand the reactions of organometallic compounds and apply.
CO4	Understanding the catalytic cycles.
CO5	Identify / predict the structure of coordination complexes using spectroscopic tools such as IR, NMR, ESR, Mossbauer and optical rotatory dispersion studies to interpret the structure of molecules by various spectral techniques.
<b>Textbooks:</b>	
1.	J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi, " <i>Inorganic Chemistry – Principles of structure and reactivity</i> ", 4 <sup>th</sup> ed., Pearson Education Inc., 2006.
2.	Christoph Elschenbroich, " <i>Organometallics</i> ", Wiley-VCH, Weinheim, 3 <sup>rd</sup> ed., 2006.
3.	D. Bannerjea, " <i>Co-ordination Chemistry</i> ", TATA Mcgraw Hill, 1993.
4.	B. D. Gupta and A. K. Elias, " <i>Basic Organometallic Chemistry: Concepts, Syntheses and Applications</i> ", University Press, 2013.
5.	F. A. Cotton, G. Wilkinson. C. A. Murillo M. Bochmann, " <i>Advanced Inorganic Chemistry</i> ", 6 <sup>th</sup> ed., Wiley Inter-science New York, 1988.
<b>Reference Books:</b>	
1.	Crabtree, Robert H. " <i>The Organometallic Chemistry of the Transition Metals</i> " 3 <sup>rd</sup> ed., New York, NY John Wiley, 2000.
2.	P. Gütllich, E. Bill, A. X. Trautwein, " <i>Mossbauer Spectroscopy and Transition Metal Chemistry: Fundamentals and Applications</i> ", 1 <sup>st</sup> ed., Springer-Verlag Berlin Heidelberg, 2011.
3.	" <i>Concepts and Models of Inorganic Chemistry</i> ", B. Douglas, D. Mc Daniel, J. Alexander, John Wiley, 3 <sup>rd</sup> ed., 1994.
4.	K. F. Purcell, J. C. Kotz, " <i>Inorganic Chemistry</i> " Saunders, Philadelphia, 1976.
5.	R. S. Drago, " <i>Physical Methods in Chemistry</i> " Saunders Philadelphia, 1977.
<b>WebResources:</b>	
1.	<a href="https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCYA5302.pdf">https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCYA5302.pdf</a>
2.	<a href="https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Inorganic_Chemistry_(LibreTexts)/14:_Organometallic_Reactions_and_Catalysis">https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Inorganic_Chemistry_(LibreTexts)/14:_Organometallic_Reactions_and_Catalysis</a>
3.	<a href="https://chem.libretexts.org/Courses/East_Tennessee_State_University/CHEM_3110:_Descriptive_Inorganic_Chemistry/11:_Organometallic_Chemistry">https://chem.libretexts.org/Courses/East_Tennessee_State_University/CHEM_3110:_Descriptive_Inorganic_Chemistry/11:_Organometallic_Chemistry</a>
4.	<a href="https://www.ncbi.nlm.nih.gov/books/">https://www.ncbi.nlm.nih.gov/books/</a>
5.	<a href="https://pubs.acs.org/page/orgnd7/tutorials">https://pubs.acs.org/page/orgnd7/tutorials</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3– Strong, 2–Medium, 1-Low**

2<sup>nd</sup> YEAR: FOURTH SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHC42	Physical Chemistry – II	Core	3	1	2	0	5	6	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the essential characteristics of wave functions and need for the quantum mechanics.										
LO2	To know the importance of quantum mechanical models of particle in a box, rigid rotor and harmonic oscillator.										
LO3	To analyze the quantum mechanics to hydrogen and polyelectronic systems.										
LO4	To familiarize the symmetry in molecules and predict the point groups.										
LO5	To apply quantum and group theories to analyze molecular models, vibrations and electronic spectra.										
Unit	Content										Hours
1	<b>Introduction to Quantum Mechanics:</b> Black body radiation, wave particle duality, uncertainty principle, photoelectric effect, hydrogen spectrum. Need for quantum mechanics, postulates of quantum mechanics. Particle wave and Schrodinger wave equation-Time independent and time dependent. Wave function, properties of wave function- Normalized, orthogonal, orthonormal, Eigen values and Eigen function: Hermitian properties of operators.										18
2	<b>Applications to Particles, Quantum Models and Hydrogen Atom:</b> Application of Schrodinger wave equation to particle in a box-(1D, 2D and 3D). Degeneracy, free particles. Harmonic Oscillator-wave equation and solution, anharmonicity, force constant and its significance. Rigid rotor-wave equation and solution, calculation of rotational constants and bond length of diatomic molecules. Hydrogen atom and hydrogen like ions, Hamiltonian-wave equation and solutions, radial and angular functions, representation of radial distribution functions.										18
3	<b>Applications to Poly Electron Atoms:</b> Approximation methods: variation methods- trial wave function, variation integral and application to particle in 1D box. Perturbation method - first order applications. Hartree-Fock self-consistent field method, Helium atom-electron spin, Pauli's exclusion principle and Slater determinant. Hohenberg-Kohn theorem and Kohn-Sham equation. Molecular orbital theory and Heitler London (VB) treatment, Energy level diagrams.										18
4	<b>Group Theory:</b> Groups, sub groups, symmetry elements and symmetry operations. Point groups-Classification, axial, non-axial and dihedral point groups- $C_n, C_{nh}, D_n, D_{nh}, D_{nd}, T_d$ and $O_h$ . Matrix representation and classes of symmetry operations, reducible irreducible and direct product representation. variation function and LCAO methods. Electronic conjugated system: Huckel method to Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene.										18

5	<b>Applications of Group Theory:</b> Reducing the reducible representation into irreducible representation. Reduction formula. Properties of irreducible representation, Great orthogonality theorem. Construction of character table for $C_{2v}$ , $C_{2h}$ , $C_{3v}$ and $D_{2h}$ point groups. Hydrogen Molecule-Applications of group theory to molecular vibrations and hybridization of simple molecules ( $H_2O$ , $NH_3$ , $BF_3$ , $CH_4$ , $XeF_4$ ).Electronic spectra of ethylene.	18
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CO	Course Outcomes
	<b>Students will be able to</b>
CO1	To discuss the characteristics of wave functions and symmetry functions.
CO2	To classify the symmetry operation and wave equations.
CO3	To apply the concept of quantum mechanics and group theory to predict the electronic structure.
CO4	To specify the appropriate irreducible representations for theoretical applications.
CO5	To develop skills in evaluating the energies of molecular spectra.
<b>Textbooks:</b>	
1.	R.K. Prasad, " <i>Quantum Chemistry</i> ", New Age International Publishers, New Delhi, 4 <sup>th</sup> ed., 2010.
2.	T. Engel & Philip Reid, " <i>Quantum Chemistry and Spectroscopy</i> ", Pearson, New Delhi, 4 <sup>th</sup> ed., 2018.
3.	D. R. Crow, " <i>Principles and Applications of Electrochemistry</i> ", CRC Press, Boca Raton, 4 <sup>th</sup> ed., 1994.
4.	F. A. Cotton, " <i>Chemical Applications of Group Theory</i> ", John Wiley & Sons, 2 <sup>nd</sup> ed., 2003.
5.	Samuel Glasstone, " <i>Textbook of Physical Chemistry</i> ", Macmillan India Ltd., New Delhi, 2 <sup>nd</sup> ed., 1998.
<b>Reference Books:</b>	
1.	N. Levine, " <i>Quantum Chemistry</i> ", Allyn & Bacon Inc, 4 <sup>th</sup> ed., 1983.
2.	P. W. Atkins, J. de Paula, J. Keeler, " <i>Atkins' Physical Chemistry</i> ", Oxford University Press, Oxford, 11 <sup>th</sup> ed., 2018.
3.	John O'M. Bockris and Amulya K. N. Reddy, " <i>Modern Electrochemistry: Ionics</i> " (Volume 1, Plenum Press, New York, 2 <sup>nd</sup> ed., 1998.
4.	R.L. Flurry. Jr, " <i>Symmetry Group Theory and Chemical applications</i> ", Prentice Hall. Inc, 1980.
5.	J. M. Hollas, " <i>Symmetry in Molecules</i> ", Chapman and Hall, London, Reprint, 2011.
<b>WebResources:</b>	
1.	<a href="https://www.sparkl.me/learn/ib/physics-hl/wave-particle-duality/revision-notes/1742">https://www.sparkl.me/learn/ib/physics-hl/wave-particle-duality/revision-notes/1742</a>
2.	<a href="https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Quantum_Mechanics/03._Solutions_to_the_Schr%C3%B6dinger_Equation/Particle_in_a_Box">https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Quantum_Mechanics/03._Solutions_to_the_Schr%C3%B6dinger_Equation/Particle_in_a_Box</a>
3.	<a href="https://www.scribd.com/document/630369698/Quantum-Mechanics-notes">https://www.scribd.com/document/630369698/Quantum-Mechanics-notes</a>
4.	<a href="https://empslocal.ex.ac.uk/people/staff/mrwatkin//teaching/Level%20%20Spectroscopy/LGroupTheory.pdf">https://empslocal.ex.ac.uk/people/staff/mrwatkin//teaching/Level%20%20Spectroscopy/LGroupTheory.pdf</a>
5.	<a href="https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Molecular_Orbital_Theory/Molecular_Quantum_Chemistry">https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Molecular_Orbital_Theory/Molecular_Quantum_Chemistry</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3– Strong, 2–Medium, 1-Low**

2<sup>nd</sup> YEAR: FOURTH SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHE41	Chemistry of Natural Products	Elective 6	4	1	1	0	4	6	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the classification, isolation, and structural elucidation of alkaloids, and apply chemical methods to determine the structures of coniine and nicotine.										
LO2	To explain the isoprene rule for classifying terpenoids, determine their structures, and understand the synthesis and functions of carotenoids like $\beta$ -carotene and vitamin A.										
LO3	To evaluate the structure and synthesis of anthocyanins and flavones, and to determine the structures of key compounds like cyanidine chloride and quercetin.										
LO4	To comprehend the biological importance, synthesis, and structure of purines like uric acid and caffeine, as well as the stereochemistry and biosynthesis of steroids like cholesterol.										
LO5	To apply the theories of color and constitution, and to determine the structure and synthesis of natural dyes such as indigoitin and alizarin.										
Unit	Content										Hours
1	<b>Alkaloids:</b> Occurrence, classification, isolation and functions of alkaloids. Classification, general methods of structural elucidation. Chemical methods of structure determination of Coniine, Piperine, Nicotine, Papaverine. Atropine, Quinine, Belladine, Cocaine, Heptaphylline, Papaverine and Morphine.										18
2	<b>Terpenoids:</b> Occurrence, Isoprene rule, classification. General methods of determining structure. Structure determination of Camphor, Abietic acid, Cadinene, Squalene, Zingiberine. <b>Carotenoids:</b> Introduction, geometrical isomerism, structure, functions and synthesis of $\beta$ -carotene and vitamin-A.										18
3	<b>Anthocyanines and Flavones:</b> Anthocyanines: Structure and general methods of synthesis of anthocyanines. Cyanidine chloride: structure and determination. Flavones: Biological importance of flavones. Structure and determination of flavone and flavonoids. Quercetin: Structure determination and importance.										18
4	<b>Purines and Steroids:</b> Purines: Occurrence and isolation of purines. Biological importance, Structure and synthesis of Uric acid and Caffeine. Steroids: Classification, nomenclature, configuration of substituents, Diels' hydrocarbon, stereochemistry, biological importance; Cholesterol-occurrence, tests, physiological activity, biosynthesis of cholesterol from squalene.										18
5	<b>Natural Dyes:</b> Occurrence, classification, isolation, purification, properties, colour and constitution - Old theories - Witt's theory and Quinonoid theory - Modern theories - Valence bond theory and Molecular orbital theory; Structural determination and synthesis of indigoitin and alizarin.										18

CO	Course Outcomes
	<b>Students will be able to</b>
CO1	To understand the biological importance of chemistry of natural products.
CO2	To scientifically plan and perform the isolation and characterization of synthesized natural products.
CO3	To elucidate the structure of alkaloids, terpenoids, carotenoids, flavanoids and anthocyanins.
CO4	To determine the structure of phytochemical constituents by chemical and physical methods.
CO5	To interpret the experimental data scientifically to improve biological activity of active components.
<b>Textbooks:</b>	
1.	G. K. Chatwal, " <i>Organic Chemistry on Natural Products</i> ", Vol. 1, Himalaya Publishing House, Mumbai, 2009.
2.	P. S. Kalsi, " <i>Stereochemistry, Conformation and Mechanism</i> ", 8 <sup>th</sup> ed., New Age International Publishers, New Delhi, 2014.
3.	O. P. Agarwal, " <i>Chemistry of Organic Natural Products</i> ", Vol. 1, Goel Publishing House, Meerut, 1997.
4.	I.L. Finar, " <i>Organic Chemistry: The Fundamental Principles</i> ", Vol. 2, 5 <sup>th</sup> ed., Pearson Education, Delhi, 2007.
5.	Jagdamba Singh, " <i>Natural Products Chemistry</i> ", 2 <sup>nd</sup> ed., Pragati Prakashan, Meerut, 2021.
<b>Reference Books:</b>	
1.	I. L. Finar, " <i>Organic Chemistry</i> ", 6 <sup>th</sup> ed., Pearson Education, Delhi, 2011.
2.	Pelletier, " <i>Chemistry of Alkaloids</i> ", Van Nostrand Reinhold Co, 2000.
3.	Shoppe, " <i>Chemistry of the steroids</i> ", Butterworthes, 1994.
4.	I. A. Khan, and A. Khanum. " <i>Role of Biotechnology in medicinal &amp; aromatic plants</i> ", Vol 1 and Vol 10, Ukkaz Publications, Hyderabad, 2004.
5.	Paula Yurkanis Bruice, " <i>Organic Chemistry</i> ", 8 <sup>th</sup> ed., Pearson, 2017.
<b>WebResources:</b>	
1.	<a href="https://www.scribd.com/presentation/423030647/General-Method-of-Structural-Elucidation-of-Alkaloid">https://www.scribd.com/presentation/423030647/General-Method-of-Structural-Elucidation-of-Alkaloid</a>
2.	<a href="https://uou.ac.in/sites/default/files/slm/MSCH-607.pdf">https://uou.ac.in/sites/default/files/slm/MSCH-607.pdf</a>
3.	<a href="https://chemistry.stackexchange.com/questions/56807/what-are-the-general-methods-for-synthesis-and-characterization-of-anthocyanins">https://chemistry.stackexchange.com/questions/56807/what-are-the-general-methods-for-synthesis-and-characterization-of-anthocyanins</a>
4.	<a href="https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCY1615.pdf">https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCY1615.pdf</a>
5.	<a href="https://www.researchgate.net/publication/305484019_Natural_Dyes">https://www.researchgate.net/publication/305484019_Natural_Dyes</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
Average	2.4	3.0	2.6	3.0	2.8	2.4	3.0	2.6	3.0	3.0	3.0

**3– Strong, 2–Medium, 1-Low**

2<sup>nd</sup> YEAR: FOURTH SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHE42	Electrochemistry	Elective 6	4	1	1	0	4	6	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the behavior of electrolytes in terms of conductance, ionic atmosphere, interactions.										
LO2	To familiarize the structure of the electrical double layer of different models.										
LO3	To compare electrodes between current density and over potential.										
LO4	To discuss the mechanism of electrochemical reactions.										
LO5	To evaluate the different types of over voltages and its applications in electro analytical techniques.										
Unit	Content										Hours
1	<p><b>Ionics:</b> Arrhenius theory - limitations, van't Hoff factor and its relation to colligative properties. Deviation from ideal behaviour. Ionic activity - mean ionic activity and mean ionic activity coefficient-concept of ionic strength; Debye Huckel theory of strong electrolytes, activity coefficient of strong electrolytes Determination of activity coefficient. Ion solvent and ion-ion interactions. Born equation. Debye-Huckel Bjerrum model. Derivation of Debye-Huckel limiting law at appreciable concentration of electrolytes-modifications and applications. Electrolytic conduction-Debye-Huckel Onsager treatment of strong electrolytes-qualitative and quantitative verification and limitations. Evidence for ionic atmosphere, ion association and triple ion formations.</p>										18
2	<p><b>Electrode-Electrolyte Interface:</b> Interfacial phenomena - Evidences for electrical double layer, polarizable and non-polarizable interfaces. Electrocapillary phenomena - Lippmann equation and electrocapillary curves. Electrokinetic phenomena - electroosmosis, electrophoresis, streaming and sedimentation potentials. Colloidal and poly electrolytes. Structure of electrical double layers- Helmholtz -Perrin, Guoy - Chapman and Stern models. Zeta potential and potential at zero charge- Applications and limitations.</p>										18
3	<p><b>Electrodics of Elementary Electrode Reactions:</b> Behaviour of electrodes: Standard electrodes and electrodes at equilibrium. Anodic and cathodic currents. Condition for the discharge of ions. Nernst equation. Polarizable and non-polarizable electrodes. Model of three electrode system. potential. Rates of simple elementary electrochemical reactions. Butler-Volmer equation-significance of exchange current density, net current density. Low and high field approximations. Symmetry factor and transfer coefficient; Tafel equations and Tafel plots.</p>										18
4	<p><b>Electrodics of Multistep Multi Electron System:</b> Rates of multi-step electrode reactions, Butler - Volmer equation for a multi-step reaction. Rate determining step. Electrode polarization and depolarization. Transfer coefficients-Significance and determination; Stoichiometric number. Electrochemical reaction mechanisms-Rate expressions, order, and surface coverage. Reduction of <math>I_3^-</math>, <math>Fe^{2+}</math> and dissolution of Fe to <math>Fe^{2+}</math>. Overvoltage –</p>										18

	chemical, electrochemical, phase, activation and concentration overpotentials. Evolution of oxygen and hydrogen at different pH. Pourbaix and Evans' diagrams.	
5	<b>Concentration Polarization, Batteries and Fuel Cells:</b> Modes of transport of electroactive species - Diffusion, migration and hydrodynamic modes. Role of supporting electrolytes. Polarography - Principle and applications. Square wave polarography. Cyclic voltammetry- anodic and cathodic stripping voltammetry and differential pulse voltammetry. Batteries- Sodium and lithium-ion batteries and redox flow batteries. Mechanism of charge storage: Conversion and alloying. Capacitors- mechanism of energy storage, charging at constant current and constant voltage. Energy production systems: Fuel Cells: classification, alkaline fuel cells, phosphoric acid fuel cells and high temperature fuel cells.	18

CO	Course Outcomes
	<b>Students will be able to</b>
CO1	To understand the behaviour of electrolytes in solution and compare the structures of electrical double layer of different models.
CO2	To predict the kinetics of electrode reactions applying Butler-Volmer equation.
CO3	To study different thermodynamic mechanism of corrosion.
CO4	To discuss the theories of electrolytes, electrical double layer, electrostatics and activity coefficient of electrolytes
CO5	To apply a knowledge to develop storage devices and electrochemical reaction mechanism.
<b>Textbooks:</b>	
1.	D. R. Crow, " <i>Principles and applications of electrochemistry</i> ", 4 <sup>th</sup> ed., Chapman & Hall/CRC, 2014.
2.	J. Rajaram and J.C. Kuriakose, " <i>Kinetics and Mechanism of chemical transformations</i> " Macmillan India Ltd., New Delhi, 2011.
3.	S. Glasstone, " <i>Electro chemistry</i> ", Affiliated East-West Press, Pvt., Ltd., New Delhi, 2008.
4.	B. Viswanathan, S. Sundaram, R. Venkataraman, K. Rengarajan and P.S. Raghavan, " <i>Electrochemistry-Principles and applications</i> ", S. Viswanathan Printers, Chennai, 2007.
5.	Joseph Wang, " <i>Analytical Electrochemistry</i> ", 2 <sup>nd</sup> ed., Wiley, 2004.
<b>Reference Books:</b>	
1.	J.O.M. Bockris and A.K.N. Reddy, " <i>Modern Electro Chemistry</i> ", vol.1 and 2B, Springer, Plenum Press, New York, 2008.
2.	J.O.M. Bockris, A.K.N. Reddy and M.G. Aldeco Morden Electro chemistry, vol. 2A, Springer, Plenum Press, New York, 2008.
3.	D. R. Crow, " <i>Principles and Applications of Electrochemistry</i> ", CRC Press, Boca Raton, 4 <sup>th</sup> ed., 1994.
4.	L.I. Antropov, " <i>Theoretical electrochemistry</i> ", Mir Publishers, 1977.
5.	K.L. Kapoor, " <i>A Text book of Physical chemistry</i> ", volume-3, Macmillan, 2001.
<b>WebResources:</b>	
1.	<a href="https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCYA5303.pdf">https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCYA5303.pdf</a>
2.	<a href="https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Electrochemistry/Electrode_Electrolyte_Interface">https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Electrochemistry/Electrode_Electrolyte_Interface</a>
3.	<a href="https://ocw.mit.edu/courses/10-626-electrochemical-energy-systems-spring-2014/c298f0094af33047862ea6f76ff54e90/MIT10_626S14_S11lec28.pdf">https://ocw.mit.edu/courses/10-626-electrochemical-energy-systems-spring-2014/c298f0094af33047862ea6f76ff54e90/MIT10_626S14_S11lec28.pdf</a>
4.	<a href="https://www.ncbi.nlm.nih.gov/books/NBK541123/">https://www.ncbi.nlm.nih.gov/books/NBK541123/</a>
5.	<a href="https://chem.libretexts.org/Bookshelves/Electrochemistry/Battery_and_Fuel_Cell_Fundamentals">https://chem.libretexts.org/Bookshelves/Electrochemistry/Battery_and_Fuel_Cell_Fundamentals</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3– Strong, 2–Medium, 1-Low**

2<sup>nd</sup> YEAR: FOURTH SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHP41	Research Tools and Techniques	PEC	1	1	0	0	2	2	25	75	100
<b>Learning Objectives</b>											
LO1	To differentiate fundamental, experimental, industrial, and interdisciplinary research and explain their core motivations.										
LO2	To apply systematic steps for selecting a research problem and demonstrate understanding of research ethics, IP rights, and plagiarism.										
LO3	To utilize major bibliographic databases for literature search and evaluate research quality using metrics (Impact Factor, h-index).										
LO4	To correctly apply at least two major citation styles (e.g., APA, MLA) and effectively use reference management software (e.g., Mendeley/Zotero).										
LO5	To calculate and interpret descriptive statistics and apply basic inferential statistical tests (F-test, T-test, or ANOVA) to analyze data.										
Unit	Content								Hours		
1	<b>Introduction</b> :Objectives and motivations in research, Fundamental, experimental, industrial and Interdisciplinary research.								6		
2	<b>Research</b> :Steps involved in selecting a research problem, criteria for ranking research topics, components, types, ethics, institutional ethical committee, plagiarism, patenting and intellectual property rights.								6		
3	<b>Techniques employed in literature search:</b> Google scholar, Web of science, SCOPUS, PUBMED, Science Direct, Research Gate. Research article segregation: Indexing and citation databases, Impact factor of journals as per citation report, h-index, g index and i10 index.								6		
4	<b>Referencing styles and techniques:</b> MLA, Harvard, Chicago, APA styles, Tools employed in referencing and citing Grammarly and Endnote. Softwares Mendeley, reference manager, Zotero etc.								6		
5	<b>Data Interpretation and analysis:</b> Analysis of Variance (ANOVA)-mean, median, mode, range, standard deviation, curve fitting, general polynomial fitting, exponential fitting, types of errors, significant tests F&Ttest.								6		

CO	Course Outcomes
	<b>Students will be able to</b>
CO1	To analyze research methodologies and rationalize appropriate research motivations/objectives.
CO2	To formulate a research problem, adhering to ethics, IP rights, and anti-plagiarism standards.
CO3	To conduct comprehensive literature reviews and critically evaluate literature credibility using scientific metrics.
CO4	To master reference management software to accurately format citations and bibliographies using specified academic styles.
CO5	To analyze and interpret quantitative data using appropriate descriptive and basic inferential statistical tests.
<b>Textbooks:</b>	
1.	C.R. Kothari, " <i>Research Methodology: Methods and Techniques</i> ", New Age International, New Delhi, 4 <sup>th</sup> ed., 2018.
2.	Ranjit Kumar, " <i>Research Methodology: A Step-by-Step Guide for Beginners</i> ", SAGE Publications, London, 5 <sup>th</sup> ed., 2019.
3.	Paul T. P. Wong, " <i>The Handbook of Research Methods in Psychology</i> ", Oxford University Press, New York, 2011.
4.	American Psychological Association, " <i>Publication Manual of the American Psychological Association</i> ", American Psychological Association, Washington, D.C., 7 <sup>th</sup> ed., 2020.
5.	R. Barker Bausell, Yi-Fang Li, " <i>Power Analysis for Experimental research: A Practical Guide for the Biological, Medical and social Sciences</i> ", Cambridge University Press, Cambridge, 2002.
<b>Reference Books:</b>	
1.	S. L. Dhingra, " <i>Fundamental Research Methods: A Step-by-Step Approach</i> ", New Age International, New Delhi, 2012.
2.	G. P. Panicker, " <i>Research Ethics and Scientific Integrity</i> ", Narosa Publishing House, New Delhi, 2021.
3.	Paul T. P. Wong, " <i>The Handbook of Research Methods in Psychology</i> ", Oxford University Press, New York, 2011.
4.	University of Chicago Press Editorial Staff, " <i>The Chicago Manual of Style</i> ", University of Chicago Press, Chicago, 17 <sup>th</sup> ed., 2017.
5.	Douglas C. Montgomery, " <i>Design and Analysis of Experiments</i> ", John Wiley & Sons, New York, 10 <sup>th</sup> ed., 2020.
<b>WebResources:</b>	
1.	<a href="https://www.scribbr.com/category/methodology/">https://www.scribbr.com/category/methodology/</a>
2.	<a href="https://www.wipo.int/en/web/ip-resources">https://www.wipo.int/en/web/ip-resources</a>
3.	<a href="https://sdunet.dk/en/research/research-analysis-and-identifiers">https://sdunet.dk/en/research/research-analysis-and-identifiers</a>
4.	<a href="https://www.google.com/search?q=https://owl.purdue.edu/owl/research">https://www.google.com/search?q=https://owl.purdue.edu/owl/research</a>
5.	<a href="https://www.graphpad.com/guides/the-ultimate-guide-to-anova">https://www.graphpad.com/guides/the-ultimate-guide-to-anova</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3
Total	15	15	15	15	15	15	15	15	15	15	15
<b>Average</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3– Strong, 2–Medium, 1-Low**

2<sup>nd</sup> YEAR: FOURTH SEMESTER

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PCHL41	<b>Biomolecules and Heterocyclic Compounds</b>	SLC	0	0	1	3	2	4	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the structures and chemical properties of mono, di, and polysaccharides, and the process of carbohydrate metabolism via glycolysis.										
LO2	To analyze the structure, function, and biosynthesis of steroids and the roles of sex, adrenocortical, and non-steroidal hormones.										
LO3	To elucidate the techniques for protein separation, the catabolism of amino acids, and the role of nucleic acids in protein biosynthesis and the urea cycle.										
LO4	To understand the structure and synthesis of nucleosides and nucleotides and the primary and secondary structures of RNA and DNA, including the Watson-Crick model.										
LO5	To evaluate the aromaticity and reactivity of fused ring heterocyclic compounds, and propose multi-step synthetic routes based on reaction mechanisms.										
Unit	Content										Hours
1	<b>Chemistry of Carbohydrates:</b> Structure - Linear and ring structures (Haworth formula) of ribose, glucose, fructose, and mannose. Chemical properties of glucose, fructose, maltose, lactose, sucrose, starch, glycogen, and cellulose. Fundamental metabolic pathway of glycolysis. Fundamental aspects of protection and deprotection of carbohydrates.										12
2	<b>Steroids and Hormones:</b> Steroids and Cholesterol - Occurrence, chemical tests, and physiological activity.Hormones -Functions of Sex Hormones (androgens and estrogens); Adrenocortical Hormones (cortisone and cortisol); Non-Steroidal Hormones (adrenaline and thyroxin).										12
3	<b>Proteins and nucleic acids-I:</b> Proteins - Separation and purification methods: dialysis, gel filtration, and electrophoresis.Amino Acid Catabolism - Transamination, oxidative deamination, and decarboxylation.Protein Biosynthesis -Role of nucleic acids. Fundamental aspects of protection and deprotection of proteins (or amino acids).										12
4	<b>Proteins and nucleic acids-II:</b> Nucleosides Synthesis - Structure and methods for the synthesis of nucleosides.Nucleotides - Conversion of nucleoside to nucleotides.Nucleic Acid Structure - Primary and secondary structure of RNA and DNA, including the Watson-Crick model.										12
5	<b>Fused Ring Heterocyclic Compounds:</b> Preparation and properties of the following: Benzofused five membered rings - Indole, isoindole, benzofuran and benzothiophene. Benzofused six membered rings - Quinoline and isoquinoline.										12

CO	Course Outcomes
	<b>Students will be able to</b>
CO1	To analyze the structures and chemical properties of various carbohydrates and explain the fundamental metabolic pathway of glycolysis.
CO2	To evaluate the structures, physiological functions, and biosynthesis of steroids, as well as differentiate the roles of various hormones.
CO3	To apply techniques for protein separation and describe the catabolic pathways of amino acids and the process of protein biosynthesis.
CO4	To explain the structure and synthesis of nucleosides and nucleotides, and articulate the key features of RNA and DNA, including the Watson-Crick model.
CO5	To critically evaluate the aromaticity and reactivity of fused-ring heterocyclic compounds and design logical synthetic pathways for their preparation.
<b>Textbooks:</b>	
6.	T. K Lindhorst, " <i>Essentials of Carbohydrate Chemistry and Biochemistry</i> ", Wiley VCH, North America, 2007.
7.	I. L. Finar, " <i>Organic Chemistry</i> " Vol-2, 5 <sup>th</sup> ed., Pearson Education Asia, 1975.
8.	V. K. Ahluwalia and M. Goyal, " <i>Textbook of Heterocyclic compounds</i> ", Narosa Publishing, New Delhi, 2000.
9.	M. K. Jain and S. C. Sharma, " <i>Modern Organic Chemistry</i> ", Vishal Publishing Co., Jalandhar, Delhi, 2014.
10.	V. K. Ahluwalia, " <i>Steroids and Hormones</i> ", Ane books pub., New Delhi, 2009.
<b>Reference Books:</b>	
6.	I. L. Finar, " <i>Organic Chemistry</i> " Vol-1, 6 <sup>th</sup> ed., Pearson Education Asia, 2004.
7.	Pelletier, " <i>Chemistry of Alkaloids</i> ", Van Nostrand Reinhold Co, 2000.
8.	Shoppe, " <i>Chemistry of the steroids</i> ", Butterworthes, 1994.
9.	I. A. Khan, and A. Khanum. " <i>Role of Biotechnology in medicinal &amp; aromatic plants</i> ", Vol 1 and Vol 10, Ukkaz Publications, Hyderabad, 2004.
10.	M. P. Singh. and H. Panda, " <i>Medicinal Herbs with their formulations</i> ", Daya Publishing House, Delhi, 2005.
<b>WebResources:</b>	
6.	<a href="https://conductscience.com/structure-classification-and-functions-of-carbohydrates/">https://conductscience.com/structure-classification-and-functions-of-carbohydrates/</a>
7.	<a href="https://www.khanacademy.org/science/biology/human-biology/endocrine-system/a/steroids">https://www.khanacademy.org/science/biology/human-biology/endocrine-system/a/steroids</a>
8.	<a href="https://www.biochemguide.com/protein-protein-purification/">https://www.biochemguide.com/protein-protein-purification/</a>
9.	<a href="https://www.ncbi.nlm.nih.gov/books/NBK26866/">https://www.ncbi.nlm.nih.gov/books/NBK26866/</a>
10.	<a href="https://www.organic-chemistry.org/namedreactions/benzofuran-synthesis.shtm">https://www.organic-chemistry.org/namedreactions/benzofuran-synthesis.shtm</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
<b>Average</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>2.6</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

**3– Strong, 2–Medium, 1-Low**

### Continuous Internal Assessment (CIA) Test

The following procedure will be followed for the award of internal marks:

CIA Exam I: Three hours duration for 75 marks (First 2 ½ Units)

CIA Exam II cum Model Exam: Three hours duration for 75 marks (Full Syllabus)

Internal Mark Distribution	Theory & Practical
CIA – I (75 Marks)	5
CIA – II (75 Marks)	5
Library Usage in Hours	5
Attendance	5
Assignment / Seminar / Observation	5
Internal Marks	<b>25</b>

### Format to Entering in all Continue Internal Assessment (CIA) Tests and Internal Marks

Reg . No.	Name	CIA - 1	CIA - 2	Marks Conve rsion	Library Usages	Atten dance	Assignment / Seminar / Observation	Total Marks	Remarks

### Recommendations for Entering Library Usage:

Library usage for UG in hours	Marks to be awarded
Minimum 10 Hours	5

### Attendance:

Attendance Earned	Category	Marks to be Awarded
91% and above	Highly Regular	5
75% butbelow90%	Regular	4
65% butbelow 74%	Shortage	3
55% butbelow 64%	Detained	2
Below54%	Redo	0

### THEORY QUESTION PAPER PATTERN END SEMESTER EXAMINATIONS FOR UG& PG DEGREE PROGRAMMES - 3 HOURS DURATION

<b>Part A</b>	To answer All the 10 Short Questions (Two Questions from each UNIT)	10 X 2=20Marks
<b>Part B</b>	ToanswerAllthe5questions (either or, type) (One Question from each UNIT)	5 X 5=25Marks
<b>Part C</b>	Toanswer3questions(out of 5 questions) (One question from each UNIT)	3 X 10=30Marks
<b>TOTAL</b>		<b>75 Marks</b>
(Equal Weight age should be given to each unit)		

**2<sup>nd</sup> YEAR: FOURTH SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
<b>24PCHC43P</b>	<b>Project</b>	<b>Core</b>	<b>0</b>	<b>0</b>	<b>6</b>	<b>0</b>	<b>5</b>	<b>6</b>	<b>25</b>	<b>75</b>	<b>100</b>
<b>Learning Objectives</b>											
LO1	Engage in a real-time project environment to apply theoretical knowledge for practical problem-solving.										
LO2	Analyze different stages of project development and implementation while demonstrating effective project collaboration.										
LO3	Demonstrate technical proficiency, analytical skills, and professional ethics in executing the assigned project work.										
LO4	Develop research project and innovative approaches relevant to the chosen project domain.										
LO5	Strengthen communication, documentation, and presentation skills required for professional project execution										
<b>REGULATIONS</b>											
<b>1</b>	Every student must undertake an individual project work in a relevant domain, preferably aligned with their area of specialization, during the course of study to gain practical and analytical exposure. After completing the third semester, the student should identify, propose, and obtain approval for a suitable project topic to be executed during the fourth semester. During the project period, students are expected to actively participate in all stages of the project, including analysis, design, implementation, and documentation.										
<b>2</b>	A comprehensive project report must be prepared and submitted by the student in the prescribed institutional format. Students have to submit the copies of the thesis in the book form (size: 21.0 cm x 13.5 cm). Dissertation text should be typed in double line spacing and Times New Roman font size 12 and number of pages should be restricted to be maximum of 100 pages.										
<b>3</b>	The project report submission will take place at the end of the fourth semester, followed by a presentation and viva voce evaluation during the semester examination.										
<b>4</b>	The evaluation of the project work will be for 100 marks, comprising 25 internal, 50 project evaluation and 25 for viva-voce, assessed jointly by internal and external examiners. The external examiner shall be appointed from affiliated colleges of Parent University, University Departments, or any other affiliated colleges.										
<b>5</b>	Students must secure at least 50% of the total marks to pass. Those who are absent/fail to meet this requirement must improve their performance and resubmit the project report in the next available attempt. The final report must include all prescribed sections and be submitted to the Controller of Examinations within the specified date.										

### **Format for the Preparation of Dissertation**

The sequence in which the dissertation should be arranged and bound should be as follows

1. Cover Page and title Page
2. Declaration
3. Certificate
4. Abstract (not exceeding one page)
5. Acknowledgement (not exceeding one page)
6. Contents (12 Font size, Times new Roman with double line spacing)
7. List of Figures/ Exhibits/Charts
8. List of tables
9. Symbols and notations/ abbreviations
10. Chapters
11. References

Distribution of marks for Dissertation: (Internal: 25+External: 75 = 100 Marks)

External: 75 Marks - Distribution

- a. For Organization and presentation of Thesis - 40 marks
- b. For the novelty /Social relevance -10 marks
- c. Viva voce - Preparation & Presentation of work - 10 marks
- a. Response to questions -10 Marks
- d. Participation / Presentation of paper in the National or State level Seminar/Conference/

Workshop/publication - 5 marks

Internal: 25 Marks – Distribution

- a. Review : 1 – 5 marks
- b. Review: 2 – 10 Marks
- c. Review: 3 – 10 marks