

Est. in 1921



# UNION CHRISTIAN COLLEGE (AUTONOMOUS) ALUVA

Affiliated to Mahatma Gandhi University, Kottayam, India  
NAAC Accredited with A++ Grade in Vth cycle  
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## *DEPARTMENT OF CHEMISTRY*



### UG SYLLABUS 2025

## UNDERGRADUATE (HONOURS) PROGRAMMES {UCC UGP (HONOURS)}

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Adopted from THE MAHATMA GANDHI UNIVERSITY  
UNDER GRADUATE PROGRAMMES  
(HONOURS) SYLLABUS  
MGU-UGP (Honours)  
(2024 Admission Onwards)

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Est. in 1921



**UNION CHRISTIAN COLLEGE (AUTONOMOUS), ALUVA  
ERNAKULAM, KERALA, 683 102**

**Affiliated to the Mahatma Gandhi University Kottayam, Kerala**



**CURRICULUM FOR UNDERGRADUATE PROGRAMME  
BACHELOR OF SCIENCE (HONOURS) IN CHEMISTRY**

**UNDER MGU-UGP (HONOURS)**

(With effect from 2025 Admissions)

Approved by the Board of Studies on 01<sup>st</sup> April 2025

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### **BOARD OF STUDIES IN CHEMISTRY**

<b>Sl. No.</b>	<b>Name and Designation</b>	<b>Position</b>
1	Dr. Simi Pushpan K, Assistant Professor, Union Christian College	Chairperson
2	Dr. Jenish Paul, Associate Professor, Union Christian College	Member
3	Ms. Smitha Roy, Assistant Professor, Union Christian College	Member
4	Ms. Minu Joys, Assistant Professor, Union Christian College	Member
5	Dr. Ajalesh B Nair, Assistant Professor, Union Christian College	Member
6	Dr. Nelson Joseph P, Assistant Professor, Union Christian College	Member
7	Dr. Neethumol Varghese, Assistant Professor, Union Christian College	Member
8	Dr. Divya Susan Philips, Assistant Professor, Union Christian College	Member
9	Dr. Sunil Sekhar A C, Assistant Professor, Union Christian College	Member
10	Dr. Soney Varghese, Professor, Nanomaterials & Devices Research Laboratory Department of Materials Science & Engineering National Institute of Technology Calicut (NITC) Kerala, INDIA Pin 673601	External Subject Expert
11	Dr. Leena R, Assistant Professor, Department of Applied Chemistry, Cochin University of Science and Technology (CUSAT)	External Subject Expert
12	Dr. Sreesha Sasi, Professor, Department of Chemistry, Maharajas College, Ernakulam	University Nominee
13	Mr. Rajesh V Peter, Associate Head-Business Excellence, Mane Kancor Ingredients Pvt Ltd., Angamaly	Alumni Representative
14	Mr. Ginish P A, Shift Chemist A. QC Lab, BPC-KRL, Kochi	Beneficiary Representative from industry/corporate sector

## **ACKNOWLEDGEMENTS**

As the Chairperson of the Board of Studies in Chemistry, I am truly delighted to share the Four-Year Undergraduate Programme (FYUG) Syllabus in Chemistry, which offers a Bachelor of Science (Honours) in Chemistry under MGU-UGP (Honours).

This curriculum has been meticulously developed to provide a robust and comprehensive foundation in the discipline while fostering analytical thinking, scientific curiosity, and research aptitude among students.

The successful formulation of this syllabus results from the dedicated and collaborative efforts of a diverse group of academic and industry professionals. I wish to express my sincere appreciation to all members of the Board of Studies for their insightful contributions, constructive feedback, and steadfast commitment throughout the curriculum development process. I extend my deepest gratitude to the external BoS members Dr. Sreesha Sasi, Dr. Soney Varghese, Dr. Leena R, Mr. Rajesh V. Peter, and Mr. Ginish P.A for their valuable perspectives, greatly enriching the syllabus's quality and relevance. I am also profoundly thankful to my esteemed fellow BoS members at Union Christian College Dr. Jenish Paul, Ms. Smitha Roy, Ms. Minu Joys, Dr. Ajalesh B Nair, Dr. Nelson Joseph P, Dr. Neethumol Varghese, Dr. Divya Susan Philips, and Dr. Sunil Sekhar A C—for their scholarly input, dedication, and enthusiastic participation in every stage of this endeavour.

This syllabus aspires not only to convey the essential theoretical and practical aspects of Chemistry but also to serve as a catalyst for innovation and academic excellence. I am confident that it will provide our students with a solid academic foundation and inspire them to make meaningful and lasting contributions to the scientific community.

**Dr. Simi Pushpan K**

**Chairperson, Board of Studies in Chemistry**

**Union Christian College, Aluva**

## **PREFACE**

With great enthusiasm and a strong sense of responsibility, we, the Board of Studies in Chemistry at Union Christian College, Aluva (Autonomous), present this meticulously crafted curriculum and syllabus, adopted from the Board of Studies in Chemistry, Mahatma Gandhi University, for the Four-Year Undergraduate Program (FYUGP) in Chemistry at our institution. We sincerely acknowledge and thank the Board of Studies in Chemistry, Mahatma Gandhi University, for the excellent syllabus they have developed.

Introducing the Four-Year Undergraduate Program represents a substantial transformation in the realm of higher education within Kerala. The Department of Higher Education of the Government of Kerala spearheads this progressive initiative, which is scheduled for implementation in the academic year 2024–25. Following this vision, Mahatma Gandhi University has engaged in a comprehensive and meticulous curriculum design process, closely adhering to the guidelines established by the Department.

Chemistry is a fundamental science that explores matter's composition, structure, properties, and changes. Known as the “central science,” chemistry connects physics, biology, and other disciplines, helping us understand everything from atoms and molecules to complex chemical reactions. Divided into branches like organic, inorganic, physical, analytical, and biochemistry, chemistry reveals how substances interact and transform—powering innovations in medicine, materials, energy, and the environment. From ancient alchemy to modern laboratories, chemistry continues to shape our world and deepen our understanding of life and nature.

The core objective of this Four-Year Undergraduate Program (UG Honours) is to impart a comprehensive and profound understanding of the interdisciplinary nature of Chemistry. The curriculum aims to equip students with the knowledge and practical skills necessary to explore and appreciate the complexities of matter and its transformations. Serving as a guiding framework, the syllabus offers a holistic journey—from fundamental principles to advanced applications—fostering scientific curiosity, analytical thinking, and a deep appreciation for Chemistry's role in both natural and applied contexts.

During the honors program, students will engage in a vibrant blend of theoretical instruction, laboratory experiments, field studies, and case-based experiential learning. This integrated approach ensures that students remain aligned with the latest advancements in chemical sciences while fostering exploration and the pursuit of research interests. The curriculum is intentionally structured to cultivate critical thinking, scientific curiosity, and a deep appreciation for Chemistry's central role in understanding and improving the world around us.

In conclusion, we look forward to guiding students through this enriching journey across the diverse domains of Chemistry. We aspire that this syllabus serves as a gateway to a transformative academic experience, establishing a robust foundation for lifelong learning, innovation, and significant contributions to the scientific community.

**Dr. Simi Pushpan.K**  
**Chairperson**  
**UG Board of Studies in Chemistry**



## PROGRAMME STRUCTURE

### Semester: 1

Course Code	Title of the Course	Type of Course DSC, DCC, MDC, SEC	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC1DSCCHE100	Fundamentals of Chemistry- 1	DSC A	4	5	3		2	
UC1MDCCHE100	Food Chemistry and Nutrition	MDC	3	4	2		2	

### Semester: 2

Course Code	Title of the Course	Type of Course DSC, DCC, MDC, SEC	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC2DSCCHE100	Fundamentals of Chemistry-2	DSC A	4	5	3		2	
UC2MDCCHE100	Diary Chemistry	MDC	3	4	2		2	

### Semester: 3

Course Code	Title of the Course	Type of Course DSC, DCC, MDC, SEC	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC3DSCCHE200	Inorganic Chemistry-1	DSC A	4	5	3		2	
UC3DSCCHE201	Organic Chemistry-1	DSC A	4	5	3		2	
UC3DSECHE200	Basic Analytical	Any	DSE	4	4		0	

	Chemistry	one							
UC3DSECHE201	Introduction to Nanoscience			4	4	4		0	
UC3DSECHE202	Safe Laboratory Practices in Chemistry			4	4	4		0	
UC3MDCCHE200	Chemistry in Everyday Life	MDC	3	3	3			0	
UC3VACCHE200	Forensic Chemistry	VAC	3	3	3			0	
UC3DSCCHE202	Inorganic and Organic Chemistry (Minor for Others)	DSC B	4	5	3			2	

#### Semester: 4

Course Code	Title of the Course	Type of Course DSC, DCC, MDC, SEC	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC4DSCCHE200	Organic Chemistry-2	DSC A	4	5	3		2	
UC4DSCCHE201	Physical Chemistry-1	DSC A	4	5	3		2	
UC4DSECHE200	Polymer Chemistry	Any one DSE	4	4	4		0	
UC4DSECHE201	Food Chemistry						0	
UC4SECHE200	Basic Analytical and Cosmetic Chemistry	SEC	3	3	3		0	
UC4VACCHE200	Basic Environmental Chemistry	VAC	3	3	3		0	
UC4DSCCHE202	Fundamentals of Physical Chemistry (Minor for Others)	DSC C	4	5	3		2	
UC4INTCHE200	Internship	INT	2					

**Semester: 5**

Course Code	Title of the Course	Type of Course DSC, DCC, MDC, SEC	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC5DSCCHE300	Organic Chemistry - 3	DSC A	4	5	3		2	
UC5DSCCHE301	Physical Chemistry- 2	DSC A	4	5	3		2	
UC5DSECHE300	Quantum Mechanics, Spectroscopy & Group Theory	DSE  Any One	4	4	4		0	
UC5DSECHE301	Green chemistry for sustainable development		4	4	4		0	
UC5DSECHE302	Environmental Chemistry		4	4	4		0	
UC5DSECHE303	Nanotechnology for Energy Applications		4	4	4		0	
UC5DSECHE304	Medicinal Chemistry		4	4	4		0	
UC5DSECHE305	Main Group Elements		4	4	4		0	
UC5SECHE300	Analytical Chemistry and Professional skills		SEC	3	3	3		0

**Semester: 6**

Course Code	Title of the Course	Type of Course DSC, DCC, MDC, SEC	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC6DSCCHE300	Inorganic Chemistry-2	DSC A	4	5	3		2	
UC6DSCCHE301	Physical Chemistry-3	DSC A	4	5	3		2	

UC6DSECHE300	Organic Chemistry-4	Any One	DSE	4	5	3		2	
UC6DSECHE301	Rubber Technology			4	5	3		2	
UC6DSECHE302	Industrial Inorganic Chemistry and Nuclear Chemistry	Any One	DSE	4	4	4		0	
UC6DSECHE303	Spectroscopic Methods of Chemical Analysis			4	4	4		0	
UC6DSECHE304	Fundamentals of Biochemistry			4	4	4		0	
UC6SECCHE300	Data Analysis using Python and Soft skills		SEC	3	3	3		0	
UC6VACCHE300	Intellectual Property Rights		VAC	3	3	3		0	
UC6VACCHE301	Research Methodology for Chemistry	Any One		3	3	3		0	

**Semester: 7**

Course Code	Title of the Course	Type of Course DSC, DCC, MDC, SEC	Credit	Hours / week	Hour Distribution/week			
					L	T	P	O
UC7DCCCHE400	Coordination and Organometallic Chemistry	DCC	4	4	4		0	
UC7DCCCHE401	Organic Chemistry-5	DCC	4	5	3		2	
UCDCCCHE402	Molecular Spectroscopy	DCC	4	4	4		0	
UC7DCECHE400	Drug Therapy and Drug Design	Any Three	DCE	4	4	4		0
UC7DCECHE401	Industrial Chemistry							
UC7DCECHE402	Advanced Chemistry of Main Group			4	4	4		0

	Elements								
UC7DCECHE403	Statistical Thermodynamics and Bioenergetics			4	4	4		0	
UC7DCECHE404	Novel Inorganic Solids			4	4	4		0	
UC7DSECHE400	Analytical Chemistry	DSE*		4	4	4		0	
UC7DSECHE401	Biophysical Chemistry			4	4	4		0	
UC7DSECHE402	Nanochemistry and Technology			4	4	4		0	

**\*MINOR**

**Semester: 8**

Course Code	Title of the Course	Type of Course	Credit	Hours/week	Hour Distribution/week			
					L	T	P	O
UC8DCCCHE400	Advanced Coordination and Organometallic Chemistry	DCC	4	6	2		4	
UC8DCCCHE401	Physical Chemistry- 4	DCC	4	6	2		4	
UC8DCECHE400	Organic Chemistry-6	DCE	4	5	3		2	
UC8DCECHE401	Group Theory and Quantum Chemistry	Any Two	DCE	4	4	4		0
UC8DCECHE402	Instrumental Methods of Chemical Analysis			4	4	4		0
UC8DCECHE403	Molecular Modelling			4	4	4		0
UC8DCECHE404	Crystallography and Electrochemistry			4	4	4		0
UC8PRJCHE400	Project	PRJ	2					

## SEMESTER 1

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Fundamentals of Chemistry-1</b>					
<b>Type of Course</b>	<b>DSC A</b>					
<b>Course Code</b>	<b>UC1DSCCHE100</b>					
<b>Course Level</b>	<b>100-199</b>					
<b>Course Summary</b>	This course covers the basic principles and concepts of atoms, elements, compounds, and fundamentals of organic chemistry. Students explore atomic structure, electron displacements in organic chemistry, reactive intermediates, and the periodic table to understand the foundation of chemical interactions.					
<b>Semester</b>	I	Credits			4	Total Hours
<b>Course Details</b>	Learning approach	Lecture	Tutorials	Practical	Others	
		3	1	1		
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Apply atomic models to forecast and explain electronic configurations, atomic behaviour, and characteristics.	A	1,2

2	Describe the relevance of organic chemistry, catenation and hybridisation.	U	1,2,10
3	Evaluate electron displacement patterns in organic molecules using arrow notation.	E	1,2
4	Utilize arrow-pushing mechanisms to illustrate and solve simple chemical reactions involving reactive intermediates.	A	1,2
5	Analyse periodic trends, the relationship between electronic configuration and the chemical reactivity of elements, including the formation of chemical bonds.	An	1,2
6	Identify metals through flame and spot tests, chloride in water, and lead in food samples, and acquire skill in organic preparation.	S	1,2,10
<p><i>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</i></p>			

## COURSE CONTENT

### Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Atomic Structure</b>			
	1.1	Atomic spectrum of hydrogen atom, explanation using Bohr atom model, limitations of Bohr atom model.	4	1
	1.2	Dual nature of matter, de Broglie equation, Heisenberg's uncertainty principle and its significance.	2	1
	1.3	Concept of orbit and orbital. Types of orbitals, shapes of s, p and d orbitals.	2	1
	1.4	Quantum numbers and their significance.	2	1

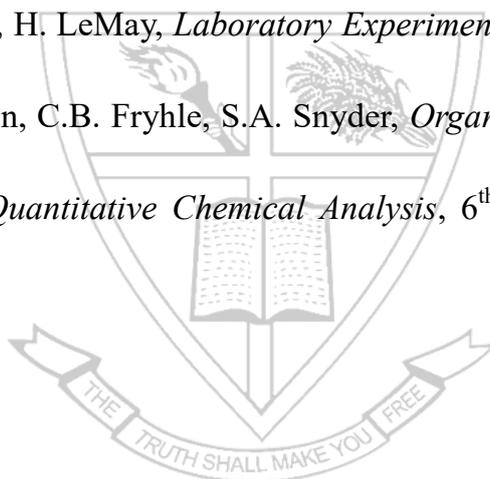
	1.5	Pauli's Exclusion Principle, Hund's rule of maximum multiplicity and Aufbau principle.	2	1
	1.6	Electronic configuration of atoms (upto atomic number 30). Stability of half-filled and completely filled electronic configurations.	3	1
	<b>Fundamentals of Organic Chemistry</b>			
<b>2</b>	2.1	Relevance of organic chemistry in day-to-day life (with 2-3 examples). Carbon: catenation and hybridisations (with examples ethane, ethene and ethyne).	3	2
	2.2	Arrow notations, bond fissions: curved arrow notation, drawing electron displacements with curved arrows, curved and fishhook arrows in organic reaction mechanisms. Polarity of bonds (basic concepts only).	2	3,4
	2.3	Homolysis and heterolysis with examples. Reactive intermediates: formation, structure and stability of carbocations, carbanions, and free radicals.	4	3,4
	2.4	Electron displacement effects: inductive effect- influence of inductive effect in the acidity of carboxylic acids. Resonance effect (delocalization, contributing structures, and stability) – hyperconjugation	6	3,4
	<b>Chemistry of Elements and Molecules</b>			
<b>3</b>	3.1	Modern periodic law – long form periodic table. Classification of elements- s, p, d and f block, metal, non-metals and metalloids.	4	5
	3.2	Diagonal relationship and anomalous	1	5

		behaviour.		
	3.3	Periodicity in properties: Atomic and ionic radii - ionization enthalpy - electron affinity (electron gain enthalpy) – electronegativity. Electronegativity scales: Pauling Scale	5	5
	3.4	Effective nuclear charge – Slater rule and its applications	2	5
	3.5	Valency and oxidation state with examples	1	5
	3.6	Introduction to molecules- types of bonds, ionic bond, covalent bond, coordinate bond	2	5
	<b>Foundation Course 1 Practical</b>			
4	4.1	<ol style="list-style-type: none"> <li>1. Demonstration of atomic models using software (non-evaluative)</li> <li>2. Detection of sodium, potassium, calcium, barium and strontium ions through flame test.</li> <li>3. Spot test of nickel, zinc and copper.</li> <li>4. Chloride ion detection in well water and tap water.</li> <li>5. Detection of lead in food samples.</li> <li>6. Draw structures of simple organic molecules and resonance structures using chem-sketch / chemdraw.</li> <li>7. Preparation of 5-nitrosalicylic acid from salicylic acid.</li> <li>8. Preparation of <i>p</i>-nitroacetanilide from acetanilide.</li> <li>9. Separation of the Components of a mixture by decantation, extraction, filtration and sublimation techniques.</li> </ol>	30	6

5	<b>Teacher-Specific content</b>
<b>Teaching and Learning Approach</b>	Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory( 25 marks)</b></p> <p>Assignments</p> <p>MCQ</p> <p>Viva</p> <p>Involvement in classroom activities</p> <p><b>Practical (15 marks)</b></p> <p>Lab skill/ analysis</p>
	<p><b>B. End Semester Evaluation (ESE)</b></p> <p><b>Theory- 50 marks – 1.5 hrs</b></p> <p>i) MCQ 10 questions: 10 X 1 = 10</p> <p>ii) Short answer 4 questions (out of 6): 4 X 3 =12</p> <p>iii) Short essay 4 questions (out of 6): 4 X 7 = 28</p> <p><b>Practical -35 marks - 2 hrs</b></p> <p>i) Lab report: 10</p> <p>ii) Viva: 10</p> <p>iii) Writing procedure: 15</p>

## References

1. A. Bahl, and B.S. Bahl, *Advanced Organic Chemistry*, S. Chand, 2010.
2. B. R. Puri, L. R. Sharma and K. C. Kalia, *Principles of Inorganic Chemistry*, Vikas Publishing Co. Jalandhar, 2013.
3. D. F. Shriver and P. W. Atkins, *Inorganic Chemistry*, 4<sup>th</sup> Edn. Oxford University Press, 2006.
4. F. A. Cotton, G. Wilkinson and P. L. Gaus, *Basic Inorganic Chemistry*, 3<sup>rd</sup> Edn. John Wiley, 2007.
5. F. P. Miller, A. F. Vandome, McB. John, *Flame Test*, VDM Publishing, 2010.
6. J. D. Lee, *Concise Inorganic Chemistry*, 5<sup>th</sup> Edn. Chapman & Hall, 2009.
7. P. W. Atkins and J. de Paula, *Physical Chemistry*, 11<sup>th</sup> Edn. Oxford University Press, 2018.
8. R.T Morrison, R.N. Boyd and S.K. Bhattacharjee *Organic Chemistry*, 7<sup>th</sup> Edn. Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
9. S M. Basavarajaiah, G. Y. Nagesh, K. R. Reddy, *Compendious Practical Organic Chemistry: Preparations, Isolation, and Chromatography*, Notion Press, 2021.
10. T. Brown, C. Murphy, H. LeMay, *Laboratory Experiments for Chemistry*, Pearson, 2018.
11. T.W. Graham Solomon, C.B. Fryhle, S.A. Snyder, *Organic Chemistry*, John Wiley & Sons, 2014.
12. Vogels *Textbook of Quantitative Chemical Analysis*, 6<sup>th</sup> Edn. Pearson Education Ltd.



## SUGGESTED READINGS

1. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry—Principles of Structure and Reactivity*, 4<sup>th</sup> Edn, Pearson Education, New Delhi, 2013.
2. J. Clayden, N. Greeves, S. Warren and P. Wothers, *Organic Chemistry*, 2<sup>nd</sup> Edn. Oxford University Press, 2012.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Food Chemistry and Nutrition</b>					
<b>Type of Course</b>	MDC					
<b>Course Code</b>	<b>UC1MDCCHE100</b>					
<b>Course Level</b>	<b>100-199</b>					
<b>Course Summary</b>	This course provides a comprehensive understanding of the composition and health implications of various food items.					
<b>Semester</b>	I	Credits			3	Total Hours
<b>Course Details</b>	Learning Approach	Lectur 2	Tutoria 1	Practic 1	Others	
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the concept of nutrition	U	1,2,3
2	Identify the use of various food additives	A	1,3,10
3	Describe the health effects of food adulterants	U	1,2,3,6.8, 10
4	Evaluate different adulterants in food	E	1,2,3,6, 10
5	Apply the concept of food chemistry to conduct simple laboratory experiments.	A	1,2,3,4, 10

**\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Introduction to Nutrition &amp; Food Additives</b>			
	1.1	Functions of food, nutrients in food- energy yielding nutrients (carbohydrates, proteins and lipids) and protective nutrients (vitamins and minerals)	3	1
	1.2	Food additives- definition, importance of food additives, types of additives -natural, synthetic and artificial- with one example. E- number	5	2
	1.3	Preservatives, food colours, flavour enhancers, sweeteners, emulsifiers, stabilizer, glazing agents, thickeners, gelling agents. (definition and applications with examples)	7	2
2	<b>Food Adulteration and Safety</b>			
	2.1	Food adulterants- definition, types (intentional and incidental contamination) and health effects.	3	3
	2.2	Common adulterants in different foods, their health effects and detection: milk, ghee, butter, honey, sweets, chilli powder, turmeric, tea, sugar and salt, black pepper, wheat and rice.	7	3
	2.3	Food adulteration act- objectives	1	4
	2.4	Modern food habits- introduction, health effects of fast food, junk food and instant food. Composition and health effects of soft drinks. a comparative study of traditional and modern food habits	4	4
<b>Food Chemistry and Nutrition Practical</b>				

3	3.1	<ol style="list-style-type: none"> <li>1. Detection of adulterants in food items-milk, turmeric powder and chili powder.</li> <li>2. Demonstration of preparation of value added food products- jam, squash.</li> <li>3. To find out the moisture content of a given food sample by Lab oven method.</li> <li>4. Test the solubility of vegetable oils in different solvents.</li> </ol>	30	5
4	<b>Teacher Specific content</b>			

<b>Teaching and Learning Approach</b>	<p style="text-align: center;"><b>Classroom Procedure (mode of transaction)</b></p> <p>Lecture Sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).</p>
<b>Assessment Types</b>	<p style="text-align: center;"><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory (15 marks)</b></p> <p>Assignments</p> <p>MCQ</p> <p><b>Practical (15 marks)</b></p> <p>Lab involvement/ report/Lab test</p>

	<p style="text-align: center;"><b>B. Semester end examination</b></p> <p style="text-align: center;"><b>Theory (35 marks)- 45 minutes</b></p> <p style="text-align: center;">MCQ 35 questions : 35 X 1 = 35</p> <p style="text-align: center;"><b>Practical (35 marks) -2 hr.</b></p> <p>I) Lab report: 10</p> <p>II) Viva: 10</p> <p>III) Writing procedure: 15</p>
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## References

1. B. Sreelakshmi, *Food Science*, New Age, 2018.
2. C. M. Weaver, J. R. Daniel, *The Food chemistry Laboratory*, CRC Press, 2005.
3. I. Bevier, *Food and Nutrition Laboratory Manual*, Forgotten Books, 2018.
4. Jayashree Ghosh, *Fundamental concepts of Applied chemistry*, S. Chand & Co. Publishers, 2010.
5. M. Swaminathan, *Food Science and Experimental foods*, Ganesh and Company, 2005.
6. S. Roday, *Food Science and Nutrition*, 3<sup>rd</sup> Edn. Oxford University Press, 2018.
7. S. Sehgal, *A Laboratory Manual of Food Analysis*, International Publishing, 2016.
8. Thankamma Jacob, *Text Books of applied chemistry for Home Science and allied Sciences*, Macmillan, 2015.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Fundamentals of Industrial Chemistry</b>					
<b>Type of Course</b>	<b>DSC B</b>					
<b>Course Code</b>	<b>UC1DSCCHE101</b>					
<b>Course Level</b>	<b>100-199</b>					
<b>Course Summary</b>	This course explores key inorganic materials, basic metallurgical operations, corrosion, industrial aspects of organic chemistry and nanochemistry.					
<b>Semester</b>	I	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
<b>Pre-requisites, if any</b>	Fundamentals of organic and inorganic Chemistry					

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply fundamental chemistry knowledge to enhance the efficiency, safety, and sustainability of chemical industries.	A	1, 2, 10.
2	Demonstrate proficiency in the selection of parameters for chemical industry processes	E	1, 2
3	Analyse availability, forms, structures, modifications, and basic industrial operations of key inorganic materials.	An	1, 2
4	Describe raw material extraction from petroleum/natural gas and the associated processes.	U	1, 2
5	Explain the fundamental concepts of nanochemistry	U	1, 2
6	Perform basic industrial chemistry	A, S	1, 2, 10

**\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Introduction to Industrial chemistry</b>			
	1.1	The difference between classical and industrial chemistry, classification of Industries, the chemical industry- basic requirements and production of chemicals and raw materials. Unit processes and unit operations. (definition and example)	4	1
	1.2	Quality control, quality assurance, process control, research and development, pollution control, human resource, safety measures, economics of chemical process, selection of parameters of chemical industry, classification of chemical reactions, batch and continuous operations, industrial chemical reactions,	4	1,2
	1.3	Raw material for organic compounds: petroleum, natural gas-fraction of crude oil, fractional distillation, cracking, reforming, hydroforming, isomerisation. Octane number and cetane number, knocking and antiknock compounds.	7	2,4
2	<b>Materials of industrial importance</b>			
	2.1	Inorganic materials of industrial importance: Alumina, silica, silicates, clay, mica, carbon, zeolites. Their availability, forms, structure and	2	1,2,3
	2.2	Organic chemicals of industrial importance: Cellulose and starch- properties, modification and important Industrial chemicals derived from them.	2	1,2,4

	2.3	Metallurgy: Basic metallurgical operations: pulverisation, calcination, roasting and refining. Physicochemical principle of extraction of iron, copper, aluminium, zinc, uranium and titanium. Steel- classification, heat treatment and passivity.	5	1, 3
	2.4	Corrosion Introduction, dry or chemical corrosion, wet or electrochemical corrosion, mechanism of electrochemical corrosion, factors influencing corrosion, corrosion control- proper designing, using pure metal, using metal alloys and cathodic protection. Chemical conversion- coating, phosphating, chromising and treatment of metal surfaces- hot dipping. Use of inhibitors. Rusting of	6	1
		<b>Nanochemistry</b>		
3	3.1	Introduction: Definition and length scales. Classifications of nanomaterials. Comparison of bulk and nanomaterials. Introduction to 'top down' and 'bottom up' approach of synthesis with suitable examples. Characteristics of Nanomaterials: nucleation and growth of nanosystems, self-assembly. Nano in Nature: Gecko Effect, lotus leaf effect, superhydrophobicity, self-cleaning and antifogging – colored glasses and dichroism	7	5
	3.2	Advanced Nanostructured Materials: Preparation and Properties and applications of graphene, CNTs and fullerenes. Nanorods, nanofibre, nanowires, nanoclay, quantum dots and nanocomposites.	8	1,2,6
4	<b>Fundamentals of Industrial Chemistry Practical</b>			

	<p>1. Simple laboratory techniques: crystallisation and distillation.</p> <p>2. Estimation of copper in brass.</p> <p>3. Water Analysis</p> <p>i) Estimation of hydroxide alkalinity, carbonate and bicarbonate alkalinity of the given water sample volumetrically</p> <p>ii) Estimation of chloride in water</p> <p>iii) Determination of total, temporary and permanent hardness using EDTA.</p> <p>iv) Estimation of chloride in water</p> <p>v) Determination COD of the given water sample</p> <p>vi) Estimation of dissolved oxygen by Winkler's method</p> <p>4. Ore Analysis</p> <p>i) To analyse the amount of calcium present in a given sample of limestone.</p> <p>ii) Quantitative analysis of calcium and magnesium in dolomite by complexometric titration.</p> <p>iii) Estimation of Iron in iron ore.</p> <p>iv) Estimation <math>MnO_2</math> in pyrolusite</p>	30	6
5	<b>Teacher Specific content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b></p> <p>Lecture</p> <p>Tutorial</p> <p>Hybrid</p> <p>ICT enabled teaching and learning</p> <p>Demonstration</p>
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<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>Theory (25 marks)</b> Assignments/ MCQ/ viva/ class test: <del>Practical (15 marks) Lab involvement and report /Lab test</del>
	<b>B. Semester end examination</b> <b>Theory ( 50 marks)- 1.5 hrs</b> MCQ 10 questions: 10 X 1 = 10 Short answer 4 questions (out of 6): 4 X 3 =12 Short essay 4 questions (out of 6): 4 X 7 = 28  <b>Practical (35 marks)- 2 hr.</b>  Lab report : 10 Viva : 10 Writing procedure:15

### References

1. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry* 8<sup>th</sup> Edn. Brooks/Cole Nelson, 2018.
2. E. Stocchi, *Industrial Chemistry, Vol-I*, Ellis Horwood Ltd. UK.
3. Gurdeep Raj, *Advanced Practical Inorganic Chemistry*, Goel Publishing House, 2020.
4. J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. J. Bockris and K. N. Reddy, *Modern Electrochemistry 2B*, 2nd Edition, Springer, 2018.
6. K. Sharma, *Industrial Chemistry*, Krishan Prakashan, 2014.
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8. R. Gopalan, D.Venkappayya, S.Nagarajan, *Engineering Chemistry*, Vikas Publications, New Delhi
9. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
10. R.E. J. Hoffmann, *Coal conversion*, the Energon Co. Lavamic, Wyoming USA
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13. S. Rani, S. K. Bashin, *Laboratory Manual on Engineering Chemistry*, Dhanpat Rai, 2012.
14. S.S. Dara, *A text book on experiments and calculations in engineering chemistry*, S. Chand & Company Ltd., Delhi, 2015.
15. Vogel's Qualitative Inorganic Analysis, 7th Edn. Pearson Education Ltd.
16. Vogel's Textbook of Quantitative Chemical Analysis, 6<sup>th</sup> Edn, Pearsons Education Ltd.
17. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Fundamentals of Petroleum Geochemistry</b>					
<b>Type of Course</b>	<b>DSC C</b>					
<b>Course Code</b>	<b>UC1DSCCHE102</b>					
<b>Course Level</b>	<b>100-199</b>					
<b>Course Summary</b>	This is a basic course in fundamentals of petroleum geochemistry. The students will be exposed to the origin of petroleum, different oil exploration techniques and composition of crude oil.					
<b>Semester</b>	I	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	75
		3	1	1		
<b>Pre-requisites, if any</b>	NIL					

## COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Formulate theories regarding the origin of petroleum	C	1,3
2	Develop an idea of the Resource, reserves and mechanics of accumulation.	A	1,3
3	Categorise various exploration techniques of crude oil	An	1,3
4	Outline the composition of crude oil	U	1,2,3
5	Explain the properties of hydrocarbon	U	2
6	Develop an idea about the analysis of quality parameters of different fuels	A	2,10

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate I, Create (C), Skill (S), Interest (I) and Appreciation (Ap)*



## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	<b>Origin of petroleum</b>			
<b>1</b>	1.1	<p>Petroleum: A natural resource, Historical overview of petroleum. Theories of origin of petroleum–biogenic and abiogenic theory. Berthelot’s view, Mendeleeff’s view, Engler’s theory and modern theory. Nature of source material. Transformation of organic matter into petroleum–diagenesis, catagenesis, metagenesis. In situ transformation of petroleum– thermal alteration, deasphalting, biodegradation and water washing. Factors controlling the occurrence of petroleum. Petroleum reserves: Proved, probable,</p>	5	1
	1.2	<p>Petroleum reservoirs: Source rock, reservoir rock- clastic and non clastic reservoir rock, development and types of porosity in these rocks, control of permeability. Hydrocarbon trap: Classification and types of hydrocarbon traps–structural, stratigraphic and combination traps. Structural Traps–Anticline traps, fault traps, fracture traps, salt domes.</p> <p>Kerogen: source material and formation, composition and distribution. Catagenesis of kerogen into petroleum and natural gas. Oil</p>	10	2

		window concept.		
<b>Oil Exploration- Petroleum exploration techniques</b>				
2	2.1	Surface exploration-Geological exploration, photogeology, remote sensing and geographic information system, geochemical exploration, geobotanical exploration. Subsurface exploration – gravity method, magnetic method, electrical method, Self-Potential method (SP), Resistivity method, electromagnetic method, seismic method, pitting, trenching, drilling and borehole logging. Borehole logging-radioactive logging, acoustics logging, density logging, core sampling.	15	3
<b>Composition of crude oil</b>				

3	3.1	Paraffins, cycloparaffins or naphthenes, aromatic hydrocarbons, olefins, sulphur compounds, nitrogen compounds, oxygen compounds, metallic constituents, organometallic hydrocarbons. Classification of crude oils: physical, chemical and genetic classification. Unconventional resources of hydrocarbons: gas hydrates, shale gas, basin centric gas, coal bed methane, tight gas.	10	4
	3.2	Properties of hydrocarbons: Density, viscosity, surface tension, cloud point, pour point, aniline point, diesel index, flash point, refractive index and calorific value.	5	5
<b>Fundamentals of Petroleum Geochemistry Practical</b>				
4		<ol style="list-style-type: none"> <li>1. Determination of density of light oils</li> <li>2. Determination of density of medium type oils</li> <li>3. Determination of Aniline point of diesel fuel</li> <li>4. Determination of Diesel Index and API gravity</li> <li>5. Determination of surface tension of kerosene</li> <li>6. Determination of Viscosity of Diesel</li> <li>7. Determination of Pour point.</li> <li>8. Determination of Cloud point.</li> </ol>	30	6
5	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom procedure (mode of transaction)</b> Lecture Tutorial Hybrid ICT enabled teaching and learning Demonstration
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>Continuous Comprehensive Assessment (CCA)</b> <b>Theory (25 marks)</b> Assignments/MCQ/ viva /class test <b>Practical (15 marks)</b> Lab involvement and report/Lab test
	<b>Semester end examination</b> <b>Theory( 50 marks) -1.5 hrs.</b> MCQ 10 questions: 10 X 1 = 10 Short answer 4 questions (out of 6): 4 X 3 =12 Short essay 4 questions (out of 6): 4 X 7 = 28  <b>Practical (35 marks)- 1hr.</b> Lab report: 10 Viva: 10 Writing procedure: 15

## References

1. *ASTM Methods*, Indian standards (Methods of test for petroleum and its Products).
2. B. K Sharma, *Industrial Chemistry*, Goyal Publication, 2000.
3. D. S. J. Jones, *Elements of Petroleum Processing*, 1996.
4. G .N.Tripathi, *Indian Petroleum Directory*, Indian Petroleum Publishers, 2007.
5. M. B. Roger, *Geological methods in mineral exploration and mining*, Springer Publications, 2<sup>nd</sup> Edition, 2010.
6. P.T. Sawant, *Engineering and General Geology*, New India Publishing Agency, New Delhi 2011.
7. R. C. Selly, *Elements of Petroleum Geology*, Academic press, London, 2016.
8. S. G James, M. Dekker, *The Chemistry and Technology of Petroleum*, 1991.

## SUGGESTED READINGS

1. J. G Speight, *Handbook of Petroleum Product Analysis*, Second edition, Wiley 2014.
2. J.M. Hunt, *Petroleum Geochemistry and Geology*, 2<sup>nd</sup> Edn W H Freeman, San Francisco. 1996.
3. K. B. Manjooran, *Modern Petroleum Chemistry—An Overview*, 2016.
4. P. H Splitz, *Petrochemicals: The Rise of an Industry*, 1988.
5. S L Sah, *Encyclopedia of petroleum science and engineering: Processing, interpretation and reservoir engineering*, Vol.2 2003.
6. S. L. Sah, *Encyclopedia of petroleum science and engineering: Exploration*, Vol.1. 2010.
7. S. Maiti, *Introduction to Petrochemicals*, 2002.
8. Z. Sajid, *Practical Handbook on Fuel Properties and Testing*, Lap Lambert Academic Publishing 2014.

## SEMESTER-II

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Fundamentals of Chemistry-2</b>					
<b>Type of Course</b>	<b>DSC A</b>					
<b>Course Code</b>	<b>UC2DSCCHE100</b>					
<b>Course Level</b>	<b>100-199</b>					
<b>Course Summary</b>	This course provides a basic understanding of the physical nature of matter, reactions in organic chemistry and the analytical tools for chemical investigations and identifications.					
<b>Semester</b>	II	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Make use of fundamental principles of analytical chemistry to solve quantitative titrimetric problems.	A	1,2
2	Classify various types of organic reactions based on their mechanisms.	U	1,2
3	Describe the fundamental principles governing the	U	1,2

	behaviour of different states of matter.		
4	Compare and contrast the properties of solids, liquids, and gases.	An	1,2
5	Apply the basic principles of analytical chemistry in preparation of standard solutions, acid-base titrations and in the determination of viscosity and surface tension.	S	1,2,10
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Basic Concepts in Analytical Chemistry</b>			
	1.1	Molecular mass - mole concept. Oxidation and reduction (electron concept only)	2	1
	1.2	Titrimetric analysis - fundamental concepts-analyte, end point, indicators etc. Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and ppb. Primary and secondary standards, quantitative dilution – problems	6	1
	1.3	Acid base concepts Arrhenius definition, Bronsted-Lowry definition and conjugate acid-base pairs, Lewis concept, ionization of acids and bases.	2	1
	1.4	Acid base titrations- strong acid -strong base, strong acid – weak base, weak acid – strong base weak acid – weak base - pH indicators (phenolphthalein and methyl orange), redox titrations	5	1

<b>Introduction to Organic Reactions</b>				
<b>2</b>	2.1	Representation of organic molecules: projection formulae (Fischer, Sawhorse, Flying wedge and Newman)	3	2
	2.2	Types of reagents: electrophiles and nucleophiles	1	2
	2.3	Addition reactions: Markovnikov's addition, peroxide effect. Elimination reactions: E <sub>1</sub> and E <sub>2</sub> mechanism. Substitution reactions (S <sub>N</sub> 1, S <sub>N</sub> 2 reactions of alkyl halides only).	8	2
	2.4	Polymers- Basic concepts. Addition polymerisation (polyethylene, PVC)	3	2
<b>States of matter</b>				
<b>3</b>	3.1	Matter and its different states (elementary idea only), intermolecular forces: dipole-dipole interaction, dipole-induced dipole interaction and induced dipole-induced dipole interaction, ion-dipole interaction, hydrogen bonding: intra and intermolecular hydrogen bonds- effect on physical properties.	4	3,4
	3.2	Gaseous state: - postulates of kinetic theory, ideal and real gas behaviour, compressibility factor deviation from ideal behaviour, van der Waals equation (no derivation)	4	3,4
	3.3	Liquid state: properties of liquids: vapour pressure, boiling point, surface tension, viscosity.	3	3, 4
	3.4	Solid state: types of solids: crystalline and amorphous solids: ionic solids: unit cell, crystal systems, Bravais lattices.	4	3,4

<b>Fundamentals of Chemistry-2 Practical</b>			
<b>4</b>	1. Calibration of apparatus -Standard flask and preparation of standard molar solutions of any two primary standards-Oxalic acid, Mohr's Salt, Na <sub>2</sub> CO <sub>3</sub> . 2. Determination of pH of different water sources, common acids and bases using pH meter/pH strips 3. Acid base titration- acidimetry and alkalimetry: titration of strong acid vs. strong base, strong acid vs. weak base and weak acid vs. strong base. 4. Estimation of citric acid in citrus fruits. 5. Determination of viscosity of liquids using Ostwald viscometer. 6. Determination of surface tension of liquids using stalagmometer. 7. Identification of substances by physical properties such as colour, melting point, boiling point, solubility, density etc.	30	5
<b>5</b>	<b>Teacher Specific content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding, encourage students to ask questions during or after the lectures, begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>C. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory (25 marks)</b></p> <p>Assignments/MCQ/Viva/Involvement in classroom activities</p>

	<p><b>Practical (15 marks)</b></p> <p>Lab involvement/report /Lab test</p>
	<p><b>D. Semester end examination</b></p> <p><b>Theory ( 50 marks)- 1.5 hrs</b></p> <p>i) MCQ 10 questions : 10 X 1 = 10</p> <p>ii) Short answer 4 questions (out of 6): 4 X 3 =12</p> <p>iii) Short essay 4 questions (out of 6): 4 X 7 = 28</p> <p><b>Practical ( 35 marks)-3 hrs.</b></p> <p>Lab report: 10</p> <p>Viva: 10</p> <p>Analysis and Procedure: 15</p>

## References

1. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, S. Chand, 2010.
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8<sup>th</sup> Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6<sup>th</sup> Edn., Pearson Education, Noida, 2013.
4. J.B. Yadav, *Advanced Practical Physical Chemistry*, Krishna Prakashan, 2016.
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6. K. L. Kapoor, *A Textbook of Physical chemistry* , Volume 1, Macmillan India Ltd, 2020.
7. K.K. Sharma, *An Introduction of Practical Chemistry*, Vikas Publishing House, New Delhi, 1984.
8. P W Atkins, *Physical Chemistry*, 11<sup>th</sup> Edn. Oxford University Press, 2018.
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11. T. Brown, C. Murphy, H. LeMay, *Laboratory Experiments for Chemistry*, Pearson, 2018.

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13. *Vogels Textbook of Quantitative Chemical Analysis*, 6<sup>th</sup> Edn. Pearson Education Ltd, 2009.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Dairy Chemistry</b>					
<b>Type of Course</b>	MDC					
<b>Course Code</b>	<b>UC2MDCCHE100</b>					
<b>Course Level</b>	<b>100-199</b>					
<b>Course Summary</b>	This course will enable students to understand various types of milk, processing methods and the production of various dairy products.					
<b>Semester</b>	II	Credits			3	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		2		1		60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PO No
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No.		Domains *	
1	Evaluate the quality and nutritive value of milk by knowing the general chemical composition	E	1,2,3,6,10
2	Describe the techniques of milk processing	U	1,2,3,10
3	Compare different types of processed milk.	U	1,2,3,6,10
4	Classify various types of milk products based on their composition and processing methods	An	1,3,10
5	Demonstrate the preparation of various milk products	A	1,2,3,4,6,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Composition and processing of Milk</b>			
	1.1	Milk- Definition, general composition of milk (cow, buffalo, goat and human) -water, protein, lactose and fat. Nutritive value of milk. Colostrum: significance, composition, difference between normal milk and colostrum.	6	1
	1.2	Physico-chemical properties of milk- color, odour, density, acidity, germicidal properties, viscosity. Adulteration of milk and detection. Preservatives and neutralizers.	5	1
	1.3	Quality assurance – FSSAI, PFA, AGMARK.	1	1
	1.4	Importance of milk processing- filtration, clarification, boiling, homogenization and pasteurization. Types of	3	2

		pasteurization- LTLT and HTST.		
<b>2</b>	<b>Special milk and Milk products</b>			
	2.1	Standardised milk - definition – merits. Homogenised milk, flavoured milk, vitaminised milk, toned milk, incitation milk, vegetable toned milk, condensed milk - definition composition and nutritive value.	4	3
	2.2	Butter - definition - composition - theory of churning – desi butter, salted butter. Ghee - major constituents - common adulterants added to ghee and their detection - rancidity - definition – prevention. Cream- definition-composition-chemistry of creaming process.	6	4
	2.3	Fermented milk products - fermentation of milk - definition and conditions. Yogurt and Curd (introduction and methods of production). Khoa and chana -definition and preparation - sweets – peda, burfi, gulab jamun, rasogolla. Milk powder - definition	5	4
<b>3</b>	<b>Dairy Chemistry Practicals</b>			
	3.1	1. Demonstration of preparation of khoa based products- peda, milk cake 2. Demonstration of preparation of chana based products- paneer 3. Determination of pH of milk 4. Determination of moisture content in paneer by lab oven method	30	5
<b>4</b>	<b>Teacher Specific content</b>			

<p><b>Teaching and Learning Approach</b></p>	<p><b>Classroom procedure (mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).</p>
<p><b>Assessment Types</b></p>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>1. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory (15 marks)</b>  Assignments/MCQ/Viva</p> <p><b>Practical(15 marks)</b>  Lab involvement/report /Lab test</p>
	<p><b>2. Semester End examination</b></p> <p><b>Theory (35 marks) -45 minutes</b>  MCQ 35 questions : 35 X 1 = 35</p> <p><b>Practical (35 marks)- 2 hr.</b></p> <p>I) Lab report: 10  II) Viva: 10  III) Writing procedure: 15</p>

**References**

1. D. Richmond, *Laboratory Manual of Dairy Analysis*, Biotech Books, 2008.
2. F.P. Wong., *Fundamentals of Dairy Chemistry*, Springer, 2012.
3. J. N. Warner, *Principles of Dairy Processing*, Wiley, 1976.
4. K.S.Rangappa and K.T Acharya., *Indian Dairy Products*, Asia Publishing House, 1975.
5. L.M. Lampert., *Modern Dairy products*, Chemical Publishing Company Inc., 1998.
6. R. Jenness and S. Patom, *Principles of Dairy Chemistry*, Wiley, 2017.
7. Sukumar De, *Outlines of Dairy technology*, Oxford, 2001.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>						
<b>Course</b>	<b>Major Chemical Industries</b>						
<b>Type of Course</b>	<b>DSC B</b>						
<b>Course</b>	<b>UC2DSCCHE101</b>						
<b>Course</b>	<b>100-199</b>						
<b>Course Summary</b>	This course deals with different types of chemical industries and practical aspects of industrial chemistry.						
<b>Semester</b>	II	Credits				4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others		
		3		1		75	
<b>Pre-requisites, if</b>	Basics of industrial chemistry						

## COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse various industries in chemistry	An	1, 2
2	Explain the applications of chemistry in various fields	U	1, 2
3	Demonstrate the types, functioning and applications of batteries	U	1, 2
4	Describe different types of polymers and polymer processing techniques.	U	1, 2
5	Explain the fundamental aspects of non-	U	1, 2
6	Conduct basic industrial chemistry experiments.	A, S	1, 2

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
<b>Silicate and Ceramics Industries</b>				
<b>1</b>	1.1	Silicate Industries Glass: Glassy state and its properties, Classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following: soda lime, lead, armoured, safety, borosilicate, fluorosilicate, coloured and photosensitive glasses	6	1,2
	1.2	Ceramics: Ceramic, their types and manufacture. High technology ceramics and their applications, super conducting and semiconducting oxides, fullerenes, carbon nanotubes and carbon fibre clays	6	1,2

	1.3	Surface Coatings: objectives, preliminary treatment of surface and classification of surface coatings. Paints and pigments - formulation, composition and related	3	1,2
	<b>Battery</b>			
2	2.1	Batteries: Primary and secondary batteries, basic theory, electrochemical cell, EMF of the cell, Nernst equation and EMF.	6	1,2,3
	2.2	Battery components and their role and. The discharge plot, the ragone plot and measures of battery performance	4	1,2,3
	2.3	Working of Pb acid, Li- ion and solid state electrolyte battery. Fuel Cells, solar cells and polymer cells.	5	1, 2, 3
	<b>Polymer Industry and Non-petroleum Fuels</b>			
3	3.1	Polymer industry: Plastics- thermosetting and thermoplastics-moulding of plastics into articles- compression moulding, injection moulding, transfer moulding, extrusion moulding, blow moulding and transfer moulding. Other methods for plastic processing- calendaring, casting, thermoforming, foaming	8	1, 2,4
	3.2	Non-petroleum fuels - CNG, LNG, biodiesel, bio-gas, fuels derived from biomass; fuel from waste; gaseous fuels. Basic idea about synthetic fuels-Fischer-Tropsch synthesis and Bergius process. Coal: types- distillation of coal-carbonization-types of carbonization.	7	1, 2, 5
	<b>Practical</b>			

4	<p>1. Alloy analysis</p> <p>i) Estimation of copper in brass</p> <p>ii) Estimation of zinc in brass</p> <p>2. To determine the percentage of <math>\text{NaHCO}_3</math> in a mixture of <math>\text{NaHCO}_3</math> and <math>\text{NaCl}</math>.</p> <p>3. Determination of weight percent of acetic acid in vinegar.</p> <p>4. Determination of percentage of iron in Mohr's salt.</p> <p>5. Determination of the percentage of silica, calcium, magnesium and iron in the given cement sample.</p>	30	6
5	<b>Teacher Specific content</b>		

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<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision.</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A.</b></p> <p style="text-align: center;"><b>Continuous Comprehensive Assessment (CCA)</b></p> <p style="text-align: center;"><b>Theory ( 25 marks)</b></p> <p>Assignments/MCQ/Viva/Involvement in classroom activities</p> <p style="text-align: center;"><b>Practical (15 marks)</b></p> <p>Lab involvement and report /Lab test</p>

	<p style="text-align: center;"><b>B. Semester end examination</b></p> <p style="text-align: center;"><b>Theory ( 50 marks)-1.5 hrs.</b></p> <p>MCQ 10 questions : 10 X 1 = 10  Short answer 4 questions (out of 6): 4 X 3 =12  Short essay 4 questions (out of 6): 4 X 7 = 28</p> <p style="text-align: center;"><b>Practical ( 35 marks)-1 hr.</b></p> <p>Lab report: 10  Viva: 10  Writing procedure: 15</p>
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## References

1. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th edn, Brooks/Cole Nelson, 2018.
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6. L.F.Hath, S. Matarm, *From Agro Carbons to petrochemicals*, Gulf publishing Co., Houston.
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8. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
9. R.E. J. Hoffmann, *Coal conversion*, the Energon Co. Lavamic, Wyoming USA
10. S. K. Friedlander, *Smoke, Dust and Haze: Fundamentals of Aerosol Behaviour*. New York: John Wiley & Sons.
11. S. Rani, S. K. Bashin, *Laboratory Manual on Engineering Chemistry*, Dhanpat Rai, 2012.
12. S.S. Dara, *A text book on experiments and calculations in engineering chemistry*, S. Chand & Company Ltd., Delhi, 2015.
13. Vogel's *Qualitative Inorganic Analysis*, 7th Edn. Pearson Education Ltd., 2014.
14. *Vogel's Textbook of Quantitative Chemical Analysis*, 6<sup>th</sup> Edn, Pearsons Education Ltd.
15. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>				
<b>Course</b>	<b>Drilling, Transportation and Refining Techniques</b>				
<b>Type of</b>	<b>DSC C</b>				
<b>Course Code</b>	<b>UC2DSCCHE102</b>				
<b>Course Level</b>	<b>100-199</b>				
<b>Course Summary</b>	This is a basic course in drilling operation and transportation techniques of petroleum products. The students will be exposed to drilling operations, oil field brines, transportation and refining of petroleum				
<b>Semester</b>	II	Credits			Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others
		3		1	
<b>Pre-requisites, if any</b>	NIL				

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Categorise various drilling operations of crude	An	1,2,3
2	Explain Transportation of crude oil	U	1,2
3	Develop Crude oil distillation procedures	A	1,2
4	Assess composition of different distillates	E	1,2
5	Classify different types Heat exchangers	U	1,2
6	Examine various Hydrocarbon testing methods	An	1,2
7	Make use of evaluation methods of various	A	1,2

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Drilling Operations &amp; Transportation of Crude Oil</b>			
	1.1	Basic drilling operations, rig and rig site, methods of drilling-cable tool method, rotary method, offshore drilling, Rig safety and environmental	5	1
	1.2	Recovery of oil - natural method (primary oil recovery) - dissolved gas drive, gas cap drive, water drive, gravity drive. Applied flow method (secondary oil recovery) - gas flood method, water flood method. Other sources of petroleum. Petroleum from coal, natural gas and its constitution. Oil field Brines: Composition, classifications, origin and alteration of oil field brines. Importance of oil field	5	1
	1.3	Oil and gas transportation-truck, tankers, pipeline transfer and railway. Type of storage tanks - cone roof and floating roof, nitrogen blanketing.	5	2
	<b>Crude oil Distillation</b>			
	2.1	Function of refineries: simple refinery, complex refinery, integrated refinery.	6	3

2	2.2	Sour gas and Sweet gas, sweetening process. Distillation of crude oil- distillation procedures, separation of products from crude oil, fractional distillation, vacuum distillation, stripping. Composition of different distillates (LPG, Propylene, Naphtha, Gasoline, Aviation fuel, Kerosene,	6	4
	2.3	Heat exchangers-types of heat	3	5
<b>Hydrocarbon and its testing</b>				
3	3.1	Testing methods: Density, atmospheric distillation, vacuum distillation, chloride content, viscosity, elemental analysis (S, Cl, N), specific gravity, sulphur content, mercaptan sulphur, existent gum, potential gum, oxidation stability, cloud point, pour point, pour point depressants, Reid vapour pressure, Cetane Index, API gravity, copper corrosion, research octane number (RON), Doctor solution test, flash point(Abel and PMC method), penetration, elastic recovery, ductility, softening point and calorific value.	15	6
<b>Drilling, Transportation and Refining Techniques Practical</b>				

4	Test Methods of Petroleum Products 1. Distillation of Petrol 2. Distillation of Kerosene 3. Distillation of Diesel 4. Determination of water content in diesel – Dean Stark Method 5. Determination of moisture content(ppm) in diesel-Potentiometric method 6. Determination of water content in furnace oil-Dean Stark Method 7. Determination of Flash point- PMC method. 8. Determination of Flash point- Abel’s method. 9. Determination of Smoke point of kerosene 10. Determination of softening point of bitumen	30	7
5	<b>Teacher Specific content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A.</b></p> <p><b>Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory ( 25 marks)</b></p> <p>Assignments/ MCQ/Viva/Involvement in classroom activities</p> <p><b>Practical ( 15 marks)</b></p> <p>Lab involvement and report /Lab test</p>

	<p><b>B.</b></p> <p style="text-align: center;"><b>Semester end examination</b></p> <p style="text-align: center;"><b>Theory ( 50 marks)-1.5 hrs.</b></p> <p>MCQ 10 questions : 10 X 1 = 10  Short answer 4 questions (out of 6): 4 X 3 =12  Short essay 4 questions (out of 6): 4 X 7 = 28</p> <p style="text-align: center;"><b>Practical ( 35 marks)-1 hr.</b></p> <p style="text-align: center;">Lab report: 10  Viva: 10  Writing procedure: 15</p>
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9. Z. Sajid, *Practical Handbook on Fuel Properties and Testing*, Lap Lambert Academic Publishing 2014.



### SEMESTER 3

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Inorganic Chemistry-1</b>
<b>Type of Course</b>	DSC A
<b>Course Code</b>	<b>UC3DSCCHE200</b>
<b>Course Level</b>	<b>200-299</b>
<b>Course Summary</b>	This course addresses bonding concepts in molecules, chemistry of p, f and d block elements and discusses the fundamentals of coordination chemistry. The practical component includes preparation of complexes

	and complexometric titrations.					
<b>Semester</b>	III	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning approach	Lecture	Tutorial	Practical	Others	
<b>Pre-requisites, if any</b>			3		1	

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply the bonding concepts to molecules.	A	1,2,10
2	Compare the physical and chemical properties of lanthanides and actinides.	An	1, 2
3	Explain different nuclear reactions.	U	1,2
4	Differentiate the theories of coordination complexes of d-block elements.	An	1,2
5	Apply the knowledge for estimation of Zn, Ca and Mg using complexometric titrations and complex preparations.	A, S	1,2,10

*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Chemical Bonding</b>			
	1.1	Properties of ionic compounds, lattice energy of ionic compounds - Born-Landé equation with derivation - solvation enthalpy and solubility of ionic compounds – Born-Haber cycle and its	3	1

	applications.		
1.2	Polarisation of ions – Fajan's rule and its applications.	2	1
1.3	Covalent Bond: VSEPR theory- Postulates and applications .Valence Bond Theory and its limitations. Hybridization: definition, characteristics, and shape of molecules (BeCl <sub>2</sub> , BF <sub>3</sub> , NH <sub>4</sub> <sup>+</sup> , H <sub>3</sub> O <sup>+</sup> , PCl <sub>5</sub> , SF <sub>6</sub> , XeF <sub>2</sub> , XeF <sub>4</sub> , XeOF <sub>2</sub> , XeOF <sub>4</sub> , and XeF <sub>6</sub> ).	5	1
1.4	Properties of covalent compounds - polarity of bonds – percentage of ionic character – dipole moment and molecular structure.	2	1
1.5	Molecular Orbital Theory: LCAO – bonding and antibonding molecular orbitals – bond order and its significance. MO diagrams of homonuclear and heteronuclear diatomic molecules: N <sub>2</sub> , O <sub>2</sub> , F <sub>2</sub> , CO and NO – comparison of bond length, magnetic behaviour and bond energy of O <sub>2</sub> , O <sub>2</sub> <sup>+</sup> , O <sub>2</sub> <sup>2+</sup> , O <sub>2</sub> <sup>-</sup> and O <sub>2</sub> <sup>2-</sup> .	3	1
<b>Chemistry of f-block elements and radioactivity</b>			
2.1	Lanthanides: lanthanide series, abundance and natural isotopes, separation of lanthanides, lanthanide contraction, similarity in properties, occurrence, oxidation states, chemical properties of Ln(III) cations, magnetic properties, colour and electronic spectra of lanthanide compounds.	6	2
2.2	Chemistry of actinides – actinide series, abundance and natural isotopes, occurrence, preparation of actinides, oxidation states, general properties.	2	2
2.3	Radioactivity – natural and artificial radioactivity; types of radioactive decay, Group displacement law, rate of disintegration - half life, nuclear fission and nuclear fusion reaction, chain reactions.	4	3
2.4	Applications of radioactive decay: carbon dating,	3	3

		and nuclear medicine. Nuclear pollution and hazards.		
<b>3</b>	<b>d-block elements and coordination compounds</b>			
	3.1	Transition Metals: General characteristics.	2	4
	3.2	Werner's theory, types of ligands, coordination number, oxidation state. Geometry of complexes with coordination numbers 4 and 6.	2	4
	3.3	Stability of complexes: factors affecting the stability of metal complexes. Chelates, chelate effect. Theory of complexometric titrations.	2	4
	3.4	Isomerism in coordination compounds – structural isomerism and stereoisomerism (complexes with 4 and 6 coordination numbers).	2	4
	3.5	Valence bond theory, geometries of tetrahedral, square planar and octahedral (inner and outer orbital) complexes. Limitations of VB theory.	3	4
	3.6	Crystal field theory, splitting of d-orbitals in octahedral, tetrahedral, and square-planar complexes-introduction to Mulliken symbol, low spin and high spin complexes. Spectrochemical series-strong and weak field ligands, CFSE, pairing energy.	4	4
<b>4</b>	<b>Inorganic Chemistry-1 Practical</b>			
	4.1	Identify salts visually – Cobalt chloride, copper chloride, copper sulphate, ferrous sulphate, ferric chloride, potassium dichromate and nickel chloride.	2	5
	4.2	Preparation of simple coordination complexes such as hexaaquacobalt(II), hexaaquacopper(II), hexaaquanickel(II) ions and prussian blue.	8	5
	4.3	Complexometric titration using EDTA Estimation of Ca, Mg and Zn Determination of hardness of water	10	5

	4.4	Permanganometry 1. Estimation of $\text{Fe}^{2+}$ 2. Estimation of oxalic acid 3. Estimation of calcium	10	5
5	<b>Teacher Specific content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom procedure (mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Demonstration of experiments</li> <li>● Hands-on training</li> </ul>
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b>  <b>A. Continuous Comprehensive Assessment</b>  <b>Theory(25 marks)</b> Assignment /Viva /Class test  <b>Practical(15 marks)</b> Lab involvement / Viva
	<b>B. Semester end examination</b>  <b>Theory: Written examination (50 Marks)-1.5 hrs.</b>  i) MCQ 10 questions : 10 X 1 = 10 ii) Short answer 4 questions (out of 6): 4 X 3 =12 iii) Short essay 2 questions (out of 3): 2 X 7 = 14 iv) Essay 1 question (out of 2): 1 X 14 = 14  <b>Practical: (35 marks)- 1 hr.</b>  Certified report, procedure and viva voce (10+15+10=35 Marks)

## References

1. B. Douglas, D. Mc Daniel and J. Alexander, *Concepts and models in Inorganic Chemistry*, 3<sup>rd</sup> Edn Wiley, 2006
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2. G.L. Miessler, and A. Tarr, Donald *Inorganic Chemistry* 3<sup>rd</sup> Edn.(adapted), Pearson, 2009
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Organic Chemistry-1</b>
<b>Type of Course</b>	DSC A
<b>Course Code</b>	<b>UC3DSCCHE201</b>
<b>Course Level</b>	<b>200-299</b>
<b>Course Summary</b>	This course explores the chemical principles underlying alkanes, alkenes, alkynes, and aromatic compounds. Additionally, it covers fundamental

	stereochemistry concepts. The practical segment of the course focuses on some methods used in organic qualitative analysis.					
<b>Semester</b>	III	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning approach	Lecture	Tutorial	Practical	Others	
		3		1		75
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Distinguish between aliphatic, aromatic, and non-aromatic compounds.	An	1,2
2	Deduce the logical mechanism of reactions of aliphatic and aromatic compounds.	E	1,2,10
3	Outline industrial uses of aliphatic compounds.	U	1,2
4	Assign R, S, E and Z notation to compounds.	A	1,2,10
5	Compare stabilities of conformations of organic molecules.	An	1,2
6	Determine aromatic/aliphatic, saturated/unsaturated character and physical constants of organic compounds by microscale analysis and systematically record the observations.	An, S	1,2,4,6,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Alkane, Alkenes and Alkynes</b>			
	1.1	Alkanes: physical properties, industrial use - LPG and petrol, preparation-Wurtz reaction.	3	1, 2

		Reactions- Free radical substitutions (chlorination) with mechanism and cracking.		
	1.2	Alkenes: physical properties, industrial uses of ethylene, preparation- Saytzeff and Hofmann eliminations, reactions- hydrogenation, hydration, hydrohalogenation, Markovnikov's rule, Kharasch effect, ozonolysis, dihydroxylation using $\text{KMnO}_4$ and bromination (with mechanisms).	7	1
	1.3	Alkynes: physical properties, industrial uses of acetylene, preparation of acetylenes- dehydrohalogenation of vicinal dihalides, reactions- acidity of alkynes, formation of metal acetylides, alkylation of terminal alkynes and conversion into higher alkynes, addition of water, bromine and alkaline $\text{KMnO}_4$ , reduction using Lindlar's catalyst	5	1
	<b>Aromatic compounds</b>			
2	2.1	Aromaticity: Definition, Hückel's rule, benzenoid aromatic compounds- benzene, naphthalene, anthracene; non-benzenoid aromatic compounds- cyclopropenyl cation, cyclopentadienyl anion, tropylium cation, heterocyclic aromatic compounds (pyridine, pyrrole and furan). Non-aromatic and antiaromatic compounds	6	3
	2.2	Benzene: molecular orbital picture, resonance energy, reactions - electrophilic aromatic substitution - nitration, halogenation, Friedel-Craft's reactions with their mechanisms.	4	1,6
	2.3	Ring activating and deactivating groups with examples. Orientation of aromatic substitution- ortho, para and meta directing effects of groups.	3	1
	2.4	Aromatic nucleophilic substitutions of halobenzenes – bimolecular displacement	2	1

		mechanism, elimination-addition (benzyne intermediate) mechanism.		
3	<b>Basic Stereochemistry</b>			
	3.1	Stereoisomerism: definition, classification, configuration and conformation, interconversion of wedge formula, Newman, Sawhorse and Fischer projection formulae	1	4
	3.2	Geometrical isomerism: Cis-trans and E/Z nomenclature (upto two C=C systems) with Cahn Ingold Prelog (CIP) rules. Methods of distinguishing geometrical isomers.	4	4
	3.3	Optical isomerism: optical activity, specific rotation, concept of chirality, stereogenic centres, enantiomerism, diastereomerism and meso compounds, optical isomers of lactic acid and tartaric acid, racemic mixture and resolution.	5	4
	3.4	Relative and absolute configuration: D and L, threo and erythro; d and l designations; CIP rules: R/ S notation (up to 2 chiral carbon atoms).	3	4
	3.5	Conformations: conformational analysis with respect to ethane, butane, cyclohexane. Relative stability and energy diagrams.	2	5
		<b>Organic Chemistry-1 Practical</b>		
4	4.1	Microscale organic analysis- test for aromatic character- ignition test, nitration test, picrate test and tests for unsaturation.	15	6
	4.2	Determination of physical constants-melting point, boiling point, specific rotation (Polarimetry)	15	6
5		Teacher Specific content		

<b>Teaching and Learning Approach</b>	<b>Classroom procedure (mode of transaction)</b> Classroom lecture Hands on training using models Demonstration and practical training in laboratory Use of molecular visualisation software Industrial Visit
<b>MODE OF ASSESSMENT</b>	<p style="text-align: center;"><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p style="text-align: center;"><b>Theory (25 marks)</b></p> <p>Pop quiz/ Assigning R and S using molecular models/open book</p> <p>Written tests</p> <p style="text-align: center;"><b>Practical(15 marks)</b></p> <p>Quiz</p> <p>Lab involvement</p> <p style="text-align: center;"><b>B. Semester end examination</b></p> <p>Written examination - 50 Marks- 1.5 hrs.</p> <p>I) MCQ 10 questions : 10 X 1 = 10</p> <p>II) Short answer 4 questions (out of 6): 4 X 3 =12</p> <p>III) Short essay 2 questions (out of 3): 2 X 7 = 14</p> <p>IV) Essay 1 question (out of 2): 1 X 14 = 14</p> <p style="text-align: center;"><b>Practical (35 Marks)- 1 hr.</b></p> <p>Viva voce-10 Marks</p> <p>Written test of practical procedures-15 Marks</p> <p>Certified report of lab works done -10Marks</p>

### References

1. Bahl, A.; Bahl, B. S. *A Textbook of Organic Chemistry*; S. Chand, 2010.
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## SUGGESTED READINGS

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2. Service, R. F. *Does life's handedness come from within?* *Science* 1999, 285, 1282-1283

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Basic Analytical Chemistry</b>					
<b>Type of Course</b>	DSE					
<b>Course Code</b>	<b>UC3DSECHE200</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	This course covers the fundamentals of analytical chemistry, and discusses topics such as SI Units, significant digits, precision, accuracy, errors, statistical treatment, calibration graphs, and Origin for data analysis. Additionally, it encompasses qualitative analysis techniques, safety protocols, titrimetric analysis, and the principles and applications of chromatography.					
<b>Semester</b>	III	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practicals	Others	
		4		0		60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain fundamental measurement concepts, and statistical analysis in analytical chemistry	U	1, 2,3,10
2	Make use of graphical representation techniques, fostering essential skills for success in analytical chemistry	An	1, 2,3
3	Apply methods for the qualitative determination of ions	A	1, 2,3
4	Develop a comprehensive knowledge of titrimetric analysis including redox titrations, complexometric titrations, conductometric titrations and potentiometric titrations	A	1, 2,3

5	Apply the principles of gravimetric analysis	A	1, 2,3
6	Analyse various separation and purification techniques of compounds	An	1, 2,3
7	Distinguish between different chromatographic methods based on their principle and mechanism	An	1, 2,3,10
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO
1	<b>Evaluation of Analytical Data and Qualitative Analysis</b>			
	1.1	SI Units, significant digits, rounding. Elementary idea of population and sample. Precision and accuracy. Types of errors – determinate and indeterminate errors. Ways to reduce determinate errors. Statistical treatment of analytical data (with Simple problems)-mean, variance and standard deviation. Limit of detection and limit of quantification.	6	1
	1.2	Graphical representation of data: calibration graphs. Introduction to software in data analysis – MS Excel, and Origin. Regression analysis-importance of coefficient of determination.	3	2
	1.3	Qualitative analysis: separation of cations into groups and group reagents. Principle of intergroup separation–solubility, ionic product, solubility product and common ion effect in the precipitation of cations. Identification test of anions-carbonate, chloride, acetate, nitrate, oxalate, fluoride, borate and phosphate ions. Elimination of interfering anions - oxalate, fluoride, borate and phosphate ions.	6	3

	<b>Chemicals apparatus and unit operations of analytical chemistry</b>			
<b>2</b>	2.1	Selecting and handling reagents and other chemicals	2	5
	2.2	Cleaning and marking of laboratory ware	2	5
	2.3	Evaporating liquids, measuring mass, equipment and manipulations associated with weighing, measuring volume, calibrating volumetric glassware	5	5
	2.4	The laboratory notebook	1	5
	2.5	Safety in the laboratory- the four principles of safety, personal protective equipment: eye protection, lab coat, shoes and long pants, gloves, respiratory protection and masks, hair, lead apron and shields.	5	5
	<b>Titrimetric and Gravimetric Analysis</b>			
<b>3</b>	3.1	Titrimetric analysis – basic concepts of redox reactions, redox titrations involving $\text{KMnO}_4$ , and $\text{K}_2\text{Cr}_2\text{O}_7$ , titration curves, redox indicators.	4	4
	3.2	Complexometric titrations – direct, indirect, back and replacement titrations, EDTA titrations. Precipitation titration - methods of argentometric titration-indicators (action not required).	6	4
	3.3	Conductometric and potentiometric titrations – principle, examples and graphical representation.	2	4
	3.4	Gravimetric analysis: unit operations in gravimetric analysis - illustrations using iron and barium estimation.	3	5
	<b>Separation and Purification of compounds</b>			
<b>4</b>	4.1	Separation and purification techniques: filtration, recrystallization, precipitation, distillation, fractional distillation, solvent extraction and sublimation.	4	6
	4.2	Chromatography- principle and classification. Chromatographic techniques: paper chromatography, thin layer chromatography, $R_f$ -values.	3	7

	4.3	Principle and applications of column chromatography, high-performance liquid chromatography (HPLC), gas chromatography, gel permeation chromatography (GPC), ion exchange chromatography, and reverse phase chromatography.	8	7
5	<b>Teacher Specific content</b>			

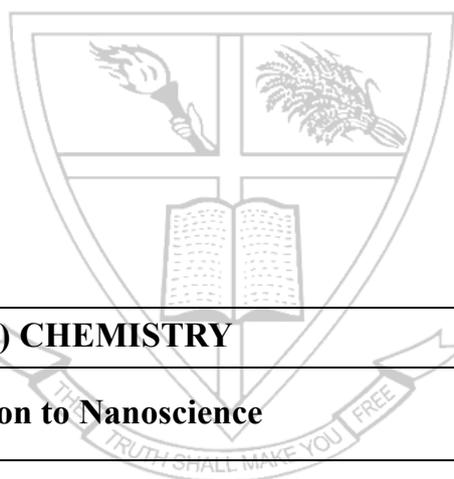
<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Demonstration of experiments</li> <li>● Hands-on training</li> </ul>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b>  <b>Theory: (30 marks)</b></p> <p>Assignments/MCQ/Class test/Viva</p>
	<p><b>B. End Semester examination (70 marks)- 2 hrs.</b></p> <p>i) Short answer 5 questions (out of 7): 5 X 4 =20</p> <p>ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>iii) Essay 1 question (out of 2): 1 X 15 = 15</p>

## References

1. A. Lee, *Scientific Endeavor*, Addison Wesley Longman, 2016.
2. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry* 9<sup>th</sup> Edn, Cengage Learning, 2013.
3. Crouch and F. J. Holler, *Applications of Microsoft Excel in Analytical Chemistry*, Cengage Learning, 2013.
4. G. D. Christian, *Analytical Chemistry*, JohnWiley and Sons, 2020.

5. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.
6. R. Puri, L. R. Sharma, Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2020.
7. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1*, 5th Edition, S. Chand and Sons, New Delhi, 2012.
8. Vogel's *Textbook of Quantitative Chemical Analysis*, 6<sup>th</sup> Edn. Pearson Education Ltd, 2009.

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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Introduction to Nanoscience</b>					
<b>Type of Course</b>	DSE					
<b>Course Code</b>	<b>UC3DSECHE201</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	This course explores basic concepts, synthesis, properties and applications of nanomaterials					
<b>Semester</b>	III	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60

<b>Pre-requisites, if any</b>	
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### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the fundamental concepts of nanomaterials.	U	1,2,3
2	Compare bottom-up and top-down approaches in nanomaterial synthesis	An	1,2,3
3	Describe various characterisation techniques of nanomaterials.	U	1,2,3
4	Explain the synthesis, properties and applications of different types of nanomaterials.	U	1,2,3
5	Analyse the applications of nanomaterials in various fields.	An	1,2,3,10

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Classification and Synthesis of Nanomaterials</b>			
	1.1	Feynman's hypothesis- scales of nanosystems- Moore's law	1	1
	1.2	Different types of nanomaterials. Classification of nanomaterials based on dimensions, and based on origin.	3	1
	1.3	Nano in nature: lotus-leaf effect, gecko's feet, butterfly wings, and magneto-tactic bacteria.	3	1
	1.4	Bottom-up approach: chemical precipitation, reduction technique, and sol-gel method.	4	2

	1.5	Top-down approach: mechano-chemical method, laser ablation, and arc-discharge method.	4	2
2	<b>Characterisation of Nanomaterials</b>			
	2.1	Imaging through electron microscopy: Interaction of electron beam with sample. Scanning electron microscope and transmission electron microscope-comparison, advantages, applications and basic instrumental features.	5	3
	2.2	Scanning probe microscopy: scanning tunneling microscope and atomic force microscope-comparison, applications and basic instrumental features.	5	3
	2.3	Characterisation through spectroscopy (elementary idea only): UV-visible, IR, X-ray photoelectron and Auger electron spectroscopy. Secondary ion mass spectrometry.	5	3
3	<b>Properties of Nanomaterials</b>			
	3.1	Metal Nanoparticles (Au, Ag) – synthesis (any one method), properties and applications	3	4
	3.2	Carbon nanotubes– classification, synthesis (any one method), properties and applications	3	4
	3.3	Quantum dots – semiconductor QDs and carbon dots – synthesis (any one method), properties and applications	3	4
	3.4	Magnetic nanoparticles – synthesis (any one method), properties and applications	3	4
	3.5	Metal oxide nanoparticles – synthesis (any one method), properties and applications	3	4
4	<b>Applications of Nanoparticles</b>			
	4.1	Medicine and Healthcare: applications of nanomaterials in medical diagnosis, advanced drug delivery systems, targeted drug delivery and therapy.	5	5
	4.2	Applications of nanotechnology in integrated circuits, data storage and displays	3	5
	4.3	Applications of nanotechnology in water purification and air pollution control	2	5

	4.4	Piezoelectric nanomaterials, hydrogen generation and storage, batteries and solar energy harvesting	3	5
	4.5	Chemical and biosensors using nanomaterials and defence applications of nanotechnology	2	5
<b>5</b>	<b>Teacher Specific content</b>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Interactive instruction (chalk&amp; board method,multimedia presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Experimental demonstrations</li> <li>● Practical training</li> </ul>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory: (30 marks)</b></p> <p>Assignments/MCQ/Class test/Viva</p>
	<p><b>B. End Semester examination (70 marks)- 2 hrs.</b></p> <p>i) Short answer 5 questions (out of 7): 5 X 4 =20</p> <p>ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>iii) Essay 1 question (out of 2): 1 X 15 = 15</p>

### References

1. Benelmekki, M. *Nanomaterials: The Original Product of Nanotechnology*; Morgan & Claypool Publishers, 2019.
2. Booker, R.; Boysen, E. *Nanotechnology*, Wiley India Pvt Ltd, 2008.
3. Hornyak, G. L.; Dutta, J.; Tibbals, H. F.; Rao, A. *Introduction to Nanoscience*; CRC Press, 2008.

4. Klabunde, K. J. *Nanoscale Materials in Chemistry*; Wiley, 2004.
5. Muralidharan, V. S.; Subramania, A. *Nanoscience and Technology*; Ane Books for, 2009.
6. N. Kumar, K. Sunita, *Essentials in Nanoscience and Nanotechnology*, Wiley, 2016.
7. Ngô, C.; Van de Voorde, M. *Nanotechnology in a Nutshell: From Simple to Complex Systems*; Atlantis Press, 2014.
8. Poole, C. P.; Owens, F. J. *Introduction to Nanotechnology*; Wiley, 2003.
9. Pradeep, T. *NANO: The Essentials: Understanding Nanoscience and Nanotechnology*; 1st Edition ed.; McGraw-Hill Education: New York, 2007.
10. Rao, C. N. R., Müller, A., Cheetham, A. K.; *Nanomaterials – An Introduction. In The Chemistry of Nanomaterials 2004, (Chapter 1)*.
11. Sengupta, A.; Sarkar, C. K. *Introduction to Nano: Basics to Nanoscience and Nanotechnology*; Springer Berlin Heidelberg, 2015.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Safe Laboratory Practices in Chemistry</b>					
<b>Type of Course</b>	DSE					
<b>Course Code</b>	<b>UC3DSECHE202</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	This course deals with proper procedures for handling, storing, and transporting chemicals safely, including the use of appropriate containers and labelling.					
<b>Semester</b>	III	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	

		4				60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify potential hazards in a laboratory setting	U	1,2,10
2	Exhibit proper handling and usage of laboratory equipment, including safety gear like goggles, gloves, and lab coats.	A	1,2,10
3	Analyse and interpret Material Safety Data Sheets (MSDS) to understand chemical properties, hazards, and proper handling techniques.	An	1,2,10
4	Assess and evaluate potential risks associated with various chemicals and experimental procedures.	U	1,2,10
5	Apply the knowledge of chemical safety in the storage, transportation and disposal of chemicals.	A	1,2,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Introduction to Laboratory Safety</b>			
	1.1	The four principles of safety: recognising hazards, assessing the risks of hazards, minimising the risks	3	1

		of hazards and preparing for emergencies.		
	1.2	Safety ethic. Food, beverages, and smelling in the lab. Basic safety rules for handling laboratory chemicals.	3	1
	1.3	Going green in the lab: examples for using safer solvents, reducing volumes and quantity, minimising wastes and hazardous by products, using less toxic reagents.	3	1,2
	1.4	Personal protective equipment: eye protection, lab coat, shoes and long pants, gloves, respiratory protection and masks, hair, lead apron and shields.	3	1,2
	1.5	The laboratory: hazards, safety features, biological storage, chemical storage, gas storage and use, glassware, electrical safety.	3	1,2
<b>2</b>	<b>Chemicals</b>			
	2.1	Safety data sheets, chemical labels, toxic compounds, corrosives -acids and bases, gases, explosives, flammable compounds and oxidizers, cryogenics	4	1,2,3,4
	2.2	Working with extremely hazardous chemicals, permanent and temporary storage containers.	2	1,2,4
	2.3	Transporting Chemicals, ethers and other peroxide-forming chemicals, picric acid and nitro compounds, hazard and precautionary statements (H- and P-codes).	4	1,5
	2.4	Chemical Waste Management: waste disposal rules and regulations, labelling of hazardous waste, waste containers, sorting of hazardous chemicals, disposal of biological samples and biohazards.	5	1,5
<b>3</b>	<b>Hazard Control Measures</b>			
	3.1	Hazard control measures: fume hoods, other laboratory ventilation, safe work procedures, emergency showers and eyewash stations.	4	1,4

	3.2	Fire and explosion safety: types of fire, fire safety and precautions, preventive measures, fire extinguishers, explosion safety, explosive mixtures.	3	1,4
	3.3	Laboratory equipment safety: vacuum pumps and systems safety, heat sources safety, heating mantles, oil and sand baths, ovens and furnaces safety, refrigerators and freezers safety, decontamination of laboratory equipment.	5	1,4
	3.4	Emergency procedures: chemical spills, fire and explosion, compressed gas leaks. Case study: Bhopal tragedy	3	1,4
<b>Demonstration experiments</b>				
4		<ol style="list-style-type: none"> <li>1. Use of Electronic Balance for weighing chemicals</li> <li>2. Measurement of volume and determination of density of liquids.</li> <li>3. Safe use of burners and glassware in the laboratory</li> <li>4. Use of safety glasses or goggles, apron, and gloves.</li> <li>5. Use of eyewash station</li> <li>6. Fire extinguishers</li> <li>7. Safety Evaluation of common chemicals in the laboratory</li> <li>8. Fume Hood</li> <li>9. Interpretation of MSDS datasheets of flammable liquids, toxic, carcinogenic, corrosive and flammable chemicals in the laboratory.</li> <li>10. Reports on the safe use of acids, bases, oxidising agents and reducing agents.</li> <li>11. Reports on first aid in the laboratory.</li> <li>12. Analysis of labels of common chemicals in the laboratory.</li> </ol>	15	1,4
5	<b>Teacher Specific content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom procedure (mode of transaction)</b> Lecture-based approach, interactive discussions, laboratory sessions, flipped classroom, peer teaching and collaborative learning.
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>Theory: (30 marks)</b> Assignments/MCQ/Class test/Viva
	<b>B. End Semester examination (70 marks)- 2 hrs.</b> i) Short answer 5 questions (out of 7): $5 \times 4 = 20$ ii) Short essay 5 questions (out of 7): $5 \times 7 = 35$ iii) Essay 1 question (out of 2): $1 \times 15 = 15$

## References

1. American Chemical Society, *Safety in Academic Chemistry Laboratories*, 8<sup>th</sup> Edn, 2017.
2. E Mohamed, *Chemical Laboratory- Safety and Techniques*, de Gruyter, 2022.
3. FENS Laboratory Safety Team, *Laboratory Safety Handbook*, Sabanci University, 2016.
4. H H Robert Jr, C F, David, *Laboratory Safety for Chemistry Students*, 2<sup>nd</sup> Edn. Wiley, 2016.
5. J I García, J A.Dobado, F C Flores, H M García, *Experimental Organic Chemistry: Laboratory Manual*, Elsevier Inc., 2016.
6. P Carson, C Mumford, *Hazardous Chemicals Handbook*, 2<sup>nd</sup> Edn. Hazardous Chemicals Handbook, 2002.
7. R S Benjamin, G Sveinbjorn, *Handbook for laboratory safety*, Elsevier, 2022.
8. S L Seager, M R Slabaugh, *Safety-Scale Laboratory Experiments*, 7<sup>th</sup> Edn. Brooks/Cole, 2010.
9. T. S. S. Dikshith, *Safe use of chemicals: a practical guide*, CRC Press, 2009.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Chemistry in Everyday Life</b>					
<b>Type of Course</b>	MDC					
<b>Course Code</b>	<b>UC3MDCCHE200</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	This course provides a comprehensive understanding of how chemistry permeates various aspects in our daily life.					
<b>Semester</b>	III	Credits			3	Total Hours
<b>Course Details</b>	Learning Approach	Lecture 3	Tutorial	Practical 0	Others	
<b>Pre-requisites, if any</b>						45

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the uses of fertilizers and pesticides and their impact on the environment.	U	1,2,3,6,7,10
2	Compare various types of drugs	An	3,6,7,10
3	Classify soaps and understand its cleansing action	U	1,2,3,6,7,10
4	Investigate the chemical components in personal care products.	An	1,2,3,6,7,10
5	Make use of theories to prepare cosmetics	A,S	1,2,3,6,7,10

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Chemistry in Agriculture and Medicine</b>			
	1.1	Fertilizers – introduction. Types of fertilizers - natural, synthetic, NPK fertilizers. Excessive use of fertilizers and its impact on the environment. Bio-fertilizers and organic manures.	4	1
	1.2	Pesticides - Introduction. Classification (brief idea only) - insecticides, fungicides, herbicides (structures not required). Excessive use of pesticides - environmental hazards. Biopesticides.	4	1
	1.3	Classification of drugs - analgesics, antipyretics, antihistamines, antacids, antibiotics and antifertility drugs with examples (structures not required). Psychotropic drugs - tranquilizers, antidepressants and stimulants with examples (structures not required). Drug addiction and abuse. Prevention and treatment.	7	2
2	<b>Chemistry in personal care products</b>			
	2.1	Soaps – introduction, types of soaps - toilet soaps, washing soaps, liquid soap, TFM and grades of soaps, cleansing action, environmental aspects.	5	3
	2.2	Composition of different types of cosmetics - toothpaste, hair dye, face and skin powders, lipsticks and perfumes, shaving creams Shampoos- ingredients and functions – different kinds of shampoos (anti-dandruff, anti-lice, herbal	10	4

		and baby shampoos). Herbal cosmetics- definition, natural ingredients used- aloe vera, turmeric, henna, amla, neem, clove Harmful effects of cosmetics.		
	<b>Demonstration Experiments</b>			
3	3.1	1. Synthesis of Organic manure 2. Preparation of Toilet soap 3. Evaluate TFM value of soap 4. Preparation of Shampoo 5. Preparation of Perfume 6. Preparation of Sanitizers	15	5
4		<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p style="text-align: center;"><b>Theory: (25 marks)</b></p> <p>Assignments</p> <p>Viva</p> <p>Classroom participation (participation in class activities)</p>

	Examination
	<p align="center"><b>B. End Semester examination</b></p> <p align="center"><b>Theory: (50 marks)- 1.5 hrs</b></p> <p>i) MCQ 9 questions : 10 X 1 = 10</p> <p>ii) Short answer 10 questions (out of 12): 10 X 4 =40</p>

## References

1. A. K. De, *Environmental Chemistry*, New age International Ltd. 2021.
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3. Buchel, K.H. *Chemistry of Pesticides*, John Wiley & Sons, New York, 1983. .
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Forensic Chemistry</b>
<b>Type of</b>	VAC

<b>Course</b>						
<b>Course Code</b>	<b>UC3VACCHE200</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	This course provides a comprehensive understanding of the basic principles of chemistry as they apply to forensic science. It focuses on enabling non-chemists to comprehend and utilize chemical concepts in forensic analysis.					
<b>Semester</b>	3	<b>Credits</b>			3	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Recognize various types of chemical substances, their properties, and their relevance in forensic contexts.	U	1,2
2	Utilize fundamental chemical principles to understand forensic analysis techniques.	A	1,2,10
3	Evaluate and interpret chemical evidence commonly encountered in forensic investigations.	An	1,2
4	Explain the role of chemistry in forensic science, including its impact on legal proceedings and criminal investigations.	U	1,2,6,8,10
5	Extract meaningful conclusions from chemical data	U	1,2,6,8

	obtained during forensic analysis.		
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transaction (Units)

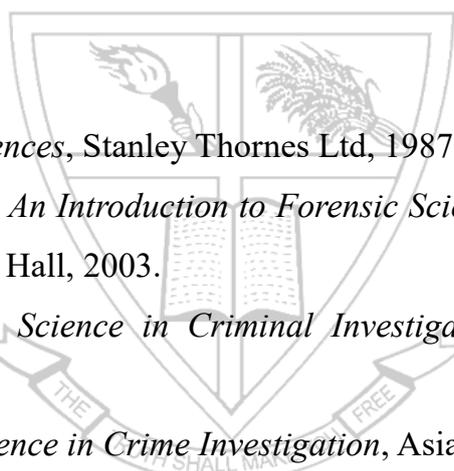
Module	Units	Course description	Hrs	CO No.
<b>1</b>	<b>Poisons</b>			
	1.1	Poisons-types and classification- diagnosis of poisons in the living and the dead – clinical symptoms - post-mortem appearances.	4	1,2,3,4,5
	1.2	Heavy metal contamination (Hg, Pb, Cd) of sea foods.	3	1,2,3,4,5
	1.3	use of neutron activation analysis in detecting Arsenic in human hair	2	1,2,3,4,5
	1.4	Treatment in cases of poisoning - use of antidotes for common poisons.	3	1,2,3,4,5
<b>2</b>	<b>Crime Detection</b>			
	2.1	Accidental explosion during manufacture of matches and fireworks.	2	1,2,3,4,5
	2.2	Human bombs- possible explosives (gelatine sticks and RDX)	3	1,2,3,4,5
	2.3	metal detector devices and other security measures for VVIP	2	1,2,3,4,5
	2.4	Composition of bullets and detecting powder burn	2	1,2,3,4,5
	2.5	Analysis of incendiary and timed bombs - spill of toxic and corrosive chemicals from tankers.	3	1,2,3,4,5
	<b>Forgery and Counterfeiting</b>			

<b>3 (a)</b>	3.1	Documents - different types of forged signatures-simulated and traced forgeries – inherent signs of forgery methods - writing deliberately modified - uses of ultraviolet rays - comparison of typewritten letters	5	1,2,3,4,5
	3.2	Checking silver line watermark in currency notes, alloy analysis using AAS to detect counterfeit coins	4	1,2,3,4,5
	3.3	Detection of gold purity in 22 carat ornaments - detecting gold plated jewels - authenticity of diamond.	3	1,2,3,4,5
<b>3 (b)</b>	<b>Tracks and Traces</b>			
	3.4	Tracks and traces - small tracks and police dogs-footprints- walking pattern or tyre marks	3	1,2,3,4,5
	3.5	Glass fracture – tool mark paints – fibres.	2	1,2,3,4,5
	3.6	Analysis of biological substances - blood, saliva, urine and hair	2	1,2,3,4,5
	3.7	DNA Finger printing for tissue identification in dismembered bodies - detecting steroid consumption in athletes and race horses	2	1,2,3,4,5
<b>4</b>	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions and demonstrations to engage students actively and visual aids like presentations and videos to enhance understanding. Utilize case studies to illustrate how forensic analysis is applied.</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>C. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>25 marks</b></p>

	Assignments Viva Classroom participation (participation in class activities) Examination
	<p style="text-align: center;"><b>D. End Semester examination</b></p> <p style="text-align: center;"><b>50 marks- 1.5 hrs.</b></p> <p>i) MCQ 9 questions : 9 X 1 = 9</p> <p>ii) Short answer 5 questions (out of 7): 5 X 4 =20</p> <p>iii) Short essay 3 questions (out of 5): 3 X 7 = 21</p>

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1. T.H.James, *Forensic Sciences*, Stanley Thornes Ltd, 1987.
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3. B R Sharma, *Forensic Science in Criminal Investigation and Trials*, 6<sup>th</sup> Edn. LexisNexis, 2020.
4. B.S. Nabar, *Forensic Science in Crime Investigation*, Asia Law House, 2022.
5. Glencoe, *Forensic Laboratory Manual*, McGraw Hill, 2001.
6. S Bell, *Forensic Chemistry*, CRC Press, 2022.
7. K M Elkins, *Introduction to Forensic Chemistry*, CRC Press, 2019.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Inorganic and Organic Chemistry</b>
<b>Type of Course</b>	DSC B
<b>Course Code</b>	<b>UC3DSCCHE202</b>
<b>Course Level</b>	<b>200-299</b>

<b>Course Summary</b>	This course provides a comprehensive understanding of the various aspects of inorganic and organic chemistry.					
<b>Semester</b>	III	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe radioactivity, its applications and nuclear reactors in India	U	1,2
2	Describe the basic principles of bioinorganic chemistry and the importance of metals in biological systems	U	1,2
3	Discuss the importance of functional groups, aromatic stability and aromatic electrophilic substitution.	U	1,2
4	Investigate the adulterants present in food	An	1,2
5	Describe the basic principles behind geometrical and optical isomerism and conformations	U	1,2
6	Apply basic principles of chemistry in volumetric analysis and organic preparations.	A	1,2,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		<b>Nuclear Chemistry and Bioinorganic Chemistry</b>		
<b>1</b>	1.1	Natural and induced radioactivity, radioactivity – detection, units of radioactivity. Modes of decay – group displacement laws. Isotopes, isobars and isotones with examples. Nuclear fission - atom bomb, nuclear fusion – hydrogen bomb.	6	1
	1.2	Nuclear reactors - nuclear reactors in India. application of radioactive isotopes, <sup>14</sup> C dating, rock dating, isotopes as tracers, radiodiagnosis and radiotherapy	4	1
	1.3	Haemoglobin and myoglobin, pH of blood, cytochromes, ferredoxin, mechanism of O <sub>2</sub> and CO <sub>2</sub> transportation and chlorophyll and photosynthesis (mechanism not expected) elementary idea of photophosphorylation.	4	2
	1.4	Photosynthesis and respiration – comparison. – Elementary idea of structure and mechanism of action of sodium potassium pump. Biochemistry of zinc and cobalt.	3	2
		<b>Food Additives &amp; Adulterants</b>		
<b>2</b>	2.1	Food Additives: Food preservatives, artificial sweeteners, flavours, emulsifying agents, antioxidants, leavening agents and flavour enhancers (definition and examples, structures not required) – Natural pigments in fruits and vegetables (carotenoids, chlorophylls and flavonoids). Artificial ripening of fruits. Common food adulterants in various food materials and their identification: Milk, vegetable oils, tea, coffee powder and chilli powder.	5	4

	2.2	Commonly used permitted and non-permitted food colours BHT, BHA and MSG - (structures not required) Fast foods and junk foods & their health effects – Soft drinks and their health effects	4	4
3	<b>Aromatic Hydrocarbons and Stereochemistry</b>			
	3.1	Nomenclature and isomerism in substituted benzene. Benzene-Structure and stability: Kekule, resonance and molecular orbital description. Mechanism of aromatic electrophilic substitution: Halogenation, nitration, sulphonation and Friedel-Crafts reactions, orientation effect of substituents.	5	3
	3.2	Aromaticity and Huckel's rule: Application to benzenoid (benzene, naphthalene and anthracene) and non-benzenoid (pyrrole, pyridine and indole) aromatic compounds.	4	3
	3.3	Conformations: Conformations of ethane, butane and cyclohexane— explanation of stability.	3	5
	3.4	Geometrical isomerism: definition – condition – geometrical isomerism in but-2-ene and but-2-ene-1,4-dioic acid – methods of distinguishing geometrical isomers using melting point and dipole moment.	4	5
	3.5	Optical Isomerism: optical activity, chirality, – enantiomers, meso compounds, diastereoisomers, optical isomerism in lactic acid and tartaric acid.	3	5
4	<b>Inorganic and Organic Chemistry Practicals</b>			
		1. <u>Permanganometry</u> i Standardization of $\text{KMnO}_4$ using (i) oxalic acid (ii) Mohr's salt ii Estimation of $\text{Fe}^{2+}$ in Mohr's salt and crystalline Ferrous Sulphate using standard $\text{KMnO}_4$ . 2. <u>Dichrometry</u>	30	6

	i. Estimation of Ferrous ions (external indicator) ii. Estimation of Ferrous ions (internal indicator) 3. Determination of physical constants: melting point, boiling point and density. 4. Preparation of m-dinitrobenzene from nitrobenzene 5. Benzoylation of phenol		
5	<b>Teacher Specific content</b>		

<b>Teaching and Learning Approach</b>	<b>Classroom procedure (mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture (chalk&amp; board, power point presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Demonstration of experiments</li> <li>● Hands-on training</li> </ul>
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>Theory (25 marks)</b> Pop quiz/Problem based assignments /Written/MCQ tests <b>Practical (15 marks)</b> Quiz/Lab involvement

## B. Semester end examination

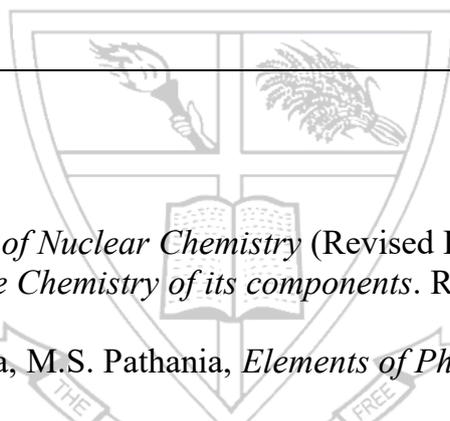
### Theory: Written examination (50 Marks)-1.5 hrs.

- i. MCQ 10 questions :  $10 \times 1 = 10$
- ii. Short answer 4 questions (out of 6):  $4 \times 3 = 12$
- iii. Short essay 2 questions (out of 3):  $2 \times 7 = 14$
- iv. Essay 1 question (out of 2):  $1 \times 14 = 14$

### Practical: 35 marks-1 hr.

- i. Viva voce-10 Marks
- ii. Written test of practical procedures-15 Mark
- iii. Certified report of lab works done -10 Marks

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## References

1. H.J. Arnikaar, *Essentials of Nuclear Chemistry* (Revised IV edn.), New Age, 1995
2. T.P. Coultate, *Food- The Chemistry of its components*. Royal Society of Chemistry, London.
3. B. R. Puri, L. R. Sharma, M.S. Pathania, *Elements of Physical Chemistry*, 3rd Edn. Vishal Pub Co., 2008.
4. I. L. Finar, *Organic Chemistry*, Vol. 1 & 2, 6th Edn. Pearson, 2002.
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6. B. R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, Milestone, Publishers New Delhi. 2013.
7. Puri and Sharma. *Advanced Organic Chemistry*.
8. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7<sup>th</sup> Edn., Pearson Education, New Delhi, 2013.
9. I. L. Finar, *Organic Chemistry*, Vol. I, 5<sup>th</sup> Edn. Pearson Education, New Delhi, 2013. 3.
10. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3<sup>rd</sup> Edn., Vishal Publishing Company Co., 2010.
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13. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6<sup>th</sup> Edn. Pearson Education 2003.
14. R. Gopalan, *Analytical Chemistry*, S. Chand and Co., New Delhi, 2003.

15. O. P. Pandey, *Practical Chemistry*, S. Chand, 2010.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>				
<b>Course Name</b>	<b>Functional operations in Chemical industry</b>				
<b>Type of Course</b>	DSC B				
<b>Course Code</b>	<b>UC3DSCCHE203</b>				
<b>Course Level</b>	<b>200-299</b>				
<b>Course Summary</b>	This course explores relevant industrial operations and processes with examples of effluent treatment and water purification processes				
<b>Semester</b>	III	Credits		4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practicals	
		3		1	Industrial Visit
<b>Pre-requisites, if any</b>	Fundamental knowledge on boiling point, solubility and nature of solvents.				

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the basic concepts and fundamental principles of unit operations.	U	1,3
2	Analyse and compare the advantages, limitations, and applications of various equipment in each unit operations	An	1,2,3
3	Demonstrate the correct use of equipment in practical applications.	E, S	1,2,3,10
4	Evaluate the efficiency and effectiveness of different unit operations.	E	1,2,3,10

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Unit Operations in Industries – introduction, types of operations, heat and mass transfer, fluid flow operations (laminar and turbulent flow, Bernoulli's	2	1
	1.2	Evaporation: principle, forced circulation, falling film, climbing film (upward flow) and wiped (agitated) film evaporators.	6	2,3,4
	1.3	Distillation-principle, types of distillation: simple, equilibrium, fractional, steam and vacuum distillations, batch and continuous distillation. Rectification, construction of rectifying column and type of columns:	8	2,3,4
	1.4	Filtration: introduction: filter media and filter aids (elementary idea). Equipment-plate and frame filter press, nutch filter, rotary drum filter. Introduction to drying process, types of dryers: -tray dryer, rotary dryer, flash dryer, spray dryer	7	2,3,4
2	2.1	Crystallisation: principles and stages of crystallisation.	2	1
	2.2	Crystal growth techniques-crystallisation from melt- Bridgman method, Czochralski method, floating zone method, Verneuil method.	4	2,3,4
	2.3	Crystallisation equipment- draft tube crystalliser, MSMR crystalliser.	4	2,3,4

3	3.1	Mixing: Introduction, mixing of liquid-liquid, solid-liquid and solid-solid systems Equipment for mixing: trough mixer, paddle mixer, tumbler mixer.	4	2,3,4
	3.2	Extraction: Principle and types of extraction (liquid-liquid, solid-liquid, supercritical extraction)	4	1,2
	3.3	Supercritical fluid extraction-theory and instrumentation	4	2,3,4
<b>Functional operations in Chemical industry Practicals</b>				
4	Distillation: To Perform a expt. on Simple Distillation using binary mixture ( Methanol + Water or Ethanol+Water)		30	3,4
	Heat of Solution $\text{KNO}_3$ , $\text{NH}_4\text{Cl}$			
	Heat of neutralization			
	Crystallisation – Any four compounds using ethyl acetate, ethanol, and water – Record the yield of recovery			
	Solvent extraction – aniline from water - methyl benzoate from water - using ether- and record the yield of recovery.			
	To study the rate of drying of solid substances: saw dust or cardboard.			
	To study the rate of drying of liquid substances			
	To crystallise the given sample of phthalic acid from hot water using fluted paper nod stemless funnel.			
	To crystallise the given sample of benzoic acid from hot water using fluted paper nod stemless funnel			

	Determine the rate of evaporation of a given liquid sample (thin solution of sugar + water, NaCl+water) in an open pan evaporator.		
<b>5</b>	<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<b>Classroom procedure (mode of transaction)</b> ICT enabled demonstrations Group discussion Lecture
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>Theory (25 marks)</b> Assignments/MCQ/viva/Involvement in classroom activities <b>Practical (15 marks)</b> Lab involvement / report /Lab test
	<b>B. Semester end examination</b> <b>Theory (50 marks)-1.5 hrs.</b> MCQ 10 questions : $10 \times 1 = 10$ Short answer 4 questions (out of 6): $4 \times 3 = 12$ Short essay 4 questions (out of 6): $4 \times 7 = 28$ <b>Practical (35 marks)-1 hrs.</b> Lab report: 10 Viva: 10 Writing procedure: 15

## References

1. D.D.Kale, *Unit Operations– 1 and 2*, Vidyarthi Griha Prakashan, Pune.

- F.G.Mann, B.C. Saunders, *Practical Organic Chemistry*, 4<sup>th</sup> Edn, Pearson Education, 2009.
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- J.H.Perry, *Chemical Engineering Hand Book*, McGraw Hill, N.Y., 2018.
- K.A.Gavhane, *Unit Operations-II Heat and Mass transfer*, NiraliPrakashan.
- Vogel's Textbook of Practical Organic Chemistry*, 5<sup>th</sup> Edn, Pearson Education, 2005.
- W. L. McCabe, P. Harriott, J. Smith, *Unit operations in Chemical Engineering*, McGraw Hill, 2022.
- W.L.Badger and J.T.Bachero, *Introduction to Chemical Engineering*, Tata McGraw Hill.
- W.L.McCabe and J.C.Smith, *Unit operations in Chemical Engineering*, Tata McGraw Hill, 2018.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>				
<b>Course Name</b>	<b>ATF and Latest Development in Fuel Technology</b>				
<b>Type of Course</b>	DSC C				
<b>Course Code</b>	<b>UC3DSCCHE204</b>				
<b>Course Level</b>	<b>200-299</b>				
<b>Course Summary</b>	This course deals with ATF and latest developments in fuel technology. The students will be exposed to drilling operations, oil field brines, transportation and refining of petroleum				
<b>Semester</b>	III	Credits			Total Hours
<b>Course Details</b>	Learning Approach	Lectur		Practica	Others
		3		1	
<b>Pre-requisites, if any</b>	NIL				

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
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1	Summarise the advantages of biofuels	U	3
2	Utilise ethanol as a biofuel	A	1,2,3,6,7
3	Classify the types of aviation fuels	U	2,3
4	Examine the test methods of aviation fuel	An	1,2,3,6,7
5	Design the manufacturing methods of aviation	C	1,2,3,6,7
6	Discover alternative aviation fuels	An	1,2,3,6,7
7	Solve different test methods for aviation fuels	C	1,2,3,6,7
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	<b>Overview of Biofuels</b>			
<b>1</b>	1.1	Biofuels-key advantages of biofuels, development of biological conversion technologies, integration of biofuels into biorefineries, environmental and economic sustainability of biofuels.	5	1
	1.2	Ethanol as a biofuel-commercial production technology (dry milling/wet milling), properties, engine performance and ethanol-fuel testing, E-85 fuels. Environmental aspects of ethanol as a biofuel-significance in the aviation sector and its concerns.	10	2
<b>2</b>	<b>Aviation Fuels</b>			

	2.1	Aviation fuels: Chemical composition and methods of obtaining ATF from crude oil, physico- chemical and functional properties of aviation fuels - AV Gas for piston engines, aviation kerosene and broad fraction fuels for turbine engines. Technology of fuel preparation before application to aircraft tanks. Sustainable aviation fuels (SAF), Bio-Aviation Turbine fuel (Bio-ATF).	5	3
	2.2	Aviation biofuels and technologies for their production. Different types of Aviation fuels and analysis: copper corrosion, aromatics, naphthalene content, silver corrosion, Water Separator Index, JFTOT, anti-oxidants, Static Dissipative Additives (SDA), distillation, total sulphur, mercaptans, lubricity, smoke point, freezing point, specific energy value. Anti-knock performance, research octane number, motor octane number, road octane number.	10	4
	<b>Manufacture of Aviation Fuels</b>			
<b>3</b>	3.1	Different methods of manufacture: hydro desulphurization, merox process, hydro treating process, atmospheric distillation. Main components in Jet (Turbine) fuel, performance criteria of ATF. Physical and chemical properties of ATF.	5	5
	3.2	Additives- lubricity additives, conductivity additives, multi-functional additives (MFA) and other additives	5	5

	3.3	Alternative Aviation fuels-First vs second generation biofuels-advantages of second generation biofuels-success criteria for biofuels in aviation.	5	6
	<b>Aviation Fuel Practical</b>			
4	Distillation of blended aviation fuels 1. Acidity of Aviation fuels 2. Copper corrosion test 3. Silver corrosion test 4. Freezing point of aviation fuels 5. Smoke point of aviation fuels 6. Flash point of aviation fuels 7. Existent gum testing 8. Doctor test using sodium plumbite 9. H <sub>2</sub> S test using 5% lead acetate 10. Test for water reaction 11. Test for mercaptans of fuel		30	7
5	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom procedure (mode of transaction)</b>  Lecture, assignments and seminars
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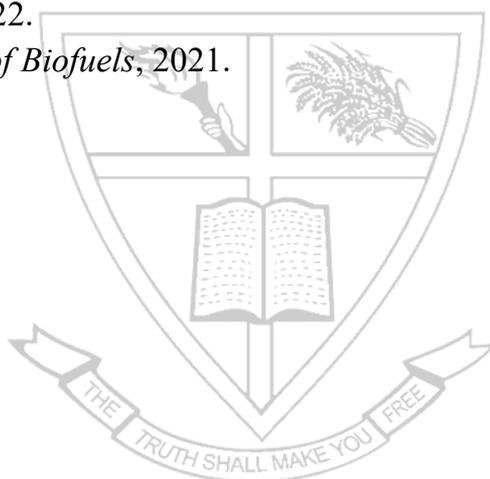
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous</b>  <b>Comprehensive Assessment (CCA)</b></p> <p><b>Theory (25 marks)</b></p> <p>Assignment</p> <p>MCQ</p> <p>Viva</p> <p>Involvement in classroom activities</p> <p><b>Practical (15 marks)</b></p> <p>Lab involvement / report/ Lab test</p>
	<p><b>B. Semester end examination</b></p> <p><b>Theory ( 50 marks)- 1.5 hrs.</b></p> <p>MCQ 10 questions : 10 X 1 = 10</p> <p>Short answer 4 questions (out of 6): 4 X 3 =12</p> <p>Short essay 4 questions (out of 6): 4 X 7 = 28</p> <p><b>Practical (35 marks)-1 hr.</b></p> <p>Lab report: 10</p> <p>Viva: 10</p> <p>Writing procedure: 15</p>

### References

1. ASTM Methods, Indian standards (Methods of test for petroleum and its Products).
2. B. Khandelwal, *Aviation Fuels*, 2021.
3. C. T. Chong, N. G. Jo-Han, *Biojet Fuels in Aviation Applications: Production, usage and impact of biofuels*, 2021.
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5. *Fundamentals of petroleum*, fifth edition, The petroleum extension service, ISBN:0-88698-231-6, 2011.
6. K. B. Manjooran, *Modern Petroleum Chemistry–An Overview*, 2016.
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8. R. Luque, J. Campelo, J. Clark, *Handbook of biofuels production: Processes and technologies*. Wood head Publishing Limited 2011.
9. V.K. Gupta, M.G. Touhy, *Biofuel Technologies*, Springer 2013.

## SUGGESTED READINGS

1. A. Dahiya, *Bioenergy: Biomass to biofuels and waste to energy*, 2<sup>nd</sup> edition, 2020.
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3. A. Yousuf, C. G. Fernandez, *Sustainable Alternatives for Aviation Fuels*, 2022.
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11. R. Luque, C. Lin, K. Wilson, C. Du, *Handbook of Biofuels Production: Processes and Technologies*, 2022.
12. S. Sahay, *Handbook of Biofuels*, 2021.



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### SEMESTER 4

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Organic Chemistry-2</b>					
<b>Type of Course</b>	DSC A					
<b>Course Code</b>	<b>UC4DSCCHE200</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	A study of the reactions of alcohols, aldehydes, ketones, carboxylic acids, and its derivatives. Practical part includes Qualitative Microscale analysis of organic compounds.					
<b>Semester</b>	4	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
<b>Pre-requisites, if any</b>		3		1		75

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Summarize the structure and uses of alcohols, aldehydes, ketones, acids, and acid derivatives.	U	1,2
2	Predict the product and reasonable mechanism for reactions of alcohols, aldehydes, ketones, carboxylic acids, and its derivatives	E	1, 2
3	Apply the functional group chemistry to interconvert alcohol, aldehyde, ketone and acid.	A	1, 2
4	Design synthetic pathways to higher and lower homologous series in acids and alcohols.	A	1, 2
5	Analyse the functional groups and systematically record the observations. (Practical)	An, S	1, 2, 4, ,10

**\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Alcohols</b>			
	1.1	Alcohols-classification (monohydric, dihydric, polyhydric, primary, secondary and tertiary), Luca's test, preparation of alcohols using Grignard reagents.	2	1, 2, 3
	1.2	Chemical Properties: esterification, reactions with sodium and $\text{KMnO}_4$ , pinacol-pinacolone rearrangement (with mechanism), ascend and descend in homologous series, alcohol metabolism in human body.	4	1, 3, 4, 5
	1.3	Phenol- acidity of phenol, effect of substituent on acidity, comparison of acidity of phenols with alcohols. Hydrogen bonding (inter and intramolecular) in phenols, effect of H-bonding on boiling point and solubility in water.	4	1, 3
	1.4	Chemical reactions of phenol: electrophilic substitution reactions-nitration, halogenation, Reimer-Tiemann reaction (with mechanisms) Structure and uses of catechol, resorcinol, quinol and picric acid.	5	3, 4, 5
2	<b>Aldehydes and Ketones</b>			
	2.1	Structure and industrial uses of representative aldehydes and ketones-formaldehyde,	2	1

		acetaldehyde, benzaldehyde and acetone.		
	2.2	Nucleophilicity of carbonyl compounds-comparison between aldehydes and ketones Nucleophilic addition reactions-reaction with HCN, ammonia derivatives (reaction with primary amine, hydroxylamine, phenylhydrazine).	4	1, 3, 4, 5
	2.3	Acidity of alpha-hydrogen in aldehydes and ketones, aldol condensation, Claisen condensation, Knoevenagel reaction, Claisen-Schmidt reaction, Perkin condensation, benzoin condensation, Cannizzaro reaction (with mechanisms)	6	1, 3, 4, 5
	2.4	Clemmensen reduction, Wolff-Kishner reduction, iodoform reaction, Beckmann rearrangement (with mechanisms) Tollen's and Fehling's reaction	3	2, 3, 4, 5
	<b>Carboxylic acids and acid derivatives</b>			
<b>3</b>	3.1	Structure and uses of formic acid, acetic acid, benzoic acid, oxalic acid, phthalic acid, and salicylic acid.	1	1
	3.2	Acidity of carboxylic acid- effect of substituents on acid strength for aromatic carboxylic acids.	1	1, 2
	3.3	Reactions of carboxylic acids: - reduction, decarboxylation and Hell – Volhard - Zelinsky reaction. Ascend and descend in carboxylic acid homologous series.	4	1, 2
	3.4	Acid derivatives-Conversion of acid to acid	3	1, 2

		chlorides, amides, esters and anhydrides Comparative study of nucleophilicity of acyl derivatives.		
	3.5	Reactions of acid derivatives with mechanisms: conversion of acid chloride to acid anhydride, ester, amide, aldehyde, and alcohol; conversion of acid anhydride to acid, ester, and amide; conversion of ester to acid, amide, primary and secondary alcohols; conversion of amide to acid, nitrile and primary amine. Reformatsky reaction.	6	1, 2
	<b>Organic Chemistry-2 Practicals</b>			
4	4.1	Qualitative microscale analysis of organic compounds- identification and preparation of derivatives of alcohols, phenols, aldehydes, ketones, carboxylic acid, and carboxylic acid derivatives.	30	1, 2, 4
5		<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Demonstration of experiments</li> <li>● Hands-on training</li> </ul>
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<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b> <b>Theory (25 marks)</b></p> <p>Pop quiz</p> <p>Problem based assignments</p> <p>Written/MCQ tests</p> <p style="text-align: center;"><b>Practical (15 marks)</b></p> <p>Quiz</p> <p>Lab involvement</p> <p><b>B. Semester end examination</b> <b>Theory: Written examination (50 Marks)-1.5 hrs.</b></p> <p style="padding-left: 40px;">i. MCQ 10 questions : <math>10 \times 1 = 10</math></p> <p style="padding-left: 40px;">ii. Short answer 4 questions (out of 6): <math>4 \times 3 = 12</math></p> <p style="padding-left: 40px;">iii. Short essay 2 questions (out of 3): <math>2 \times 7 = 14</math></p> <p style="padding-left: 40px;">iv. Essay 1 question (out of 2): <math>1 \times 14 = 14</math></p> <p style="text-align: center;"><b>Practical: 35 marks-1 hrs.</b></p> <p>Viva voce-10 Marks</p> <p>Written test of practical procedures-15 Marks</p> <p>Certified report of lab works done -10 Marks</p>
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### References

1. A. Bahl, B. S. Bahl, *Advanced Organic Chemistry*; S. Chand, 2010.
2. B. S. Furniss, A. J. Hannaford, V. Rogers, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*; 5th ed.; Pearson Education, 2005.
3. F. A. Carey, R. J. Sundberg, *Advanced Organic Chemistry: Part A: Structure and Mechanisms*; Springer Science & Business Media, 2007.

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7. J. McMurry, *Organic Chemistry*; 7<sup>th</sup> Edn. Cengage Learning, 2013.
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13. V. K. Ahluwalia, S. Dhingra, *Comprehensive Practical Organic Chemistry- Qualitative Analysis*; University Press, 2000.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Physical Chemistry- 1</b>					
<b>Type of Course</b>	DSC A					
<b>Course Code</b>	<b>UC4DSCCHE201</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	This course deals with the fundamental concepts of gaseous state, ionic and phase equilibria, and solutions.					
<b>Semester</b>	IV	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	1		
<b>Pre-requisites, if any</b>						

## COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Interpret the properties of real and ideal gases and calculate the critical constants theoretically.	E	1,2
2	Distinguish the different types of molecular velocities and define various terms involved on molecular motion.	An	1,2
3	Utilize the concepts of acids, bases and buffer solutions to calculate ionic product, pH and ionic strength.	A	1,2
4	Interpret different phases coexist in phase diagram.	E	1,2
5	Identify different types of solutions and its properties.	A	1,2
6	Distinguish the colligative properties of solutions and calculate the molar mass.	U	1,2
7	Make use of theoretical knowledge and execute experiments in phase equilibria, critical solution temperature and colligative properties.	A,S	1,2,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

## COURSE CONTENT

### Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
		<b>GASEOUS STATE</b>		
1	1.1	Deviation of real gases from ideal behaviour: causes of deviation, van der Waals equation of state for real gases. Boyle temperature. Critical phenomena and Andrew's isotherms of CO <sub>2</sub> , continuity of states, critical constants and their calculation from van der Waals equation. Virial equation of state, van der Waals equation expressed in Virial form.	5	1
	1.2	Maxwell Boltzmann distribution laws of molecular velocities (graphical representation – derivation not required) and their importance. Temperature dependence of these distributions.	5	1, 2

	1.3	Collision properties: Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules (No derivation). Relation between mean free path and coefficient of viscosity.	5	2
2	<b>IONIC EQUILIBRIA</b>			
	2.1	Introduction – Concepts (Lowry-Bronsted and Lewis concept) of acids and bases, relative strength of acid-base pairs, influence of solvents, Dissociation constants – acids, bases, and polyprotic acids. Ostwald’s dilution law.	4	3
	2.2	Degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water- pH. Effects of solvents on ionic strength.	3	3
	2.3	Buffer solutions – Mechanism of buffer action, Henderson equation. Hydrolysis of salts (concepts only).	3	3
	<b>PHASE EQUILIBRIA</b>			
3(a)	3.1	The phase rule (no-derivation). One component system – water and sulphur systems.	2	4
	3.2	Two component systems- simple eutectic; lead-silver system. Application to metallurgy-Pattinson’s process.	3	4
3(b)	<b>SOLUTIONS</b>			
	3.3	Introduction , binary liquid solutions, Raoult’s law, ideal and non-ideal solutions, Vapour pressure – composition and temperature – composition curves of ideal and non-ideal binary liquid solutions.	5	5
	3.4	Critical solution temperature (CST). Solubility of gases in liquids – Henry’s law and applications. Distribution of a solute between two solvents– Nernst distribution law.	5	6

	3.5	Colligative properties of dilute solutions – vapour pressure lowering, boiling point elevation and freezing point depression. Molar mass determination (no derivation) -related problems – osmotic pressure –laws of osmotic pressure – reverse osmosis – purification of seawater. Abnormal molecular masses – van't Hoff factor – degree of association and degree of dissociation.	5	6
<b>Physical chemistry 1 - Practicals</b>				
4	4.1	Determination of CST of Phenol-water system Effect of KCl/Succinic acid on Critical Solution Temperature of phenol-water system Determination of unknown concentration of KCl/Succinic acid using CST method Transition temperature of salt hydrates. (Sodium thiosulphate, sodium acetate) Determination of mass of solvent/molecular mass of solute using transition temperature. Construction of phase diagram of simple eutectics (Naphthalene-Biphenyl System) Molecular weight determination by Rast's method. (Using naphthalene, camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene etc. as solute.)	30	7
5		<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board and powerpoint presentations)</li> <li>● Interactive sessions and simulations,</li> <li>● Visual aids like videos and models to enhance understanding.</li> <li>● Peer discussions.</li> <li>● Laboratory experiments and hands-on training</li> </ul>
<b>Assessment Types</b>	

	<p><b>MODE OF ASSESSMENT</b></p> <p><b>Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory: (25 marks)</b></p> <p>Pop quiz Assignment Class test(MCQ/written)</p> <p><b>Practical: (15 marks)</b></p> <p>Lab involvement / skill/ Report of lab works done</p>
	<p><b>Semester end examination</b></p> <p><b>Theory: Written examination (50 Marks)- 1.5 hrs</b></p> <p>MCQ 10 questions : <math>10 \times 1 = 10</math>  Short answer 4 questions (out of 6): <math>4 \times 3 = 12</math>  Short essay 2 questions (out of 3): <math>2 \times 7 = 14</math>  Essay 1 question (out of 2): <math>1 \times 14 = 14</math></p> <p><b>Practical: 35 marks-1 hr.</b></p> <p>Viva voce-10 Marks  Written test of practical procedures-15 Marks  Certified report of lab works done -10 Marks</p>

## References

1. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd., 2019.
2. F. Daniels and R. A. Alberty, *Physical Chemistry*, 3rd ed., John Wiley and Sons, Inc., New York, 2021.
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8. Puri, Sharma, Pathania, *Principles of Physical Chemistry*, 48<sup>th</sup> Edn. Vishal Publishing Company, 2012

### Suggested Readings

1. Glasstone, Lewis, Elements of Physical Chemistry, Macmillan student editions, 2nd revised, Van Nostrand, 1960.
2. J. C. Kotz, P. M. Treichel, J. R. Townsend, *General Chemistry*, Cengage Learning India Pvt. Ltd. New Delhi (2009).
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- 5.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Polymer Chemistry</b>					
<b>Type of Course</b>	DSE					
<b>Course Code</b>	<b>UC4DSECHE200</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	This course explores synthesis, structure, properties and applications of important polymers.					
<b>Semester</b>	IV	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the fundamental concepts of polymers, polymerisation reactions and techniques	U	1,2,3
2	Analyse basic determinants of polymer properties	An	1,2,3
3	Develop a comprehensive idea of tacticity in polypropylene and Ziegler-Natta polymerisation of alkenes.	A	1,2,3
4	Examine the structures, properties, and applications of addition polymers, condensation polymers and polymer resins	U	1,2,3
5	Identify the importance of the vulcanization process and the practical aspects of formulating rubber compounds.	A	1,2,3
6	Analyse the applications of advanced polymers	An	1, 2
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1.	<b>Introduction to polymers and polymerisation reactions</b>			
	1.1	Monomers, oligomers, and polymers. Classification of polymers-based on origin, structure and intermolecular forces Importance of polymers in life- proteins and DNA. (Elementary idea only).	5	1,2
	1.2	Addition polymerisation of olefins - classification (cationic, anionic and free radical), mechanism.	4	1
	1.3	Mechanism of condensation polymerisation (polyamides and polyesters) and ring opening	5	1,2

		polymerisation (Nylon 6). Living polymerisation -definition and applications only		
	1.4	Self-healing polymers and shape-memory polymers- definition and applications only	1	1,2
2.	<b>Polymerisation Techniques</b>			
	2.1	Definition, advantages, disadvantages and examples of bulk polymerisation, suspension polymerisation, solution polymerisation and emulsion polymerisation.	5	1
	2.2	Structure-property relationships of polymers: tacticity in polypropylene –isotactic, syndiotactic and atactic. Ziegler-Natta polymerisation of alkenes. Crystalline and amorphous polymers. Basic determinants of polymer properties: Polymer chain flexibility, Factors affecting chain flexibility.	5	1,4
	2.3	Molecular weight of polymers: Number average ( $M_n$ ), weight average ( $M_w$ ), Polydispersity index. Glass transition temperature ( $T_g$ ): Definition. Factors influencing glass transition temperature ( $T_g$ ). Importance of $T_g$ .	5	3
3.	<b>Chemistry of Commercial Polymers</b>			
	3.1	Brief introduction to the structure, properties and applications of the following addition polymers: polyolefins (LDPE, HDPE and PP), poly (vinyl chloride), polystyrene, poly (vinyl acetate), acrylic polymers (PAN and PMMA), fluoropolymers (PTFE).	5	5
	3.2	Brief introduction to the structure, properties and applications of the following polymers: aliphatic polyamides (Nylon 6,6 and Nylon 6), aromatic polyamides (Kevlar), polyesters (PET).	4	5
	3.3	Brief introduction to structure, properties and applications of the following resins:	3	5

		Formaldehyde resins (PF, UF and MF), polyurethanes, polycarbonates and epoxy resins.		
	3.4	Introduction to vulcanisation of natural rubber- types of vulcanisation (EV, semi-EV and CV), activator system, accelerator system. Formulation of a rubber compound – rubber mat.	3	6
	<b>Polymeric Materials for Special Applications</b>			
	4.1	Support materials: materials based on polystyrene-cross linking with divinylbenzene-applications.	3	6
	4.2	Drug release agents: biodegradable polyurethane Temperature sensitive polymers as drug delivery agents: LCST polymers-examples and applications.	5	6
	4.3	Conducting polymers: polyacetylene- doping, synthesis and applications	3	6
	4.4	Photo-conducting polymers: applications of poly(vinyl carbazole)	2	6
	4.5	Heat and flame retardant polymers: nomex-applications	2	6
5	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (mode of transaction)</b> Lecture-based approach, interactive discussions, laboratory sessions, flipped classroom, peer teaching and collaborative learning.
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>30 marks</b> <b>Assignments</b>

	<p><b>MCQ</b></p> <p><b>Class test</b></p> <p><b>Viva</b></p>
	<p><b>B. End Semester examination</b></p> <p><b>70 marks- 2 hrs.</b></p> <p>i) Short answer 5 questions (out of 7): 5 X 4 =20</p> <p>ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>iii) Essay 1 question (out of 2): 1 X 15 = 15</p>

## References

1. Ravve, *Principles of Polymer Chemistry*, Springer, 2012.
2. C. E. Carraher, *Seymour/Carraher's Polymer Chemistry*: 6th Edn. CRC Press, 2003.
3. F. W. Billmeyer, *Textbook of Polymer Science*, John Wiley & Sons, 2007.
4. G. Odian, *Principles of Polymerization*, 4<sup>th</sup> Edn. Wiley, 2004.
5. J. M. Garcia, *Smart Polymers*, De Gruyter, 2022.
6. M. N. Subramanian, M. N. *Basics of Polymer Chemistry*; River Publishers, 2022.
7. P. Ghosh, *Polymer Science & Technology*, 2<sup>nd</sup> Edn. Tata McGraw-Hill, New Delhi, 2002.
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10. R. W. Lenz, *Organic Chemistry of Synthetic High Polymers*; Interscience Publishers, New York, 1967.
11. V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, *Polymer Science*, Wiley, 1986.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course</b>	<b>Food Chemistry</b>

<b>Name</b>						
<b>Type of Course</b>	DSE					
<b>Course Code</b>	UC4DSECHE201					
<b>Course Level</b>	200-299					
<b>Course Summary</b>	This course covers the scientific principles behind the composition, structure, properties, and reactions of food components. It also deals with topics related to the various substances added to food to enhance flavour and taste, improve texture and prolong shelf life.					
<b>Semester</b>	IV	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse the chemical composition of various food components such as proteins, carbohydrates, lipids, vitamins, and minerals.	An	1,2,3
2	Apply principles of food chemistry to understand and predict the behaviour of food during processing, storage and cooking.	A	1,2,3
3	Explain the significance of food additives.	U	1,2,3
4	Analyse the impact of food practices in the society	An	1,2,4,5, 6, 8
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Food Additives</b>			
	1.1	Food additives – definition. Preservatives- natural food preservatives, traditional food preservation methods, artificial preservative agents, modern food preservation techniques, safety concerns of food preservatives.	3	2,3
	1.2	Food Colours- classification, chemistry of food colourants, non-permitted food colours, quality assurance of food colourants.	2	2,3
	1.3	Fragrances, flavouring agents and enhancers- classification, chemistry, quality control of flavour compounds.	2	2,3
	1.4	Emulsifiers- mechanism, role, types with examples.	1	2,3
	1.5	Stabilisers, gums, thickeners and gelling agents	1	2,3
	1.6	Antioxidants- types, chemistry, safety concerns of antioxidants.	2	2,3
	1.7	Food acids and acidity regulators, flour treatment/ improving agents, leavening agents, anticaking agents, minerals and mineral salts, dietary supplements- vitamins	3	2,3
	1.8	FSSAI, Food safety and standards act	1	2,3
2	<b>Role of Water, Carbohydrates, Lipids and Proteins in Food</b>			
	2.1	Structure and chemical properties of water, solute effects on water: state of water in foods, water activity: principles, measurement, control, effects and related concepts.	4	1
	2.2	Carbohydrates- basic chemistry, reactivity and sweetness of simple sugars and oligosaccharides, sugar derivatives: sugar alcohols, glycosides. Browning and related reactions. Polysaccharides- starch, cellulose, gums.	4	1,2

	2.3	Lipids- content and role in food, chemical, nutritional and physical properties, processing of fats and oils, degradation reactions.	3	1,2
	2.4	Proteins- amino acids and proteins, physical properties of proteins,: hydration, ionization, colloidal behaviour, functional properties, effects of food processing: changes occurring in chemical, functional & nutritional properties of proteins	4	1,2
	<b>Enzymes, Vitamins and Minerals</b>			
	3.1	Food enzymes: enzymes acting on carbohydrates, proteins and lipids.	3	1,2
	3.2	Vitamins- fat-soluble vitamins, water-soluble vitamins, sources of vitamins, general causes of variation/losses of vitamins in food, biological function of vitamins, toxicity of vitamins.	5	1,2
	3.3	Essential mineral elements, nutritional aspects of minerals, bioavailability, effect of processing on mineral bioavailability, chemical and functional properties of minerals in foods.	5	1,2
	3.4	Societal role of food chemists	2	4
	<b>Herbs and Spices</b>			
	4.1	Black Pepper: black pepper and white pepper, blackening of pepper, piperine- properties. Health benefits.	3	
	4.2	Ginger: components, medicinal uses.	2	
	4.3	Turmeric: uses, components and medicinal applications	2	
	4.4	Cinnamon: components and uses.	2	
	4.5	Cardamom: Components and uses.	2	
	4.6	Adulteration of herbs and spices.	2	
	4.7	Wine: production of wine grapes and wine.	2	
<b>3</b>				
<b>4</b>				

5	<b>Teacher Specific Content</b>
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<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (mode of transaction)</b> Lecture-based approach, interactive discussions, laboratory sessions, flipped classroom, peer teaching and collaborative learning.
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>30 marks</b> Assignments/MCQ/Class test/Viva
	<b>B. End Semester examination (70 marks)- 2hrs.</b> i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

## References

1. A. V. Ramani, *Food Chemistry*, Mjp Publishers. 2011.
2. C. M. Weaver and J. R. Daniel, *The Food chemistry Laboratory*, CRC Press, 2005.
3. D. D. Miller and C. K. Yeung, *Food Chemistry A Laboratory Manual*, Wiley, 2022.
4. H. D. Belitz, W.Grosch and P. Schieberle, *Food Chemistry*, 4<sup>th</sup> Edn. Springer, 2009.
5. J. M. deMAN, *Principles of Food Chemistry*, Springer, 2018.
6. N. Agarwal and A. Srivastava, *Food Chemistry*, Anu Books, 2023.
7. S. Damodaran, K. L. Parkin, Fennema's *Food Chemistry*, 5<sup>th</sup> Edn. CRC Press 2017.
8. S. S. Nielsen, *Food Analysis Laboratory Manual*, 3<sup>rd</sup> Edn. Springer, 2019.
9. T. A. M. Msagati, *Chemistry of Food Additives and Preservatives*, John Wiley & Sons, 2013.
10. T. Coultate, *Food: The Chemistry of Its Components*, 6<sup>th</sup> Edn. RSC. 2015.
11. V. Kontogiorgos, *Introduction to Food Chemistry*, Springer, 2021.

12. V. Kontogiorgos, *Introduction to Food Chemistry*, Springer, 2021.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Basic Analytical and Cosmetic Chemistry</b>					
<b>Type of Course</b>	SEC					
<b>Course Code</b>	<b>UC4SECCHE200</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	This course covers hand care, nail, personal hygiene, and oral care product formulation along with an introduction to Analytical Chemistry. Emphasizing practical skills in product formulation and analytical techniques.					
<b>Semester</b>	IV	Credits			3	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
<b>Pre-requisites, if any</b>	Nil					

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Illustrate the chemistry behind hand care and hygiene products	U	1,3,10
2	Formulate a range of personal care and hygiene	S	2,3,10

	products, preparing them for roles in the cosmetic and pharmaceutical industries.		
3	Discuss the fundamentals of analytical chemistry	U	1,3
4	Apply techniques for soil and water analysis	A,S	2,3,10
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Hand Care Products and nail preparation</b>			
	1.1	Hand Care Products: Introduction, formulation of hand sanitizers and hand wash. General ingredients and preparation of: (a) Hand wash (b) Antibacterial hand wash (c) Hand sanitizer	8	1,2
	1.2	Nail preparation: Structure of nail, Nail lacquers, Nail polish remover. General Ingredients and Preparation of: Nail polish and nail polish remover	7	1,2
2	<b>Personal hygiene products and oral hygiene products</b>			
	2.1	Personal hygiene products: Total fatty matter, alkali content, and pH of soaps. Bathing soap and toilet soap. Antiperspirants and deodorants. General Ingredients and preparation of (a) Soaps (b) Cream Soaps (c) Liquid soaps	8	1,2

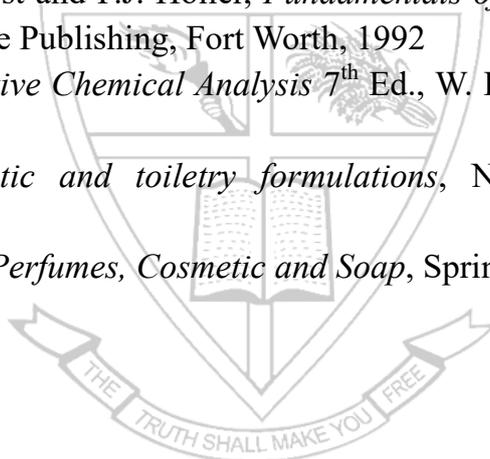
		(hands on training )		
	2.2	Oral hygiene products: Common problems associated with teeth and gums. Principles of formulation of Oral hygiene products. Role of herbs in oral care: neem and clove. Flavors and essential oils. General Ingredients and preparation of (a) Tooth powder (chemical-based and herbal) (b) Toothpaste (hands on training )	7	1,2
	<b>Analytical Chemistry</b>			
	3.1	Introduction: Introduction to analytical chemistry and its interdisciplinary nature. Concept of sampling.	3	3
3	3.2	Analysis of soil: composition of soil, concept of pH and pH measurement. a. Determination of pH of soil samples. (hands on training )	5	4
	3.3	Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, and water purification methods. a. Determination of pH, acidity, and alkalinity of a water sample. (hands on training )	7	4
4		<b>Teacher Specific content</b>		

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (mode of transaction)</b> <b>Lectures, discussions, hands-on training, presentations and group activities</b>
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (CCA)</b>

	<b>(25 marks)</b> Performance in activities/Assignments/MCQ examination
	<p style="text-align: center;"><b>B. End Semester examination</b> <b>(50 marks)-1.5 hrs.</b></p> <p style="text-align: center;">Short answer 10 questions (out of 12): 10 X 2 =20</p> <p style="text-align: center;">Short essay 6 questions (out of 8): 5 X 6 = 30</p>

### References

1. D.A. Skoog and J.J. Leary, *Instrumental Methods of Analysis*, Saunders College Publications, New York, 1992
2. D.A. Skoog, D.M. West and F.J. Holler, *Fundamentals of Analytical Chemistry* 6<sup>th</sup> Edn., Saunders College Publishing, Fort Worth, 1992
3. D.C. Harris, *Quantitative Chemical Analysis* 7<sup>th</sup> Ed., W. H. Freeman and Co., New York, 2007
4. E.W. Flick , *Cosmetic and toiletry formulations*, Noyes Publications, New York,2001
5. H. Butler , *Poucher's Perfumes, Cosmetic and Soap*, Springer,2000



<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Basic Environmental Chemistry</b>
<b>Type of Course</b>	VAC
<b>Course Code</b>	<b>UC4VACCHE200</b>
<b>Course Level</b>	<b>200-299</b>

<b>Course Summary</b>	This course explores various aspects of environmental chemistry such as greenhouse effect, air and water pollution and renewable energy sources.					
<b>Semester</b>	4	<b>Credits</b>			3	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical 1	Others	
		3				45
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe basic concepts of environmental chemistry.	U	1,2, 3, 4, 5, 6, 8
2	Describe strategies for the remediation and purification of contaminated soil, air and water.	U	1,2,10
3	Apply principles of green chemistry to propose sustainable solutions for minimizing environmental contamination.	A	1,2,6,8,10
4	Discuss the basic chemical processes involved in air and water pollution and global warming identifying key sources.	U	1,2,8

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		<b>Introduction to the Environment</b>		

	1.1	Classification of the environment-troposphere, stratosphere, mesosphere, thermosphere, exosphere, hydrosphere, lithosphere and biosphere	5	1
	1.2	Greenhouse gases and global warming: natural occurring greenhouse gases, anthropogenic greenhouse gases, other greenhouse gases, ozone, global warming potential (GWP), emission metrics, influence of technology on global warming.	8	4
	1.3	Schemes to reduce greenhouse gases: capture and storage of carbon dioxide, sequestration of CO <sub>2</sub> . other schemes to reduce greenhouse gases, removing CO <sub>2</sub> from the atmosphere: direct air capture, carbon dioxide emissions in the future	7	2,4
	<b>Air and Water Pollution</b>			
2	2.1	Water pollution causes, categories of water pollution, the long-term consequences of water pollution, basic idea of waste water purification and disinfection	5	2,3,4
	2.2	Air pollution: particulates, fog smog, acid rain, ozone umbrella, depletion- causes, basic idea of air quality improvement methods.	5	2,3,4
	<b>Renewable Energy and Sustainability</b>			
3	3.1	Renewable energy: hydroelectric, wind, solar, geothermal, and marine energy and their storage and hydrogen as sustainable energy	6	3
	3.2	Biomass energy: biofuels and their resources, decarbonization with biomass utilization. Conversion of biomass to other fuels- ethanol fuel, biodiesel fuel, fuel from algae. Biogas	6	3
	3.3	Sustainable materials: environmental effects of mining and mineral extraction, sustainable utilization of geospheric mineral resources-	3	3

		metals and nonmetal mineral resources		
4	<b>Teacher Specific content</b>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (mode of transaction)</b></p> <p>Lecture-based approach, interactive discussions, laboratory sessions, flipped classroom, peer teaching and collaborative learning.</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>25 marks</b></p> <p>Assignments</p> <p>Viva</p> <p>Classroom participation (participation in class activities)</p> <p>Examination</p>
	<p><b>B. Semester end examination</b></p> <p><b>50 marks-1.5 hrs.</b></p> <p>i) MCQ 10 questions : <math>9 \times 1 = 9</math></p> <p>ii) Short answer 5 questions (out of 7): <math>5 \times 4 = 20</math></p> <p>iii) Short essay 3 questions (out of 5): <math>3 \times 7 = 21</math></p>

### References

1. *Chemistry in the Community*, A Project of the American Chemical Society, W H Freeman & Company, 2011.
2. C H. Middlecamp, *Chemistry in Context: Applying Chemistry to Society*, A Project of the American Chemical Society, McGraw-Hill, 2012.
3. C Baird, M Cann, *Environmental Chemistry*, W. H. Freeman and Company, 2012.

4. D W. Connell, *Basic Concepts of Environmental Chemistry*, 2<sup>nd</sup> Edn. CRC Press, 2005.
5. A K De, A K De, *Environmental Chemistry*, 10<sup>th</sup> Edn. New Age International, 2021.
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7. V. Subramanian, *A Text Book Of Environmental Chemistry*. Wiley, 2020.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Fundamentals of Physical Chemistry</b>					
<b>Type of Course</b>	<b>DSC C</b>					
<b>Course Code</b>	<b>UC4DSCCHE202</b>					
<b>Course Level</b>	<b>200-299</b>					
<b>Course Summary</b>	This course provides the student a thorough knowledge about solids and surface chemistry. It also gives basic information on green chemistry and nano chemistry along with an introduction on spectroscopy.					
<b>Semester</b>	IV	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe types of solids, crystals and properties of	U	1,2

	solids		
2	Discuss the adsorption of gases by solids	U	1,2
3	Analyse the properties and applications of colloids	An	1,2
4	Apply the basic principles of electrochemistry to conductance and emf measurements.	A	1,2
5	Apply the principles of electrochemistry to conduct simple laboratory experiments.	A, S	1,2
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	<b>Solid State</b>			
<b>1</b>	1.1	Classification of solids: amorphous and crystalline – differences. Crystal lattice, unit cell, examples of simple cubic, bcc and fcc lattices, calculation of number of atoms in a unit cell, calculation of lattice parameters of cubic unit cell.	6	1
	1.2	Electrical properties: Conductors, semiconductors and insulators, band theory, superconductors. Magnetic Properties: classification-paramagnetic, diamagnetic, ferromagnetic, antiferromagnetic and ferrimagnetic. Permanent and temporary magnets.	6	1
	<b>Surface chemistry and colloids</b>			
<b>2</b>	2.1	Adsorption – types of adsorption of gases by solids, factors influencing adsorption, Freundlich and Langmuir adsorption isotherm (derivation not required).	3	2

	2.2	True solution, colloidal solution and suspension. Classification of colloids: lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples. Purification of colloids by electro dialysis and ultrafiltration.	4	3
	2.3	Properties of colloids: Brownian movement, Tyndall effect, electrophoresis. Origin of charge and stability of colloids, zeta potential, coagulation, Hardy-Schulze rule, protective colloids, gold number. Emulsions.	3	3
	2.4	Applications of colloids: delta formation, medicines, emulsification, micelle formation, cleaning action of detergents and soaps.	2	3
	<b>Electrochemistry</b>			
	3.1	Introduction, Faraday's laws of electrolysis, electrochemical equivalent and chemical equivalent	3	4
	3.2	Specific conductance, equivalent conductance and molar conductance , variation of conductance with dilution - Kohlrausch's law - degree of ionization of weak electrolytes	4	4
	3.3	Application of conductance measurement: s determination of degree of dissociation of weak electrolytes, conductometric titrations involving strong acid- strong base, strong acid-weak base, weak acid- strong base, and precipitation titrations.	5	4
<b>3</b>	3.3	Galvanic cells - Cell and electrode potentials - IUPAC sign convention, Types of electrodes: reference electrodes – standard hydrogen electrode and calomel electrode, indicator electrodes-metal-metal ion electrodes, Quinhydrone electrode and Redox electrodes. Standard electrode potential - Nernst equation, electrochemical series. Gibb's Helmholtz equation and EMF of a cell.	7	4

	3.4	Potentiometric titrations of acid-base, redox and precipitation reactions.	2	4
	<b>Physical Chemistry Practicals</b>			
4	1. Viscosity-percentage composition of sucrose solution. 2. Transition temperature of salt hydrates, e.g. Sodium thiosulphate Sodium acetate etc. 3. Critical solution temperature of phenol water system 4. Conductometric titration of strong acid Vs. strong base 5. Potentiometric titrations : $\text{Fe}^{2+}$ Vs. $\text{Cr}_2\text{O}_7^{2-}$ and $\text{Fe}^{2+}$ Vs. $\text{KMnO}_4$ 6. Determination of molecular weight by Rast's method. 7. Phase diagram of two component systems		30	5
5	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Demonstration of experiments</li> <li>● Hands-on training</li> </ul>
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b>  <b>B. Continuous Comprehensive Assessment</b>  <b>Theory (25 marks)</b> Assignment Class test (MCQ/Written)  <b>Practical (15 marks)</b> Lab involvement Quiz

	<p><b>B. Semester end examination</b></p> <p><b>Theory: Written Examination (50 Marks)- 1.5 hrs.</b></p> <p>i) MCQ 10 questions : 10 X 1 = 10  ii) Short answer 4 questions (out of 6): 4 X 3 =12  iii) Short essay 2 questions (out of 3): 2 X 7 = 14  iii) Essay 1 question (out of 2): 1 X 14 = 14</p> <p><b>Practical: (35 marks)- 1 hr.</b></p> <p>Certified report, procedure and viva voce (10+15+10= 35 Marks)</p>
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### References

1. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5<sup>th</sup> Edn., John Wiley and Sons, Canada, 1980
2. G. K. Vemulapalli, *Physical Chemistry*, Prentice-Hall of India Pvt. Ltd., 1997.
3. G. M. Barrow, *Physical Chemistry*, 5th Edition, Tata McGraw Hill Education, New Delhi, 2006.
4. J. B. Yadav: *Advanced Practical Physical Chemistry*, Krishna Prakashan Media, 2016.
5. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.
6. R. C. Das and B. Behra; *Experiments in Physical Chemistry*, Tata McGraw hill, 2010.
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8. R. Puri, L. R. Sharma and M. S. Pathania, *Principles of Physical Chemistry*, 48<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2020.
9. S. Glasstone, *An Introduction To Electrochemistry*, Legare Street Press, 2022.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Functional operations in Chemical Industry</b>
<b>Type of Course</b>	DSC B
<b>Course Code</b>	<b>UC3DSCCHE203</b>
<b>Course Level</b>	<b>200-299</b>

<b>Course Summary</b>	This course explores relevant industrial operations and processes with examples of effluent treatment and water purification processes					
<b>Semester</b>	III	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practicals 1	Others	
		3		1	Industrial Visit	75
<b>Pre-requisites, if any</b>	Fundamental knowledge on boiling point, solubility and nature of solvents.					

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### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the basic concepts and fundamental principles of unit operations.	U	1,3
2	Analyse and compare the advantages, limitations, and applications of various equipment in each unit operations	An	1,2,3
3	Demonstrate the correct use of equipment in practical applications.	E, S	1,2,3,10
4	Evaluate the efficiency and effectiveness of different unit operations.	E	1,2,3,10

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
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1	1.1	Unit Operations in Industries – introduction, types of operations, heat and mass transfer, fluid flow operations (laminar and turbulent flow, Bernoulli's	2	1
	1.2	Evaporation: principle, forced circulation, falling film, climbing film (upward flow) and wiped (agitated) film evaporators.	6	2,3,4
	1.2	Distillation-principle, types of distillation: simple, equilibrium, fractional, steam and vacuum distillations, batch and continuous distillation. Rectification, construction of rectifying column and type of columns.	8	2,3,4
	1.3	Filtration: introduction: filter media and filter aids (elementary idea). Equipment-plate and frame filter press, notch filter, rotary drum filter. Introduction to drying process, types of dryers: -tray dryer, rotary dryer, flash dryer, spray dryer	7	2,3,4
2	2.1	Crystallisation: principles and stages of crystallisation.	2	1
	2.2	Crystal growth techniques-crystallisation from melt- Bridgman method, Czochralski method, floating zone method, Verneuil method.	4	2,3,4
	2.3	Crystallisation equipment- draft tube crystalliser, MSMR crystalliser.	4	2,3,4
3	3.1	Mixing: Introduction, mixing of liquid-liquid, solid-liquid and solid-solid systems Equipment for mixing: trough mixer, paddle mixer, tumbler mixer.	4	2,3,4
	3.2	Extraction: Principle and types of extraction (liquid-liquid, solid-liquid, supercritical extraction)	4	1,2
	3.3	Supercritical fluid extraction-theory and instrumentation	4	2,3,4

<b>Functional operations in Chemical industry Practicals</b>			
<b>4</b>	Distillation: To Perform a expt. on Simple Distillation using binary mixture ( Methanol + Water or Ethanol+Water)	<b>30</b>	<b>3,4</b>
	Heat of Solution KNO <sub>3</sub> , NH <sub>4</sub> Cl		
	Heat of neutralization		
	Crystallisation – Any four compounds using ethyl acetate, ethanol, and water – Record the yield of recovery		
	Solvent extraction – aniline from water - methyl benzoate from water - using ether- and record the yield of recovery.		
	To study the rate of drying of solid substances: saw dust or cardboard.		
	To study the rate of drying of liquid substances		
	To crystallise the given sample of phthalic acid from hot water using fluted paper nod stemless funnel.		
	To crystallise the given sample of benzoic acid from hot water using fluted paper nod stemless funnel		
Determine the rate of evaporation of a given liquid sample (thin solution of sugar + water, NaCl+water) in an open pan evaporator.			
<b>5</b>	<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<b>Classroom procedure (mode of transaction)</b> ICT enabled demonstrations/Group discussion/ Lecture
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<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b>  <b>A. Continuous Comprehensive Assessment (CCA)</b>  <b>Theory (25 marks)</b> Assignments/MCQ/viva/Involvement in classroom activities  <b>Practical (15 marks)</b> Lab involvement / report /Lab test
	<b>B. Semester end examination</b>  <b>Theory (50 marks)-1.5 hrs.</b> MCQ 10 questions : 10 X 1 = 10 Short answer 4 questions (out of 6): 4 X 3 =12 Short essay 4 questions (out of 6): 4 X 7 = 28 <b>Practical (35 marks)- 1 hr.</b> Lab report: 10 Viva: 10 Writing procedure: 15

### References

1. W.L.Badger and J.T.Bachero, *Introduction to Chemical Engineering*, Tata McGraw Hill.
2. W.L.McCabe and J.C.Smith, *Unit operations in Chemical Engineering*, Tata McGraw Hill, 2018.
3. J.H.Perry, *Chemical Engineering Hand Book*, McGraw Hill, N.Y., 2018.
4. D.D.Kale, *Unit Operations– 1 and 2*, Vidyarthi Griha Prakashan, Pune.
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6. J. D. Seader, E. J. Henley and D. K. Roper, *Separation Process Principles*, Wiley, 2006.
7. J.F. Richardson, J. H. Harker, J. R. Backhurst, *Particle Technology and Separation Processes*, Butterworth-Heinemann.
8. W. L. McCabe, P. Harriott, J. Smith, *Unit operations in Chemical Engineering*, McGraw Hill, 2022.
9. *Vogel's Textbook of Practical Organic Chemistry*, 5<sup>th</sup> Edn, Pearson Education, 2005.
10. F.G.Mann, B.C. Saunders, *Practical Organic Chemistry*, 4<sup>th</sup> Edn, Pearson Education, 2009.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>				
<b>Course Name</b>	<b>ATF and Latest Development in Fuel Technology</b>				
<b>Type of Course</b>	DSC C				
<b>Course Code</b>	<b>UC3DSCCHE204</b>				
<b>Course Level</b>	<b>200-299</b>				
<b>Course Summary</b>	This course deals with ATF and latest developments in fuel technology. The students will be exposed to drilling operations, oil field brines, transportation and refining of petroleum				
<b>Semester</b>	III	Credits			Total Hours
<b>Course Details</b>	Learning Approach	Lectur		Practica	Others
		3		1	
<b>Pre-requisites, if any</b>	NIL				

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Summarise the advantages of biofuels	U	3
2	Utilise ethanol as a biofuel	A	1,2,3,6,7
3	Classify the types of aviation fuels	U	2,3
4	Examine the test methods of aviation fuel	An	1,2,3,6,7
5	Design the manufacturing methods of aviation	C	1,2,3,6,7
6	Discover alternative aviation fuels	An	1,2,3,6,7
7	Solve different test methods for aviation fuels	C	1,2,3,6,7

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
<b>Overview of Biofuels</b>				
1	1.1	Biofuels-key advantages of biofuels, development of biological conversion technologies, integration of biofuels into biorefineries, environmental and economic sustainability of biofuels.	5	1
	1.2	Ethanol as a biofuel-commercial production technology (dry milling/wet milling), properties, engine performance and ethanol-fuel testing, E-85 fuels. Environmental aspects of ethanol as a biofuel-significance in the aviation sector and its concerns.	10	2
<b>Aviation Fuels</b>				
2	2.1	Aviation fuels: Chemical composition and methods of obtaining ATF from crude oil, physico- chemical and functional properties of aviation fuels - AV Gas for piston engines, aviation kerosene and broad fraction fuels for turbine engines. Technology of fuel preparation before application to aircraft tanks. Sustainable aviation fuels (SAF), Bio-Aviation Turbine fuel (Bio-ATF).	5	3
	2.2	Aviation biofuels and technologies for their production. Different types of Aviation fuels and analysis: copper corrosion, aromatics, naphthalene content, silver corrosion, Water Separo meter Index, JFTOT, anti-oxidants, Static Dissipative Additives (SDA), distillation, total sulphur, mercaptans, lubricity, smoke point, freezing point, specific energy value. Anti-knock performance, research octane number,	10	4

		motor octane number, road octane number.		
3	<b>Manufacture of Aviation Fuels</b>			
	3.1	Different methods of manufacture: hydro desulphurization, merox process, hydro treating process, atmospheric distillation. Main components in Jet (Turbine) fuel, performance criteria of ATF. Physical and chemical properties of ATF	5	5
	3.2	Additives- lubricity additives, conductivity additives, multi-functional additives (MFA) and other additives	5	5
	3.3	Alternative Aviation fuels-First vs second generation biofuels-advantages of second generation biofuels-success criteria for biofuels in aviation.	5	6
4	<b>Aviation Fuel Practical</b>			
		Distillation of blended aviation fuels 1. Acidity of Aviation fuels 2. Copper corrosion test 3. Silver corrosion test 4. Freezing point of aviation fuels 5. Smoke point of aviation fuels 6. Flash point of aviation fuels 7. Existent gum testing 8. Doctor test using sodium plumbite 9. H <sub>2</sub> S test using 5% lead acetate 10. Test for water reaction	30	7

5	<b>Teacher Specific content</b>		
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<b>Teaching and Learning Approach</b>	<b>Classroom procedure (mode of transaction)</b> Lecture, assignments and seminars
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory (25 marks)</b></p> <p>Assignment</p> <p>MCQ</p> <p>Viva</p> <p>Involvement in classroom activities</p> <p><b>Practical (15 marks)</b></p> <p>Lab involvement / report / Lab test</p>
	<p><b>B. Semester end examination</b></p> <p><b>Theory ( 50 marks)- 1.5 hrs.</b></p> <p>MCQ 10 questions : 10 X 1 = 10</p> <p>Short answer 4 questions (out of 6): 4 X 3 =12</p> <p>Short essay 4 questions (out of 6): 4 X 7 = 28</p> <p><b>Practical (35 marks)-1 hr.</b></p> <p>Lab report: 10</p> <p>Viva: 10</p> <p>Writing procedure: 15</p>

## References

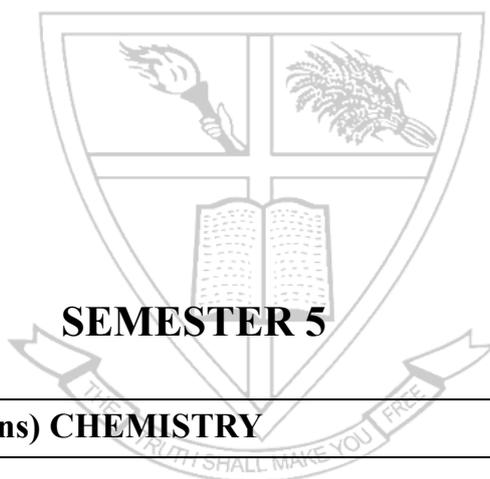
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  5. *Fundamentals of petroleum*, fifth edition, The petroleum extension service, ISBN:0-88698-231-6, 2011.
  6. K. B. Manjooran, *Modern Petroleum Chemistry—An Overview*, 2016.
  7. N. Naderpour, *Petrochemical Production Process*, S. B. S Publishers, 2008.
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  9. V.K. Gupta, M.G. Touhy, *Biofuel Technologies*, Springer 2013.

### SUGGESTED READINGS

1. S. Sahay, *Handbook of Biofuels*, 2021.
2. R. Luque, C. Lin, K. Wilson, C. Du, *Handbook of Biofuels Production: Processes and Technologies*, 2022.
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7. M. Smith, *Aviation Fuels*, 1970.
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9. C. Chunk, *Biofuels for Aviation: Feedstocks, Technology and Implementation*, 2016.
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11. B. Khandelwal, *Aviation Fuels*, Academic press, UK, 2021.
12. J. Gammon, *Aviation Fuel Quality Control Procedures*, 3<sup>rd</sup> edition, ASTM international publishers, 2004.

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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>			
<b>Course Name</b>	<b>Organic Chemistry - 3</b>			
<b>Type of Course</b>	DSC A			
<b>Course Code</b>	<b>UC5DSCCHE300</b>			
<b>Course Level</b>	<b>300-399</b>			
<b>Course Summary</b>	This course explores nitro compounds, amines, cyanides, isocyanides ethers and epoxides, heterocyclic compounds, active methylene compounds and organic photochemistry. Practical part of the course includes qualitative microscale analysis and reactions of nitrogen containing compounds			
<b>Semester</b>	V	<b>Credits</b>	4	<b>Total Hours</b>

<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	75
		3	0	1		
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Predict the product and reasonable mechanism for the reactions of nitro compounds, amines, diazonium salts, cyanides, and isocyanides	A	1,2
2	Explain the reactions of ethers and epoxides	U	1
3	Identify the aromaticity, properties and biological significance of heterocyclic compounds	A	1,2,3
4	Outline synthetic applications of active methylene compounds	U	1,2
5	Apply photochemical methods to organic synthesis	A	1,2
6	Analyse and prepare nitrogen containing compounds and systematically record the observation	An, S	1,2,4,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
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<b>Nitrogen Containing Compounds</b>				
1	1.1	Nitro Compounds: Preparation of aliphatic and aromatic nitro compounds Tautomerism of nitromethane.	1	1
	1.2	Reactions of nitro compounds: Reduction products of nitrobenzene in acidic, neutral and alkaline media. Electrolytic reduction, and selective reduction of polynitro compounds.	3	1
	1.3	Preparation of amines: Gabriel's phthalimide synthesis, Hoffmann bromamide reaction (with mechanisms).	2	1
	1.4	Basicity of aliphatic and aromatic amines – a comparative study, Hinsberg test, Quaternary amine salts as phase-transfer catalysts.	4	1
	1.5	Preparation of diazonium salts from aromatic amines, conversion of diazonium salts to benzene, phenol, chloro, bromo, iodo and fluoro benzenes, nitro benzene and azo dyes with mechanisms.	3	1
	1.6	Cyanides- Preparation from alkyl halides and carboxylic acids. Reactions- hydrolysis, reduction, reaction with Grignard reagent Isocyanides- preparation from alkyl halides and primary amines. Reactions-hydrolysis, reduction.	2	1
<b>Ethers, Epoxides and Heterocyclic Compounds</b>				
2	2.1	Williamson's ether synthesis. Reactions of ethers - cleavage with HI, Claisen Rearrangement, Zeisel's method of estimation of alkoxy groups.	3	2
	2.2	Structure of epoxides, Reactions of epoxides with alcohols, ammonia derivatives and LAH.	2	2

	2.3	Classification of heterocyclic compounds, structure and aromaticity of furan, thiophene, pyrrole, pyridine and indole	3	3
	2.4	Synthesis and reactions- furan, thiophene, pyrrole (Paal Knorr synthesis and Knorr pyrrole synthesis), Pyridine (Hantzsch synthesis), Indole (Fischer Indole Synthesis),	5	3
	2.5	Importance of purines and pyrimidines in biological systems- adenine, thymine, guanine, cytosine and uracil	2	3
	<b>Active Methylene Compounds and Organic Photochemistry</b>			
	3.1	Structure and synthetic applications of ethyl acetoacetate and diethyl malonate (synthesis of carboxylic acids and ketones)	5	4
3	3.2	Photochemistry: introduction. Photochemical versus Thermal reactions. Electronic excitation and fate of excited molecules.	2	5
	3.3	Photochemical reactions: Norrish type I and II reactions of acyclic ketones, Paterno-Buchi reaction and photo-Fries reaction (with mechanisms), Barton reaction (nitrite ester), di- $\pi$ methane rearrangement  Photochemistry of vision	8	5
	<b>Organic Chemistry – 3 Practicals</b>			
4		Qualitative Microscale analysis of organic compounds- Identification and preparation of derivatives of amines, amides and nitro-compounds, amides  Preparation of m-dinitro benzene from nitro benzene  Synthesis of methyl orange  Biginelli Reaction	30	6

5		<b>Teacher-Specific content</b>		
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<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture - offline</li> <li>● Practical</li> </ul>
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory (25 marks)</b></p> <p>Pop quizzes</p> <p>Problem based assignments</p> <p>Written/MCQ Tests</p> <p><b>Practical (15 marks)</b></p> <p>Quiz</p> <p>Lab involvement</p>
	<p><b>B. End Semester examination</b></p> <p><b>Theory: Written examination - 50 Marks-1.5 hrs.</b></p> <p>i. MCQ 10 questions : <math>10 \times 1 = 10</math></p> <p>ii. Short answer 4 questions (out of 6): <math>4 \times 3 = 12</math></p> <p>iii. Short essay 2 questions (out of 3): <math>2 \times 7 = 14</math></p> <p>iv. Essay 1 question (out of 2): <math>1 \times 14 = 14</math></p> <p><b>Practical (35 Marks)-1 hr.</b></p> <p>Viva voce-10 Marks</p> <p>Written test of practical procedures-15 Marks</p> <p>Certified report of lab works done -10 Marks</p>

## References

1. Clayden, J.; Greeves, N.; Warren, S. *Organic Chemistry*; Oxford University Press, USA, 2012.
2. Solomons, T. W. G.; Fryhle, C. B. *Organic Chemistry*; John Wiley & Sons, 2008.
3. Carey, F. A.; Sundberg, R. J. *Advanced Organic Chemistry: Part A. Structure and Mechanisms*; 5th ed.; Springer: New York, 2007.
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5. Morrison, R. T.; Boyd, R. N. *Organic Chemistry*, 6th ed.; Prentice Hall International, 1992.
6. Norman, R. O. C.; Coxon, J. M. *Principles of Organic Synthesis*; 3rd ed.; CRC Press: 1993.
7. Finar, I. L. *Organic Chemistry Volume 1*; Pearson Education, 2007.
8. Bahl, A.; Bahl, B. S. *A Textbook of Organic Chemistry*; S. Chand, 2010.
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12. Bruice, P. Y. *Organic Chemistry*; Pearson, 2017.
13. Furniss, B. S.; Hannaford, A. J.; Rogers, V.; Smith, P. W. G.; Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry*; 5th ed.; Pearson Education, 2005

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Physical Chemistry- 2</b>					
<b>Type of Course</b>	DSC A					
<b>Course Code</b>	<b>UC5DSCCHE301</b>					
<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course covers the basic ideas of solid state, photochemistry and thermodynamics.					
<b>Semester</b>	V	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	1		75
<b>Pre-requisites, if any</b>						

## COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Illustrate the basic aspects of ionic solids and identify the crystal structure.	An	1, 2
2	Explain the types of defects in solids and properties of semiconductors and liquid crystals.	U	1, 2
3	Apply the fundamental principles of photochemistry to photochemical reactions.	U	1, 2
4	Explain the fundamental laws of thermodynamics and its application in isothermal, adiabatic and Joule-Thomson expansion processes.	U	1, 2
5	Apply the principles of chemical thermodynamics to thermochemical processes and systems of variable compositions.	A	1, 2
6	Apply principles of physical chemistry to conduct laboratory experiments.	A, S	1,2,4, 10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	<b>SOLID STATE</b>			
1	1.1	Anisotropy in crystals, Laws of Crystallography – Law of constancy of interfacial angles, Law of rational indices. Weiss and Miller indices. X-Ray diffraction by crystals, Bragg's law	4	1
	1.2	Structure of ionic compounds of the type AX (NaCl, CsCl, ZnS) and AX <sub>2</sub> (CaF <sub>2</sub> , Na <sub>2</sub> O) Defects in crystals – stoichiometric and non-stoichiometric defects. Electrical conductivity, semiconductors- n-type, p-type, Superconductivity (Elementary ideas)	6	1,2

	1.3	Liquid crystals - Classification, structure thermographic behavior and applications.	5	2
	<b>PHOTOCHEMISTRY</b>			
2	2.1	Laws of photochemistry-Grothus-Draper law, Stark-Einstein law. Jablonski diagram-fluorescence, phosphorescence, non-radiative processes, internal conversion, intersystem crossing.	3	3
	2.2	Quantum yield, examples of low and high quantum yields, photochemical reactions (decomposition of HBr, isomerisation of maleic acid to fumaric acid), photosensitised reactions (photosynthesis, isomerization of 2-butene), chemiluminescence, bioluminescence.	3	3
	<b>THERMODYNAMICS</b>			
3	3.1	Internal energy and enthalpy. Heat capacities at constant volume ( $C_v$ ) and at constant pressure ( $C_p$ ), relationship between $C_p$ , $C_v$ and R  First law of thermodynamics – Mathematical statement of first law. Reversible process and maximum work. Calculation of work, heat, internal energy change and enthalpy change for the expansion of an ideal gas under reversible isothermal and adiabatic condition.	7	4
	3.2	The Joule-Thomson effect – derivation of the expression for Joule-Thomson coefficient. Significance of Joule-Thomson coefficient, inversion temperature.	2	4
	3.3	Limitations of first law. Second law – Different statements of second law, thermodynamic scale of temperature. Carnot cycle and its efficiency, Carnot theorem.  Concept of entropy – Definition and physical significance. Entropy as a function	10	5

		of volume and temperature, entropy as a function of pressure and temperature. Criteria of spontaneity and equilibrium. Gibbs and Helmholtz free energies and their significances- criteria of equilibrium and spontaneity. Gibbs-Helmholtz equation		
	3.4	Third law of thermodynamics-statement and determination of absolute entropies of substances. Partial molar quantities – Chemical potential – Gibbs–Duhem equation Zeroth law of thermodynamics	5	5
		<b>Physical chemistry II- Practicals</b>		
4		<ol style="list-style-type: none"> <li>1. Heat of neutralization</li> <li>2. Heat of solution – KNO<sub>3</sub>, NH<sub>4</sub>Cl (Determination of heat of solution from solubility measurements)</li> <li>3. Surface tension - Determination of the surface tension of a liquid (Drop number method or Drop weight method).</li> <li>4. Surface tension - Determination of Parachor values</li> <li>5. Determination of the composition of two liquids by surface tension measurements</li> <li>6. Determination of CMC of surfactants by surface tension measurements</li> </ol>	30	6
5		<b>Teacher-Specific content</b>		

<b>Teaching and Learning Approach</b>	<p style="text-align: center;"><b>Classroom Procedure (Mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture Sessions, (chalk &amp; board, powerpoint presentation)</li> <li>● Interactive sessions and simulations,</li> <li>● Visual aids like videos and models to enhance understanding.</li> <li>● Peer discussions.</li> <li>● Laboratory experiments and hands-on training</li> </ul>
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<b>Assessment Types</b>	<p style="text-align: center;"><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>Continuous Comprehensive Assessment (CCA)</b></p> <p style="text-align: center;"><b>Theory: 25 marks</b></p> <p>Pop quiz</p> <p>Assignment</p> <p>Class test (MCQ/written)</p> <p style="text-align: center;"><b>Practical : 15 marks</b></p> <p>Lab involvement and skill</p> <p>Report of lab works done</p>
	<p style="text-align: center;"><b>Semester end examination</b></p> <p style="text-align: center;"><b>Theory:</b> Written examination (50 Marks)-1.5 hrs.</p> <p>i. MCQ 10 questions : <math>10 \times 1 = 10</math></p> <p>ii. Short answer 4 questions (out of 6): <math>4 \times 3 = 12</math></p> <p>iii. Short essay 2 questions (out of 3): <math>2 \times 7 = 14</math></p> <p>iv. Essay 1 question (out of 2): <math>1 \times 14 = 14</math></p> <p style="text-align: center;"><b>Practical: (35 Marks)-1 hr.</b></p> <p>Viva voce: 10 marks</p> <p>Writing procedure: 15 marks</p> <p>Certified lab report: 10 marks</p>

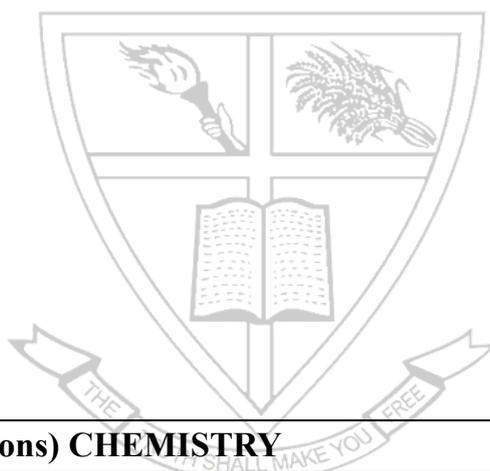
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8. Puri, Sharma and Pathania, *Principles of Physical Chemistry*, 48<sup>th</sup> Edn. Vishal Publishing Company, 2020.

### Suggested Readings

1. R P W Atkins, "*Physical Chemistry*", Oxford University Press, 2019.
2. J. Rajaram, J. C. Kuriakose, *Chemical thermodynamics: classical, statistical and irreversible*, Dorling Kindersley (India), New Delhi, 2013
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>			
<b>Course Name</b>	<b>Quantum Mechanics, Spectroscopy &amp; Group Theory</b>			
<b>Type of Course</b>	<b>DSE</b>			
<b>Course Code</b>	<b>UC5DSECHE300</b>			
<b>Course Level</b>	<b>300-399</b>			
<b>Course Summary</b>	This course covers fundamental principles and applications in the realm of molecular structure, behaviour, and interactions. This course deals with the basic principles of quantum chemistry, spectroscopic techniques like rotational, vibrational, electronic and NMR and group theory.			
<b>Semester</b>	<b>V</b>	<b>Credits</b>	<b>4</b>	<b>Total Hours</b>

<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate the fundamental concepts of quantum mechanics and describe its application to simple systems.	U	1
2	Examine the correlation between angular and radial wave functions in determining orbital shapes	An	2
3	Illustrate the basic concepts of various spectroscopic techniques.	U	2
4	Deduce various symmetry elements and point groups in molecules	E	4,5
5	Develop the group theoretical rules to generate group multiplication tables, matrix representations and classes.	A	2
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		<b>Quantum Mechanics</b>		
<b>1</b>	1.1	Classical mechanics: Concepts – Newtonian equations of motion and Hamiltonian equation of motion.	1	1
	1.2	Failures of Classical mechanics: Blackbody radiation, photoelectric effect, Compton effect and atomic spectra.	3	1
	1.3	Schrodinger wave equation; postulates of quantum	3	1

		mechanics – wave function postulate, operator postulate, Hermitian operator, eigen function postulate, expectation value postulate, time dependent postulate.		
	1.4	Application of quantum mechanics to simple systems – Particle in 1-D box, normalization of wave function, application to 1,3 butadiene.	3	1
	1.5	Schrödinger equation for hydrogen atom – Coordinate system – cartesian and spherical polar coordinates, wave equation in spherical polar coordinates and its components - Radial and angular functions (derivation not required)	3	1
	1.6	Shapes of orbitals (s and p) – sketch of angular and radial wave functions. Radial distribution function	2	2
		<b>Molecular Spectroscopy-I</b>		
2	2.1	Introduction: electromagnetic radiation, regions of the spectrum, interaction of electromagnetic radiation with matter, various types of molecular spectroscopic techniques, Beer-Lambert's law, intensity of absorption, Factors affecting intensity - signal to noise ratio, natural line width. Doppler broadening, Born-Oppenheimer approximation	4	3
	2.2	<i>Rotational spectroscopy</i> : Rigid rotor and derivation of moment of inertia. Rotational energy levels, selection rules, relative population of energy levels, appearance of rotational spectra, calculation of bond length in diatomic molecules	5	3
	2.3	<i>Vibrational spectroscopy</i> : harmonic oscillator (concept only), calculation of force constant and energy levels, selection rules, concept of anharmonicity, Morse	6	3

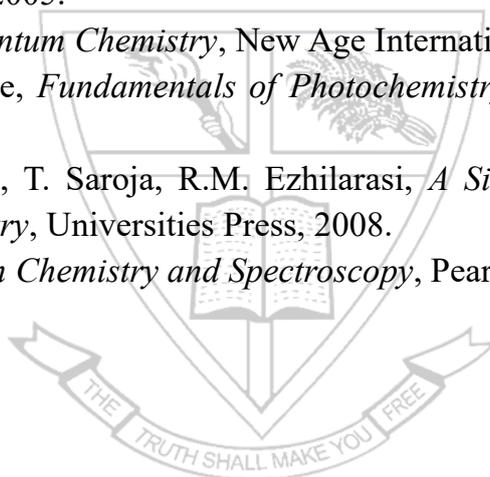
		potential, dissociation energies, fundamental frequencies, overtones, hot bands, Fermi resonance. Degrees of freedom for polyatomic molecules, IR spectrum of water & carbon dioxide.		
		<b>Molecular Spectroscopy-II</b>		
<b>3</b>	3.1	<i>Electronic spectroscopy</i> : singlet and triplet states, selection rules (Spin and Laporte selection rule), Franck-Condon principle – transition, dissociation and predissociation, Polyatomic molecules – qualitative description of $\sigma$ , $\pi$ and n- molecular orbitals, their energy levels and the respective transitions.	9	3
	3.2	<i>Nuclear Magnetic Resonance (NMR) spectroscopy</i> : Nuclear spin quantum number, energies of nuclei in magnetic field, Larmor precession, chemical shift and $\delta$ scale. Factors affecting chemical shift, spin-spin coupling, coupling constant.	6	3
		<b>Group Theory</b>		
<b>4</b>	4.1	Symmetry elements and operations, determination of distinct symmetry operations of $C_n$ and $S_n$ .	2	4
	4.2	Mathematical groups: Properties	1	4
	4.3	Point group, classification into MLS, MHS and MSS. Determination of point groups of molecules belonging to $C_n$ , $C_s$ , $C_i$ , $C_{nv}$ , $C_{nh}$ , $C_{\infty v}$ , $D_{nh}$ , $D_{\infty h}$ , $D_{nd}$ , $T_d$ and $O_h$ point groups.	5	4

	4.4	Abelian groups, cyclic groups, sub groups. Similarity transformation, classes - $C_{2v}$ and $C_{3v}$ . Group multiplication tables (GMTs) - $C_{2v}$ and $C_{3v}$ . Matrix representation of symmetry elements of E, $C_n$ , $S_n$ , i, $\sigma$ .	7	4,5
5		<b>Teacher-Specific content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <p>Lecture (chalk &amp; board, powerpoint presentation, flipped classroom)</p> <p>Group Discussion – thought problems; mind mapping</p> <p>Peer interaction</p> <p>Demonstration using simulations / models</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><i>Theory (30 marks)</i></p> <p>Quiz</p> <p>Assignment</p> <p>Problem based test - Open book</p> <p>Written exam</p>
	<p><b>B. Semester end examination</b></p> <p><b>70 marks- 2 hrs.</b></p> <p>MCQ – 10 marks (1 mark each – 10 nos)</p> <p>Short answer questions – 24 marks (3 marks each – 8 out of 10 nos)</p> <p>Long answer questions – 21 marks (7 marks each – 3 out of 5 nos)</p> <p>Essay type question – 15 marks (1 out of 2 nos)</p>

## References

1. A.S. Kunju, G. Krishnan, *Group Theory and its Applications in Chemistry*, PHI Learning, 2010.
2. Banwell, C. N. & Mc Cash, E. M. *Fundamentals of Molecular Spectroscopy*, 4<sup>th</sup> Edn. Tata McGraw-Hill: New Delhi, 2006.
3. D. L. Pavia, G. M. Lampman, G. S. Kriz, *Introduction to spectroscopy*, 3<sup>rd</sup> Edn, Thomson Brooks/Cole, 2001.
4. F.A. Cotton, *Chemical Applications of Group Theory*, 3<sup>rd</sup> Edn. Wiley Eastern, 1990.
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11. S. Swarnalakshmi, T. Saroja, R.M. Ezhilarasi, *A Simple Approach to Group Theory in Chemistry*, Universities Press, 2008.
12. T. Engel, *Quantum Chemistry and Spectroscopy*, Pearson Education, 2006.



<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>			
<b>Course Name</b>	<b>Green chemistry for sustainable development</b>			
<b>Type of Course</b>	DSE			
<b>Course Code</b>	<b>UC5DSECHE301</b>			
<b>Course Level</b>	<b>300-399</b>			
<b>Course Summary</b>	This course explores fundamentals of green chemistry covering aspects from synthesis design to waste management and energy usage.			
<b>Semester</b>	V	Credits	4	Total Hours

<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		60
<b>Pre-requisites, if any</b>	Basic concepts on green chemistry					

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Familiarize the basic concepts of green chemistry	U	1,2,3,6,7
2	Recognize twelve principles and importance of green chemistry	U	1,2,3,6,7
3	Identify alternative methods and solvents for green synthesis	A	1,2,3,6,7
4	Evaluate the adverse effects of chemicals to environment and select safer green methods for synthesis	E	1,2,3,6,7
5	Deduce the importance of green technologies in sustainable growth of Industry and society	E	1,2,3,6,7
6	Apply suitable energy efficient processes	A	1,2,3,6,7
7	Develop cleaner production and treatment mechanisms for pollution prevention.	A	1,2,3,6,7
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Introduction to green chemistry</b>			
	1.1	Introduction. Goals and challenges of Green Chemistry: Introduction of Green protocol: Rules - Rio declaration- Montreal protocol, Kyoto protocol.	3	1

	1.2	Twelve principles of Green Chemistry with their explanations and special emphasis on the following with examples: Designing a Green Synthesis using these principles; prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products Atom Economy, calculation of atom economy, Atom economic and atom uneconomic reactions: rearrangement (Claisen and fries rearrangements), addition (Michael and Diels Alder reactions), substitution and elimination reactions.	7	2
2	<b>Prevention and minimization of toxic materials (Green alternatives)</b>			
	2.1	Prevention/ minimization of hazardous/ toxic products: reducing toxicity, measuring toxicity- LD <sub>50</sub> & LC <sub>50</sub> , Ames test Sources of waste, cost of waste, problems caused by waste, waste minimization techniques, on site waste treatment, reuse and recycling.	5	4
	2.2	Catalysis and green chemistry-Parameters that affect the inherent greenness of a catalyst, comparison of heterogeneous and homogeneous catalysts, elementary ideas on asymmetric catalysts, photocatalysts, biocatalysts and phase transfer catalysts (definition only)	5	4
	2.3	Prevention of chemical accidents- designing greener processes, inherently safer design (ISD), subdivisions of ISD- Minimization, simplification, substitution, moderation and limitation	5	4
	2.4	Energy requirements for reactions - alternative sources of energy: use of microwaves- microwave heating, microwave assisted reactions (in water and solvent free reactions) and ultrasonic energy.	5	6
3	<b>Green synthesis</b>			
	3.1	Green strategies for organic synthesis, green solvents-water, supercritical fluids (supercritical carbon dioxide, supercritical water), ionic liquids, fluoros biphasic solvent, PEG, immobilized solvents and greenness of solvents, solventless processes.	8	3
	3.2	Organic synthesis using green reagents- oxygen, singlet oxygen, ozone, hydrogen peroxide and peroxy acids. Polymer supported reagents- poly-n-	9	3

		bromosuccinimide, polymeric organotin dihydride reagent, polystyrene carbodiimide, polystyrene sulfide, polymer supported peracid, organic synthesis using biocatalyst- biochemical (microbial) oxidations, biochemical (microbial) reductions.		
4	<b>Phase Transfer Catalysts and Green Industrial Processes</b>			
	4.1	Organic synthesis using phase transfer catalysts- mechanism, types of phase transfer catalysts and its advantages. Applications of PTC in organic synthesis: synthesis of nitriles, alcohols, azides and alkyl fluorides from alkyl halides. Green synthesis of following compounds: adipic acid, adiponitrile, ibuprofen, alcohols, aromatic nitriles, cyclohexane oxime, 1-octanol, 3-phenyl catechol.	9	3
	4.2	Green industrial processes: Pollution statistics from various industries, polymer industry, textile industry, greener approach of dyeing, eco-friendly pesticides, pharmaceutical industry, wastewater treatment.	4	7
5	<b>Teacher-Specific content</b>			
<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Case studies</li> <li>● Debates</li> <li>● Quizzes</li> </ul>			
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (Total 30 marks)</b> <b>Theory</b> Assignment/ Quiz/ Class test – written/ Class test - MCQ			
	<b>B. Semester end examination</b> <b>Theory: Written examination (70 Marks)-2 hrs.</b> MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)			

## References

1. A K De, A K De, *Environmental Chemistry*, 10<sup>th</sup> Edn. New Age International, 2021.
2. A. K. Das, *Environmental Chemistry with Green Chemistry*, Books and allied (P) Ltd., 2010.
3. M. Kirchoff, and M.A. Ryan, *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC, 2002
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7. P.T. Anastas, and J. C. Warner, *Green Chemistry: Theory and Practice*, Oxford University Press, 1998
8. R. Sanghi, M.M Srivastava, *Green Chemistry Environment Friendly Alternatives*, Narosa Publishing House, 2006
9. V.K. Ahluwalia, *Green Chemistry: Environmentally Benign Reactions*, Ane Books India, New Delhi, 2006.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Environmental Chemistry</b>					
<b>Type of Course</b>	DSE					
<b>Course Code</b>	<b>UC5DSECHE302</b>					
<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course provides an overview of environmental planning, energy sources and its conservation, impact assessment, chemical toxicology, water pollution and air pollution. It also addresses soil composition, waste management, effluent treatment methods, emphasizing the use of plants, animals, and microorganisms for pollution control and waste recycling.					
<b>Semester</b>	V	Credits				Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial 1	Practical	Others	

		4		0		60
<b>Pre-requisites, if any</b>	Basic understanding of energy conservation, toxicity effects of various chemicals, water pollution, air pollution and waste management.					

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recognize the importance of environmental management and impact assessment	U	1,2,6,7,8
2	Identify the toxic effects of chemicals	A	1,2,6,7,8
3	Develop a comprehensive knowledge of water pollution, including its various types, effects, and sources.	A	1,2,6,7,8
4	Discuss sampling and measurement of diverse water quality parameters	U	1,2,6,7,8
5	Explain environmental impacts of atmospheric pollution sampling and analysis of key pollutants	U, E	1,2,6,7,8
6	Analyse the soil composition, reactions, soil sampling techniques and management of sustainable agricultural and environmental practices.	An	1,2,6,7,8
7	Build a comprehensive idea about effluent, water and wastewater treatment methods, biological agents in pollution control and waste management principles	A	1,2,6,7,8
8	Analyse sustainable waste management practices	An	1,2,6,7,8,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Environmental Management, Impact Assessment and Chemical Toxicology</b>			
	1.1	Basic principles, concepts and scope of environmental planning, Conservation of energy - Renewable and non-renewable energy sources- nuclear energy, solar energy, hydrogen, non-conventional energy sources.	3	1
	1.2	Environmental pollution - concepts and definition. Impact assessment- aim, concepts and methods. Environmental management system - ISO-14001.	3	1
	1.3	Toxicity -effects, toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, CO, NO <sub>x</sub> , SO <sub>2</sub> , O <sub>3</sub> , PAN, CN, pesticides and carcinogenic substances	9	2
2	<b>Water Pollution</b>			
	2.1	Types, effects and sources of water pollution. Thermal pollution.	3	3
	2.2	Sampling and measurement of water quality - odour, colour, EC, turbidity, TDS, salinity, COD, BOD, DO, coliform, pH, acidity, CO <sub>2</sub> , alkalinity, hardness, phosphate, fluoride, chloride, cyanide, sulphide, sulphate and metals- As, Cd, Fe, Pb and Hg.	12	4
3	<b>Air Pollution and Lithosphere</b>			
	3.1	Primary pollutants, hydrocarbons-photochemical smog, particulates, radioactivity, effects of atmospheric pollution - acid rain, ozone layer depletion.	4	5
	3.2	Air pollution accidents - Bhopal and Chernobyl, air quality standards. Sampling and analysis of pollutants - CO, SO <sub>2</sub> , H <sub>2</sub> S, hydrocarbons, SPM.	4	5
	3.3	Composition of soil - reactions in soil. Wastes and pollutants in soil. Sampling procedures and analysis of soil- cation exchange capacity, lime status, lime requirement, gypsum requirement, pH, N, P, K, S, Ca, and Mg. Management of solid waste.	7	6

	<b>Effluent and Waste Management</b>			
4	4.1	Effluent - definition and characteristics. Methods for water and wastewater treatment and systems (physical, chemical, and biological).	5	7
	4.2	Plants, animals and microorganisms for controlling pollution and treatment of effluents. Waste management- definition, characterization, sources and classification.	5	7
	4.3	Waste Management – 3Rs. Waste treatment and disposal –Methods for management for hazardous and toxic wastes.	5	8
5	<b>Teacher Specific content</b>			
<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Case studies</li> <li>● Debates</li> <li>● Quizzes</li> </ul>			
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>A. Continuous Comprehensive Assessment</b></p> <p style="text-align: center;"><b>Theory (Total 30 marks)</b></p> <p>Assignment-</p> <p>Quiz</p> <p>Class test</p> <p>Class test - MCQ</p>			
	<p style="text-align: center;"><b>B. Semester end examination</b></p> <p style="text-align: center;"><b>Theory: Written examination (70 Marks)- 2 hrs.</b></p> <p>MCQ – 10 marks (1 mark each – 10 nos)</p>			

Short answer questions – 24 marks (3 marks each – 8 out of 10 nos)
Long answer questions – 21 marks (7 marks each – 3 out of 5 nos)
Essay type question – 15 marks (1 out of 2 nos)

## References

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2. G. K. Ghosh, *Environmental pollution - A scientific study*, Ashish Publishing House, 2005.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Nanotechnology for Energy Applications</b>
<b>Type of Course</b>	DSE

<b>Course Code</b>	<b>UC5DSECHE303</b>					
<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course explores the intersection of nanotechnology and energy systems. It covers the applications of nanotechnology in the field of energy conversion and storage.					
<b>Semester</b>	V	<b>Credits</b>			<b>Total Hours</b>	
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical		Others
		4				60
<b>Pre-requisites, if any</b>	Basic understanding of synthesis and properties of nanomaterials.					

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Develop a comprehensive knowledge base regarding global energy needs, consumption patterns, classification of energy sources and the energy conservation.	A	1, 2,3,6,7
2	Differentiate between conventional and non-conventional energy sources.	An	1, 2,3,6,7
3	Analyse various photovoltaic technologies, including Solar Cells.	An	1, 2,3,6,7
4	Explain the working principle and architecture of energy storage devices including batteries and capacitors	U	1, 2,3,6,7
5	Discuss about hydrogen storage technologies	U	1, 2,3,6,7
6	Develop a comprehensive knowledge of nanostructured materials	U	1, 2,3,6,7
7	Build a strong foundation in the role of MOFs and two-dimensional materials in energy related applications	A	1, 2,3,6,7
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
<b>Introduction to energy technologies</b>				
1	1.1	Global energy requirements and consumption. Classification of renewable and non-renewable energy technologies. Conventional energy sources – pros and cons ( <i>with relevant case studies</i> ). Challenges in the development and implementation of renewable energy technologies	9	1
	1.2	Non-conventional sources of energy: Tidal energy, geothermal energy and biomass.	2	1,2
	1.3	Energy conversion, transport, and storage- challenges and outlooks	4	1
<b>Nanomaterials for Energy Conversion</b>				
2	2.1	Principles of photovoltaic energy conversion (PV): Types of Solar cells: DSSC, OPV , Bulk Hetero Junction (BHJ-SC) , Quantum dots, ,Perovskites and Silicon Solar cells	8	3
	2.2	Nano, micro, poly crystalline and amorphous silicon solar cells. Nano and micro Si-composite structure, various techniques of Si deposition.	4	3
	2.3	Fuel Cells: Working principle and architecture, micro-fuel cell technologies.	3	3
<b>Nanomaterials for Storage Technology</b>				
3	3.1	Introduction to battery technology ( <i>working principle and architecture</i> ), primary and secondary batteries (Lithium-ion Batteries), cathode and anode materials.	5	4,6
	3.2	Capacitors- Principles and materials design. Electrical double layer model. Pseudocapacitor, electrochemical supercapacitors.	5	4,6

	3.3	Hydrogen storage: Materials and methods, MOFs, metal hydrides and hydrogen storage capacity.	5	5,6
		<b>State-of-the-art materials in Energy storage and conversion</b>		
4	4.1	Nanostructured carbon-based materials, nano-oxides, novel hybrid electrode materials.	5	6
	4.2	Introduction to MOFs and its role in energy storage and conversion. COFs ( <i>elementary idea only</i> ).	5	7
	4.3	Elementary idea of the state-of-the-art two-dimensional materials: graphene, boron nitride, carbon nitride, metal chalcogenides (MoS <sub>2</sub> , MoSe <sub>2</sub> , etc.).	5	7
5	<b>Teacher Specific content</b>			
<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Case studies</li> <li>● Debates</li> <li>● Quizzes</li> </ul>			
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>Theory</b> Assignment Quiz Class test – written Class test - MCQ			
	<b>B. Semester end examination: 70 marks-2 hrs.</b> MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)			

## References

1. A. Manthiram, *Science and Technology of Lithium Batteries-Materials Aspects: An Overview*, Kluwer Academic Publisher, 2000.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Medicinal Chemistry</b>					
<b>Type of Course</b>	<b>DSE</b>					
<b>Course Code</b>	<b>UC5DSECHE304</b>					
<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course explores fundamental aspects of medicinal chemistry such as drug discovery, drug action, different classes of drugs, adverse effects of drugs and drug delivery systems.					
<b>Semester</b>	V	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	1	0		60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse the fundamental aspects of medicinal chemistry such as drug discovery and drug effectiveness.	An	1, 2,3
2	Examine various aspects of drug action.	An	1, 2,3
3	Describe different classes of drugs with suitable examples.	U	1, 2,3,6
4	Explain adverse effects of drugs.	U	1, 2,3
5	Discuss advanced drug delivery systems.	U	1, 2,3,7

**\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	<b>Introduction to Medicinal Chemistry</b>			
1	1.1	Overview of medicinal chemistry: definition and scope of medicinal chemistry. Drugs: classification, sources and routes of administration.	5	1
	1.2	Drug discovery: target identification and validation, lead identification and optimisation, preclinical testing, pharmacology/toxicology and clinical studies- phase I, II and III. Ways of identification of lead compounds.	7	1
	1.3	Effectiveness of a drug: chemotherapeutic index and therapeutic index. Drug selectivity.	3	1
	<b>Drug Action</b>			
2	2.1	The pharmacokinetic phase: absorption, distribution, metabolism and elimination (ADME) of the drug. Bioavailability of a drug.	5	2

		The pharmacodynamics phase.		
	2.2	Drug metabolism: sites of drug metabolism and phase I and phase II reactions. Prodrugs.	6	2
	2.3	Drug receptors (elementary idea only), agonists and antagonists, partial agonists. Elementary idea of induced fit theory of drug action.	4	2
<b>Classes of Drugs</b>				
3	3.1	Definition of the following classes of drugs with use of the given example: anaesthetics- thiopentone sodium, sedatives- phenobarbital, anti-epileptic drugs- clobazam, anxiolytic agents-benzodiazepine, narcotic analgesics – morphine and anticancer drugs- cisplatin.	5	3
	3.2	Definition of the following classes of drugs with use of the given example: adrenergic stimulants- adrenaline, adrenergic blockers- tolazoline, cholinergic stimulants- acetylcholine, cholinergic blockers- dicyclomine and cardiotonic drugs- digoxin.	5	3
	3.3	Definition of the following classes of drugs with use of the given example: antibiotics- chloramphenicol, antiviral drugs: amantadine, antimalarials- chloroquine, tranquilisers: benzodiazepines and antipsychotics- phenothiazine.	5	3
<b>Adverse Drug Effects and Drug Delivery Systems</b>				
4	4.1	Adverse drug effects: predictable and unpredictable drug reactions and severity. Classification of adverse drug effects, pharmacovigilance and prevention of adverse drug effects.	7	4
	4.2	Drug formulations- sustained-release, controlled release, programming the release and prodrugs. Nanomaterials in drug delivery: liposomes, polymer nanoparticles, chitosan nanoparticles, nanosponge and targeted drug delivery in cancer using nanoparticles. Gene delivery: applications of nanoparticles in gene	8	5

		delivery.		
5	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Demonstration of experiments</li> </ul>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>C. Continuous Comprehensive Assessment</b></p> <p style="text-align: center;"><b>Theory (Total 30 marks)</b></p> <p>Assignment</p> <p>Quiz</p> <p>Class test – written</p> <p>Class test - MCQ</p>
	<p style="text-align: center;"><b>D. Semester end examination</b></p> <p style="text-align: center;"><b>Theory: Written examination (70 Marks) – 2hrs.</b></p> <p>MCQ – 10 marks (1 mark each – 10 nos)</p> <p>Short answer questions – 24 marks (3 marks each – 8 out of 10 nos)</p> <p>Long answer questions – 21 marks (7 marks each – 3 out of 5 nos)</p> <p>Essay type question – 15 marks (1 out of 2)</p>

## References

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2. C. O. Wilson, J. M. Beale, J. H. Block, *Textbook of Organic Medicinal and Pharmaceutical Chemistry*, 12<sup>th</sup> Edn., Lippincott Williams and Wilkins, 2010
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5. G. Thomas, *Fundamentals of Medicinal Chemistry*, Wiley, 2003.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Main Group Elements</b>					
<b>Type of Course</b>	DSE					
<b>Course Code</b>	<b>UC5DSECHE305</b>					
<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course explores the basic aspects of main group elements					
<b>Semester</b>	V	Credits				Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	

		4				60
<b>Pre-requisites if</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the classification of S block elements in the periodic table: general trends	U	1,2
2	Apply knowledge of fundamental chemical principles to explain and predict the behavior	A	1,2
3	Analyse the structural aspects of boron and silicon compounds	An	1,2
4	Apply knowledge of halogens and interhalogens to predict the outcomes of simple reactions.	A	1,2
5	Apply Valence Bond and Molecular Orbital theories to explain bonding in noble gas compounds	A	1,2

*number (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		Chemistry S Block Elements		

	1.1	General characteristics: melting point, flame colouration, reducing nature, diagonal relationships and anomalous behaviour of first member of each group. Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water. Common features such as ease of formation, thermal stability, energetics of dissolution, and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.	8	1
	1.2	Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium. Solutions of alkali metals in liquid ammonia and their properties	7	1
2	<b>Chemistry of p-Block Elements</b>			
	2.1	Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Catenation, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group. Synthetic diamonds ( elementary idea)	8	2
	2.2	Catenation and heterocatenation` in inorganic compounds. Types of inorganic polymers. Comparison with organic polymer, preparation and uses of borazine - similarities in structure with benzene. Boron nitrides- comparison with graphite.	7	2

		<b>Important Group 13 and Group14 compounds</b>		
3	3.1	Comparative studies including diagonal relationship of group 13 and 14 elements. Anomalous behaviour of Boron. Preparation, structure, and bonding of diborane, uses of diborane. STYX numbers	8	3
4	3.2	Boron nitrides, boranes, carboranes and metallocarboranes. Silicates and classification, aluminosilicates, natural and synthetic zeolites and application of zeolites as molecular sieves. Silicon based polymers-silicones, silicon rubbers (preparation, important properties and uses)	7	3
	<b>Halogen and Noble Gas Compounds</b>			
	4.1	Properties of halogens. Interhalogens - classification- general preparation- structures of AB, AB <sub>3</sub> , AB <sub>5</sub> and AB <sub>7</sub> types. Reactivity (ClF, ICl <sub>3</sub> , ClF <sub>3</sub> , IF <sub>5</sub> and IF <sub>7</sub> ).	7	4
	4.2	Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF <sub>2</sub> , XeF <sub>4</sub> and XeF <sub>6</sub> ; Bonding in noble gas compounds (Valence bond and MO treatment for XeF <sub>2</sub> ), Shapes of noble gas compounds (VSEPR theory).	8	5
5	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> Lectures (chalk & board, multimedia presentations) Group Discussions Case studies Quizzes
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b>  <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>Theory: 30 marks</b> Quiz Assignment Problem based test - Open book Written exam
	 <b>B. Semester end examination</b> <b>Theory: Written examination theory (70 Marks)- 2 hrs.</b> MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

## References

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2. F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann, *Advanced Inorganic Chemistry*, 6<sup>th</sup> Edn. John Wiley and Sons, 2007.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Analytical Chemistry and Professional skills</b>					
<b>Type of Course</b>	SEC					
<b>Course Code</b>	<b>UC5SECHE300</b>					
<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course provides a comprehensive introduction to analytical chemistry, focusing on interdisciplinary concepts, precision in analysis, and practical applications in soil and water studies. It incorporates hands-on experiences, including workshops, interview training, industrial visits, and expert interactions, culminating in a career-oriented project for enhanced professional readiness.					
<b>Semester</b>	V	Credits			3	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
<b>Pre-requisites, if any</b>	Nil					

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Outline the fundamentals of analytical chemistry	U	1,2
2	Conduct soil and water analysis	An	1,2,4,10
3	Explain the principles of chromatographic techniques	U	1,2

4	Apply the principles of Thin Layer Chromatography and column chromatography for purification and separation purposes.	A	1,2,10
5	Develop professional skills effectively and contribute meaningfully to their chosen fields.	E	4,9, 10
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
	<b>Analytical Chemistry</b>			
1	1.1	<b>Introduction:</b> Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision, and sources of error in analytical measurements.	3	1
	1.2	<b>Analysis of soil:</b> Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions in soil by complexometric titration.	6	2
	1.3	<b>Analysis of water:</b> Definition of pure water, sources responsible for contaminating water, water sampling methods, and water purification methods. a. Determination of pH, acidity, and alkalinity of a water sample. b. Determination of the Hardness of water.	6	2
		<b>Chromatographic techniques</b>		
2	2.1	Introduction to chromatography: Basic principles of chromatography, types of chromatography	2	3

	2.2	Theory and Application -Gas chromatography, High-Performance Liquid Chromatography (HPLC)	5	3
	2.3	Theory, application, and demonstration of Thin Layer Chromatography and Column Chromatography (Hands on Training)	8	4
		<b>Professional Development</b>		
<b>3</b>		<ul style="list-style-type: none"> <li>● Workshop on career awareness</li> <li>● Training sessions for interviews</li> <li>● Industrial visit</li> <li>● Interaction with industrial experts</li> <li>● Create minor project</li> </ul>	15	5
<b>4</b>		<b>Teacher-Specific content</b>		

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> Lectures, discussions, group activities, seminars, industrial visits and study tours
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>Total : 25 marks</b> <b>Performance in activities</b> <b>Industrial visit report</b> <b>Project work</b>
	<b>B. Semester end examination ( 50 marks)-1.5 hrs.</b> Short answer questions – 20 marks (2 marks each – 10 out of 12 nos)

	Long answer questions – 30 marks (5 marks each – 6 out of 8 nos)
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## References

1. D .A. Skoog, J. J. Leary, *Instrumental Methods of Analysis*, Cengage India Private Limited, 2020.
2. D. A. Skoog, D. M. West, F. J. Holler, *Fundamentals of Analytical Chemistry*, 6<sup>th</sup> Ed., Cengage Learning India Pvt. Ltd., 2022.
3. D. C. Harris, *Quantitative Chemical Analysis* 7<sup>th</sup> Edn. W. H. Freeman and Co., New York, 2007
4. E. Helfman, *Chromatography*, Van Nostrand, Reinhold, New York
5. E. Lederer and M. Lederer, *Chromatography*, Elsevier, Amsterdam.
6. J. A. Dean, *Chemical separation methods*, Von Nostrand Reinhold, New York
7. R.P.W Scott, *Techniques and Practice of Chromatography*, Marel Dekker Inc., New York



## SEMESTER 6

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Inorganic Chemistry-2</b>
<b>Type of Course</b>	DSC A
<b>Course Code</b>	<b>UC6DSCCHE300</b>
<b>Course Level</b>	<b>300-399</b>
<b>Course Summary</b>	This course explores concepts of coordination chemistry, organometallic compounds and bioinorganic chemistry. This course also provides the

	basic analytical skills on qualitative and quantitative analysis of inorganic ions.					
<b>Semester</b>	VI	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
<b>Pre-requisites, if any</b>	<b>Inorganic Chemistry-1</b>					

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Compare the theories of coordination chemistry	An	1,2
2	Explain the mechanisms of substitution reactions	U	1,2
3	Describe the key concepts of inorganic and organometallic chemistry	E	1,2
4	Illustrate stability of organometallic compounds, clusters and their application in industrial catalysts.	U	1, 2, 10
5	Explain the importance of various metal ions in biological systems	U	1,2,10
6	Analyse different complexes based on colourimetry and electronic spectra	An	1,2,10

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		<b>Coordination Chemistry- 2</b>		

	1.1	Merits and demerits of VBT and CFT	1	1
	1.2	Crystal field splitting in tetragonally distorted octahedral geometry, Jahn-Teller distortion in Cu (II) complexes.	2	1
	1.3	MO theory, evidences for metal-ligand covalency- Nephelauxetic effect, MO diagram of complexes of octahedral symmetry (sigma bonding only)	3	1
	1.4	Spectral and magnetic properties of metal complexes- d-d transition, electronic absorption spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ ion. Charge transfer spectra e.g. $\text{KMnO}_4$ , $\text{K}_2\text{Cr}_2\text{O}_7$ (Elementary idea). Types of magnetic behaviour, spin-only formula, calculation of magnetic moments.	3	1
	1.5	Reactivity of metal complexes-Labile and inert complexes	1	2
	1.6	Ligand substitution reactions : - $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ , ligand substitution reactions in square planar and octahedral complexes	3	2
	1.7	Trans effect- theories and applications- polarization and $\pi$ -bonding theory.	2	1
	<b>Organometallic Compounds</b>			
2	2.1	Introduction to organometallic compounds, hapticity	1	3
	2.2	18- electron rule, numerical problems and stability	2	3
	2.3	Ferrocene: Preparation, structure, aromaticity and reactions (acetylation, alkylation).	2	3
	2.4	Metal-alkene complexes – Preparation and structure of Zeise's salt	1	3
	2.5	Catalytic properties of organometallic compounds - Zeigler Natta catalyst in the polymerization of alkene. Wilkinson catalyst in the hydrogenation of alkene (mechanism not expected).	2	4
	2.6	Preparation and structure of mononuclear carbonyls- $\text{Mo}(\text{CO})_6$ , $\text{Fe}(\text{CO})_5$ and $\text{Ni}(\text{CO})_4$	3	4

	2.7	Polynuclear carbonyls, bridged carbonyls and bonding in metal carbonyls – $\text{Mn}_2(\text{CO})_{10}$ and $\text{Fe}_2(\text{CO})_9$ .	2	4
	2.8	Synergic effect and use of IR data in metal carbonyls to explain extent of back bonding	1	4
	2.9	Quadruple bond structure of $[\text{Re}_2\text{Cl}_8]^{2-}$ . Quintuple bond (non-evaluative)	1	4
	<b>Introduction to Bioinorganic Chemistry</b>			
	3.1	Essential and non – essential metals	1	5
	3.2	Mechanism of ion transport- Ion pump ( $\text{Na}^+$ and $\text{K}^+$ )	2	5
	3.3	Porphyryns, Oxygen carriers- hemoglobin and myoglobin- structure and functions, oxygen transport mechanism, cooperativity effect, Bohr effect	3	5
	3.4	Cytochromes- Structure and functions of Cytochrome P-450	1	5
3	3.5	Non-heme proteins- structure and functions of hemocyanin & hemerythrin	1	5
	3.6	Photosynthesis- Chlorophylls (Structure not needed) – Z-scheme (only)	2	5
	3.7	Electron transfer proteins- structure and functions of ferredoxin, rubredoxin. Zinc containing metalloenzymes: carbonic anhydrase and carboxypeptidase. Vitamin $\text{B}_{12}$ (structure not expected)	3	5
	3.8	Toxicity of metals - Cd, Hg, Pb and Cr, with specific examples.	1	5
	3.9	Treatment of metal toxicity by chelation therapy (EDTA)	1	5
	<b>Inorganic Chemistry-2 Practicals</b>			
4	4.1	Colorimetric estimation of Fe, Cu, Ni, Mn, Cr, $\text{NH}_4^+$ , nitrate and phosphate ions. Or UV- Visible spectral studies of different	15	6

		coordination compounds		
	4.2	Study of the reactions of the following radicals with a view to their identification and confirmation. $\text{Pb}^{2+}$ , $\text{Al}^{3+}$ , $\text{Zn}^{2+}$ , $\text{Mn}^{2+}$ , $\text{Ni}^{2+}$ , $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Mg}^{2+}$ , $\text{NH}_4^+$ , $\text{CO}_3^{2-}$ , $\text{SO}_4^{2-}$ , $\text{Cl}^-$ , $\text{Br}^-$ , $\text{CH}_3\text{COO}^-$ Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the above list without interfering radicals by Semi-micro method only. (Minimum of 5 mixtures to be analysed)	15	6
5	<b>Teacher-Specific content</b>			

Est. in 1921

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Demonstration of experiments</li> <li>● Hands-on training</li> </ul>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment</b></p> <p style="text-align: center;"><b>Theory: 25 marks</b></p> <p>Quiz</p> <p>Assignment</p> <p>Class test</p> <p style="text-align: center;"><b>Practical : 15 marks</b></p> <p>Lab involvement and skill</p> <p>Report of lab works done</p>

	<p><b>B. Semester end examination</b></p> <p><b>Theory:</b> Written examination (50 Marks)-1.5 hrs</p> <p style="padding-left: 40px;">i. MCQ 10 questions : 10 X 1 = 10</p> <p style="padding-left: 40px;">ii. Short answer 4 questions (out of 6): 4 X 3 =12</p> <p style="padding-left: 40px;">iii. Short essay 2 questions (out of 3): 2 X 7 = 14</p> <p style="padding-left: 40px;">iv. Essay 1 question (out of 2): 1 X 14 = 14</p> <p style="text-align: center;"><b>Practical: (35 Marks)- 1 hr.</b></p> <p>Viva voce: 10 marks</p> <p>Writing procedure: 15 marks</p> <p>Certified lab report: 10 marks</p>
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## References

1. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6<sup>th</sup> Edn., Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry–Principles of Structure and Reactivity*, 4<sup>th</sup> Edn., Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5<sup>th</sup> Edn. Oxford University Press, New York, 2010.
4. J.D. Lee, *Concise Inorganic Chemistry*, 5<sup>th</sup> Edn. Oxford University Press, New Delhi 2008.
5. R. Gopalan and V. Ramalingam, *Concise Coordination Chemistry*, 1<sup>st</sup> Edn., Vikas Publishing House, New Delhi, 2001.
6. B. D. Gupta and A. J. Elias *Basic Organometallic Chemistry, Concepts, Synthesis and Applications*, 2<sup>nd</sup> Edn. University Press 2013
7. I. Bertini, H. B. Gray and S. J. Lippard, J. S. Valentine, *Bioinorganic chemistry*, University Science Books, 1994.
8. J. A. Cowan, *Inorganic Biochemistry: An Introduction*, VCH Publishing, 1993.
9. W. Kaim, B. Schwederski, B. *Bioinorganic chemistry: Inorganic Elements in the Chemistry of Life*, Wiley, 2006
10. Jeffery, G.H., Bassett, J., Mendham, J. and Denney, R.C., Eds., *Vogel's Textbook of Quantitative Chemical Analysis*, 5<sup>th</sup> Edn., Longman Scientific and Technical, Harlow, 1989

## SUGGESTED READINGS

1. Catherine E. Housecroft, Alan G. Sharpe C. E. Barnes, *Inorganic Chemistry* 4<sup>th</sup> Edn. Journal of Chemical Education, 2003.
2. N. N. Greenwood, A. Earnshaw, *Chemistry of the Elements*, Butterworth-Heinemann, 2012.
3. *Synthesis of a Stable Compound with Fivefold Bonding Between Two Chromium(I) Centers*. SCIENCE, 4 Nov 2005 844-847, 10.1126/science.1116789
4. W. Pfennig, *Principles of Inorganic chemistry*. John Wiley & Sons, 2015.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Physical Chemistry- 3</b>					
<b>Type of Course</b>	DSC A					
<b>Course Code</b>	<b>UC6DSCCHE301</b>					
<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course deals with the principles of surface chemistry, colloids, chemical kinetics, electrochemistry, and electromotive force.					
<b>Semester</b>	VI	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture 3	Tutorial	Practical 1	Others	
						75
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Assess different kinds of adsorption and adsorption isotherms.	E	1,2
2	Explain different types of colloidal systems,	U	1,2

	purification methods and properties of colloidal particles.		
3	Interpret nature of various chemical reactions and describe the kinetics of parallel and chain reactions.	An	1,2
4	Make use of the principles of chemical kinetics to study the mechanism of homogeneous and heterogeneous catalysis.	A	1,2
5	Describe the mechanism and factors affecting electrolytic conductance. Analyse properties of electrolytic conductance.	A	1,2
6	Utilize conductance measurements in quantitative analysis.	A	1,2
7	Categorise different electrodes based on their function and apply Nernst equation to calculate electrode potential.	A	1,2
8	Apply the theoretical concepts of electrolytic conductance, adsorption and viscosity in practical experiments.	A	1, 2, 10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
<b>SURFACE CHEMISTRY AND COLLOIDAL STATE</b>				
<b>1</b>	1.1	Adsorption – types, adsorption of gases by solids – factors influencing adsorption, Freundlich adsorption isotherm, Langmuir adsorption isotherm –derivation of Langmuir adsorption isotherm.	5	1
	1.2	Types of solutions – true, colloid and suspensions, Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples, purification of colloids – ultra filtration and electro dialysis.	5	2

	1.3	Properties of colloids: Brownian movement, Tyndall effect, electrophoresis. Electrical double layer and zeta potential. Coagulation of colloids, Hardy-Schulz rule. Micelles and critical micelle concentration, sedimentation and streaming potential.	5	2
	<b>CHEMICAL KINETICS</b>			
2	2.1	Arrhenius equation, concept of activation energy, Collision theory - kinetic theory of collisions, steric factor. Types of complex reactions - consecutive reactions, opposing reactions, parallel reactions, Chain reactions. Steady state approximation.	5	3
	2.2	Catalysis: Homogeneous catalysis, enzyme catalysis – Heterogeneous catalysis – Surface catalysis, Elementary idea about Autocatalysis.	2	4
	<b>ELECTROCHEMISTRY AND ELECTROMOTIVE FORCE</b>			
3	3.1	Ionic mobility: - relation with ionic conductance (with derivation), influence of temperature on ionic conductance, ionic conductance and viscosity – Walden's rule. Abnormal ionic conductance of $H^+$ and $OH^-$ .	5	5
	3.2	Debye-Hückel theory of strong electrolytes – the concept of ionic atmosphere, asymmetry and electrophoretic effect, Debye- Hückel-Onsager equation (no derivation). Activity, mean ionic activity coefficient, ionic strength, Debye-Hückel limiting law (no derivation).	5	5
	3.3	Applications of conductance measurements – determinations of degree of dissociation of weak electrolytes, determination of solubility and solubility products of sparingly soluble salts, conductometric titrations involving strong acid- strong base, weak acid- strong base, strong acid-weak base, mixture of a	5	6

		strong acid and weak acid against strong base and precipitation titrations.		
	3.4	Reversible cells - Daniel cell. Reference electrodes – Standard Hydrogen Electrode, Calomel electrode. Electrode potential – Electrochemical series. Representation of cells (IUPAC), Electrode reactions and cell reactions.	4	7
	3.5	Derivation of Nernst equation for electrode potential and cell potential, Calculation of equilibrium constant from EMF data. Applications of emf measurements – determination of pH using glass electrode. Potentiometric titrations- acid-base and redox reaction.	4	7
<b>Physical chemistry – 3 Practicals</b>				
4		<p>1. Viscosity – Determination of viscosity of sucrose/glycerol.</p> <p>2. Determination of composition of binary liquid mixture using viscometry (toluene-nitrobenzene)</p> <p>3. Determination of molecular weight of a polymer using viscometry (polystyrene in toluene)</p> <p>4. Viscometry: Verification of Kendall's equation-full experiment</p> <p>5. Conductometry</p> <ul style="list-style-type: none"> <li>•Determination of equivalent conductance of an electrolyte</li> <li>•Determination of dissociation constant and degree of dissociation of a weak acid</li> <li>•Verification of Onsager equation</li> </ul> <p>6. Adsorption:</p> <ul style="list-style-type: none"> <li>•Verification of Freundlich and Langmuir adsorption isotherm - Charcoal Acetic acid or Charcoal-Oxalic acid system.</li> <li>•Determination of concentration of given acid using the isotherm</li> </ul>	30	8
5	<b>Teacher-Specific content</b>			

<p><b>Teaching and Learning Approach</b></p>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture sessions, (chalk &amp; board, powerpoint presentation)</li> <li>● Interactive sessions and simulations,</li> <li>● Visual aids like videos and models to enhance understanding.</li> <li>● Peer discussions.</li> <li>● Laboratory experiments and hands-on training</li> </ul>
<p><b>Assessment Types</b></p>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory : 25 marks</b></p> <p>Pop quiz</p> <p>Assignments</p> <p>Test for each unit (MCQ/written)</p> <p><b>Practical : 15 marks</b></p> <p>Lab involvement and skill</p> <p>Report of lab works done</p>
	<p><b>Semester end examination</b></p> <p><b>Theory: Written examination (50 Marks)- 1.5 hrs</b></p> <ol style="list-style-type: none"> <li>i. MCQ 10 questions : <math>10 \times 1 = 10</math></li> <li>ii. Short answer 4 questions (out of 6): <math>4 \times 3 = 12</math></li> <li>iii. Short essay 2 questions (out of 3): <math>2 \times 7 = 14</math></li> <li>iv. Essay 1 question (out of 2): <math>1 \times 14 = 14</math></li> </ol> <p><b>Practical: (35 Marks)-1 hr.</b></p> <p>Viva voce: 10 marks</p> <p>Writing procedure: 15 marks</p> <p>Certified lab report: 10 marks</p>

## References

1. G. K. Vemulapalli, *Physical Chemistry*, Prentice-Hall of India Pvt. Ltd, 1996.
2. G. Raj, *Advanced Physical Chemistry*, Goel publishing house, 2016.
3. G. W. Castellan, *Physical Chemistry*, 4<sup>th</sup> Edn. Narosa Publishing House 2018.
4. Glasstone and Lewis, *Elements of Physical Chemistry*, Macmillan, 1967.
5. K. L. Kapoor, *A Textbook of Physical chemistry*, Volume 5, 4<sup>th</sup> edition, Macmillan India Ltd., 2018.
6. Puri, Sharma and Pathania, *Principles of Physical Chemistry*, 48<sup>th</sup> Edition, Vishal Publishing Company, 2020.
7. S. Glasstone, *An Introduction to Electrochemistry*, East-West Press (Pvt.) Ltd. 2006.
8. S. H. Marron and J. B. Lando, *Fundamentals of Physical Chemistry*, Macmillan Ltd, 1974.

## Suggested Readings

1. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd., 2019.
2. G. M. Barrow, *Physical Chemistry*, Tata McGraw-Hill (2007).
3. R P W Atkins, *Physical Chemistry*, Oxford University Press (12<sup>th</sup> Edition), 2020.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Organic Chemistry-4</b>
<b>Type of Course</b>	DSE
<b>Course Code</b>	<b>UC6DSECHE300</b>

<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course examines the structure and biological importance of polypeptides, amino acids, proteins, nucleic acids, carbohydrates, natural products, lipids, vitamins, steroids, and hormones. Practical part of the course comprises extraction of natural products.					
<b>Semester</b>	VI	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	1		75
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Predict the synthetic pathway of polypeptides and amino acids	A	1,2
2	Identify the structure and biological importance of proteins and nucleic acids	A	1,2,3
3	Examine the structure, properties, and industrial applications of carbohydrates	An	1,2
4	Predict the interconversion of carbohydrates	A	1,2
5	Identify the structure and properties of natural products and lipids	A	1,2
6	Describe the classification structure and biological	U	1,2,3

	significance of vitamins, steroids, and hormones		
7	Make use of theory to synthesis and extract various components of oils and tea leaves	A,S	1,2,3,4, 10
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Amino Acids, Peptides, Proteins and Nucleic Acids</b>			
	1.1	Amino Acids-Classification. Synthesis-Gabriel phthalimides synthesis, Strecker synthesis, Ionic properties and Ninhydrin reaction. Zwitterion structure and Isoelectric point.	4	1
	1.2	Polypeptides- Synthesis -DCC method. Merrifield's solid phase peptide synthesis.	3	1
	1.3	Primary, secondary, tertiary and quaternary structure of proteins: $\alpha$ -helix and $\beta$ -pleated sheets. Denaturation of proteins.	4	2
	1.4	Nucleicacids: Components of nucleic acids, nucleosides and nucleotides. Structure of DNA, Watson, and Crick model. Differences between DNA and RNA. Protein biosynthesis, Replication of DNA	4	2

<b>Carbohydrates</b>				
2	2.1	Classification of carbohydrates.	1	3
	2.2	Fischer and Haworth projections of glucose and fructose. Cyclic structure of glucose. Reactions of glucose and fructose - osazone formation, Tollen's reagent.	4	3
	2.3	Epimers, mutarotation and anomers.	3	3
	2.4	Chain lengthening and chain shortening of aldoses - Kiliani-Fischer synthesis and Wohl degradation. Interconversion of aldoses and ketoses.	3	4
	2.5	Sucrose-Structure, reactions and uses of sucrose	1	3
	2.6	Structure and properties of starch and cellulose (elementary idea). Industrial applications of cellulose.	3	3
<b>Natural products, Lipids ,Vitamins, Steroids and Hormones</b>				
3	3.1	Natural products. Terpenoids: Classification, isoprene rule. Essential oils - citral and geraniol – chemical properties and uses. Alkaloids: Classification based on source, isolation, general properties, physiological effects of coniine and nicotine.	4	5
	3.2	Lipids. Oils and fats: Biological functions. Trans fat and their effect.	5	5

		Hydrogenation, Rancidity. Acid value, Saponification value, Iodine value and RM value. Soaps - Types and cleansing action. Synthetic detergents - Comparison between soaps and detergents.		
	3.3	<b>Vitamins.</b> Classification, structure, biological functions and deficiency diseases of vitamins A, B <sub>12</sub> and C	2	6
	3.4	<b>Steroids</b> Diels' hydrocarbon. Structure and functions of cholesterol. Elementary idea of HDL and LDL.	2	6
	3.5	<b>Hormones</b> Biological functions of steroid hormone - Estrogen, peptide hormone-Insulin and amine hormone-Thyroxine. (Structure not required). Artificial hormone -Birth control pill.	2	6
		<b>Organic Chemistry IV Practical</b>		
4	4.1	1.Extraction of caffeine from tea leaves/tea dust powder 2. Extraction of volatile oils by Clevenger's method (Hydro distillation method). 3.Solvent extraction -isolation of lycopene from tomato 4. Determination of saponification value of the fat and oils by taking any real sample	30	7

		5. Determination of acid value of the fat and oils by taking any real sample		
<b>5</b>	<b>Teacher-Specific Content</b>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <ul style="list-style-type: none"> <li>• Lecture (chalk &amp; board, powerpoint presentation)</li> <li>• Group discussion</li> <li>• Peer teaching</li> <li>• Demonstration of experiments</li> <li>• Hands-on training</li> </ul>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory: 25 marks</b></p> <p>Quiz /Assignment /Class test</p> <p><b>Practical : 15 marks</b></p> <p>Lab involvement and skill</p> <p>Report of lab works done</p> <p><b>B. Semester end examination</b></p> <p><b>Theory: Written examination (50 Marks)-1.5 hrs.</b></p> <ol style="list-style-type: none"> <li>i. MCQ 10 questions : 10 X 1 = 10</li> <li>ii. Short answer 4 questions (out of 6): 4 X 3 =12</li> <li>iii. Short essay 2 questions (out of 3): 2 X 7 = 14</li> <li>iv. Essay 1 question (out of 2): 1 X 14 = 14</li> </ol> <p><b>Practical: (35 Marks)-1 hr.</b></p> <p>Viva voce: 10 marks</p> <p>Writing procedure: 15 marks</p>

	Certified lab report: 10 marks
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## References

1. Bahl, A.; Bahl, B.S. *Advanced Organic Chemistry*; S. Chand, 2010.
2. Carey, F. A.; Sundberg, R. J.; *Advanced Organic Chemistry: Part A: Structure and Mechanisms*; Springer Science & Business Media, 2007.
3. Clayden, J; Greeves, N; Warren, S. *Organic chemistry*; Oxford University Press, 2012.
4. Finar, I. L. *Organic Chemistry*; Vol. 1& 2; Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
5. Furniss, B. S.; Hannaford, A. J.; Rogers, V.; Smith, P. W. G.; Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry*; 5<sup>th</sup> Edn.; Pearson Education, 2005.
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10. Norman, R. O. C.; Coxon, J. M. *Principles of Organic Synthesis*; Routledge, 2017.
11. Pine, S. H. *Organic Chemistry*; Tata McGraw-Hill, 2014.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Rubber Technology</b>
<b>Type of Course</b>	DSE
<b>Course Code</b>	<b>UC6DSECHE301</b>

<b>Course Level</b>	<b>300-399</b>				
<b>Course Summary</b>	This course explores the basic aspects of rubber its modifications and applications				
<b>Semester</b>	VI	<b>Credits</b>			<b>Total Hours</b>
<b>Course Details</b>	Learning Approach				
		3		1	75
<b>Pre-requisites, if any</b>					

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basics of rubber and latex chemistry	U	1,2,3
2	Apply knowledge on different aspect of Vulcanization and Compounding in rubber	A	1,2,3
3	Understand the different application of rubber in different sectors	U	1,2,3
4	Analyse physical and chemical properties of latex and dry rubber	An, S	1,2,3,10

*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skilled (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		Natural rubber and latex		

1	1.1	Origin – Natural Rubber Latex, tapping, processing, properties and applications – Conversion of Latex into dry rubber – Properties of dry rubber – Classification based on technical specifications Natural rubber, isoprene rubber, butyl rubber, nitrile rubber, chloroprene rubber and styrene-butadiene rubber	8	1
	1.2	Definition of latex, classification, latex particle size and distribution, stability and destabilization of lattices, comparison between lattices and polymer solution Natural rubber latex –origin, tapping, bulking and preservation, composition of field latex, properties, preservation, methods of concentrating latex - creaming, centrifuging, & evaporation,– Specification and testing- (national and ISO) for latex grades (ASTM D 1076 )	7	1
2	<b>Vulcanization and Compounding</b>			
	2.1	Theory and mechanism of sulphur and non-sulphur vulcanization (with and without accelerators), rheo-curve of compounded rubber, properties of vulcanized rubber - Vulcanizing ingredients & their sequence of mixing: Activators and accelerators: mechanisms of action. Other cure systems based on metal oxides, peroxides, etc. retarders, inhibitors anti-reversion agents.	4	2
	2.2	Fillers: Carbon black-Its preparation, structure, properties and their effect on rubber properties. Silica fillers & coupling agents. Other fillers: Clay, calcium carbonate, titania etc. Nano-fillers: Reinforcement by filler: Reinforcement, factors influencing elastomers reinforcement, fillers characteristics, main effects of fillers on vulcanizate properties, influence of fillers characteristics on the cross linking process, filler incorporation, the role of bound rubber, reinforcement and crosslink density.	6	2

	2.3	Processing aids, plasticizers, process additives, release agents, Other additives like colourants, blowing agents, factice, fire retardants, antistatic agents, deodorants and reodorants, biocides and fungicides etc. Anti-degradants: Introduction, autoxidation of hydrocarbon polymers, amine & phenolic antioxidants & other types, anti-zonants, Prevention of ozone attack with the use of waxes & saturated polymer for ozone protection.	5	2
<b>3</b>	<b>Application of Rubber in Different Sectors</b>			
	3.1	Functions of tyres– Role of rubber and unique properties of rubbers for the applications. Tyre constructions – generic design features and materials. Tubeless tyres – comparison. Mechanics of rubber – Cord composites. Inflation pressure – Contact area, tyre deflections – Design factors and principles. Classifications of tyres – Essential design criteria Rolling resistance friction	8	3
	3.2	Overview of rubber's use in various industrial and consumer products such as hoses, belts, gaskets, and seals, as well as in footwear, sports equipment, and household items. Medical Devices: Examination of rubber's critical role in healthcare, including in the manufacture of gloves, catheters, contraceptives, and various medical devices where flexibility and biocompatibility are essential. Aerospace Industry: Discussion on the use of rubber in the aerospace industry, such as in seals, gaskets, and fuel tank linings, highlighting rubber's resistance to extreme temperatures and conditions.	7	3
<b>4</b>	<b>Rubber Technology Practicals</b>			

	4.1	<p style="text-align: center;"><b>I. Latex Analysis</b></p> <ol style="list-style-type: none"> <li>1. Determination of total solid content of latex</li> <li>2. Determination of alkalinity of latex</li> <li>3. Determination of dry rubber content of latex</li> <li>4. Determination of volatile fatty acid number of latex</li> <li>5. Determination of viscosity of latex</li> <li>6. Determination of KOH number</li> <li>7. Determination of coagulum</li> <li>8. Determination of sludge</li> <li>9. Determination of mechanical stability time (MST)</li> <li>10. Determination of density</li> </ol> <p style="text-align: center;"><b>II. Dry Rubber Analysis</b></p> <ol style="list-style-type: none"> <li>1. Determination of dirt</li> <li>2. Determination of Po and PRI</li> <li>3. Determination of ash</li> <li>4. Determination of nitrogen</li> <li>5. Determination of volatile matter</li> </ol> <p style="text-align: center;"><b>III. Mixing behaviour of NR on two roll mill</b></p>	30	4
5		<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> Lectures (Chalk & Board, Multimedia presentations) Group Discussions Case studies Quizzes
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<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory : 25 marks</b></p> <p>Quiz</p> <p>Assignment</p> <p>Problem based test - Open book</p> <p>Written exam</p> <p><b>Practical : 15 marks</b></p> <p>Lab involvement and skill</p> <p>Report of lab works done</p>
	<p><b>B. Semester End examination</b></p> <p><b>Theory: Written examination (50 Marks)- 1.5 hrs.</b></p> <p>i. MCQ 10 questions : <math>10 \times 1 = 10</math></p> <p>ii. Short answer 4 questions (out of 6): <math>4 \times 3 = 12</math></p> <p>iii. Short essay 2 questions (out of 3): <math>2 \times 7 = 14</math></p> <p>iv. Essay 1 question (out of 2): <math>1 \times 14 = 14</math></p> <p><b>Practical: (35 Marks)-1 hr.</b></p> <p>Viva voce: 10 marks</p> <p>Writing procedure: 15 marks</p> <p>Certified lab report: 10 marks</p>

## References

1. J. E. Mark, B. Erman, M. Roland, *The Science and Technology of Rubber*, Academic Press, 2013
2. J. M. Martin and W.K. Smith, *Handbook of Rubber Technology*, CBS Publisher 2007

3. J. Urbanski, W. Czerwinski, K. Janicka, *Handbook for analysis of synthetic polymer and plastics*, Ellis Harwood Ltd. 1977
4. J.A. Brydson, *Rubber Chemistry*, Allied science Publishers, London, 1978.
5. J.K. Setright, *Automobile Tyre*, Chapman and Hall, 1972.
6. M. Morton, *Rubber Technology*, Chapman Hall, 1995.
7. R.C. Klingender, *Handbook of speciality elastomers*, CRC Press, 2008.
8. S. Blow, *Hand Book of Rubber Technology*, Hanser Gardner, 2000.
9. W.C. Wake, *Analysis of Rubbers and Rubber like Polymers*, 2<sup>nd</sup> Edn, Wiley Interscience, 1969.
- 10.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Industrial Inorganic Chemistry and Nuclear Chemistry</b>					
<b>Type of Course</b>	DSE					
<b>Course Code</b>	<b>UC6DSECHE302</b>					
<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course is designed to provide students with a comprehensive understanding of the industrial processes involved in the production of inorganic compounds and the principles governing nuclear reactions.					
<b>Semester</b>	VI	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

#### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No

1	Analyse different industrially important inorganic materials.	An	1,2, 6
2	Evaluate the important processes involved in metallurgy	E	1,2 ,6
3	Explain the catalytic properties of inorganic materials	E	1,2,6
4	Illustrate the basics of chemical explosives and rocket propellants	U	1,2,6,10
5	Analyse different aspects of nuclear chemistry, its applications and associated problems.	An	1,2,6,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

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## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	<b>Glass, Ceramic and Cements</b>			
1	1.1	<b>Glass</b> -Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate glass, coloured glass and photosensitive glass.	5	1
	1.2	<b>Ceramics</b> -Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications. Bioceramics.	5	1
	1.3	<b>Cement</b> -Classification of cement, ingredients and their role, manufacture of cement and the setting process, quick setting cements. Biocement- Living building materials	5	1
2		<b>Metallurgy</b>		

	2.1	Minerals in India, mineral processing, chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents.	5	2
	2.2	Electrolytic reduction, hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: electrolytic process, Van Arkel-de Boer process and Mond's process, Zone refining.	7	2
	2.3	Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.	3	2
	<b>Introduction to Chemical Explosives, rocket propellants and catalysis</b>			
<b>3</b>	3.1	General principles and properties of catalysts, homogenous catalysis, and heterogenous catalysis (catalytic steps and examples), their industrial applications, deactivation, or regeneration of catalysts. Phase transfer catalysts, application of zeolites and metal organic frameworks as catalysts.	7	3
	3.2	Origin of explosive properties in inorganic compounds. Categorisation of explosives (low explosives – high explosives – primary, secondary, intermediary, tertiary). Explosive properties of Gun powder, lead azide, TNT, PETN, cyclonite (RDX).	6	4
	3.3	A Brief History and introduction of chemical rocket propellants. Liquid propellants, ecofriendly propellants and solid propellants	2	4
	<b>Nuclear Chemistry</b>			
<b>4</b>	4.1	Nucleus and its classification, nuclear forces, nuclear stability, binding energy, nuclear models. Radioactive decay, radioactive elements, general characteristics of radioactive decay, decay kinetics - decay constant, half-life, mean life period, units of radioactivity.	5	5

	4.2	Measurement of radioactivity, Geiger-Muller detector, scintillation detectors, nuclear reactor: classification of reactors, uranium reactor, breeder reactor. Nuclear reactors in India (Brief Idea). Nuclear fusion and stellar energy. Units of radiation energy (Rad, Gray, Rontgen)	5	5
	4.3	Nuclear pollution and radiological safety: interaction of radiation with matter, radiolysis of water, radiation dosimetry. Radioactive isotopes and their applications, isotopic dilution analysis, neutron activation analysis, disposal of nuclear waste, nuclear disaster (nuclear accidents–case study).	5	5
5	<b>Teacher-Specific content</b>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <p>Lecture (chalk &amp; board, powerpoint presentation)</p> <p>Group discussion</p> <p>Peer teaching</p> <p>Industrial Visit/ visit to a nuclear Reactor (IGCAR/KNPP etc.)</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory: 30 marks</b></p> <p>Quiz</p> <p>Class test for each unit (MCQ/written)</p>
	<p><b>B. Semester end examination</b></p> <p><b>Theory: Written examination (70 Marks) -2 hrs.</b></p> <p>i) Short answer 5 questions (out of 6): 5 X 4 =20</p> <p>ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>iii) Essay 1 question (out of 2): 1 X 15 = 15</p>

## References

1. H.J. Arnika, *Essentials of Nuclear Chemistry*, 4<sup>th</sup> Edn. New Age International Private Limited, 2011.
2. Harvey, B. G. *Introduction to Nuclear Physics & Chemistry*, Prentice – Hall, 2012.
3. J. A. Kent, *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi, 1997.
4. J. W. T. Spinks, R.J. Woods R. J. *An Introduction to Radiation Chemistry*, 3<sup>rd</sup> Edn. Wiley–Blackwell, 1990.
5. K. Sharma, *Engineering Chemistry*, Goel Publishing House, Meerut, 2000.
6. N. Nesmeyanov, *Radiochemistry*, MIR Publication, Moscow.
7. Overman R. T, *Basic concept of Nuclear Chemistry*, Chapman & Hall, 1963.
8. P. C. Jain and M. Jain, *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi, 2015.
9. R. Gopalan, D. Venkappayya, S. Nagarajan, *Engineering Chemistry*, 4<sup>th</sup> Edn. Vikas Publications, New Delhi.
10. R. M. Felder and R. W. Rousseau, *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi, 2004
11. S.F. Sarner, *Propellant Chemistry*, Reinhold Publishing Co., 1966
12. Stocchi, *Industrial Chemistry*, Vol-I , Ellis Horwood Ltd. UK, 1990
13. T. Urbanski, *Chemistry and Technology of Explosives* Vol.I to IV, Pergamon Press, 1984
14. W. D. Kingery, H. K. Bowen and D. R. Uhlmann, *Introduction to Ceramics*, Wiley Publishers, New Delhi, 2012.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Spectroscopic Methods of Chemical Analysis</b>
<b>Type of Course</b>	<b>DSE</b>
<b>Course Code</b>	<b>UC6DSECHE303</b>
<b>Course Level</b>	<b>300-399</b>
<b>Course Summary</b>	This course covers various spectroscopic methods, including principles, instrumentation and applications.

<b>Semester</b>	VI	<b>Credits</b>				<b>Total Hours</b>
<b>Course Details</b>	<b>Learning Approach</b>	<b>Lecture</b>	<b>Tutorial</b>	<b>Practical</b>	<b>Others</b>	
		4		0		60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Discuss instrumentation in IR, NMR and electronic spectroscopic techniques.	U	1,2
2	Describe the fundamental principles of Raman, EPR, NQR, Mossbauer, Fluorescence and X-ray spectroscopic techniques in chemical analysis.	U	1,2
3	Evaluate the advantages and limitations of Raman spectroscopy, EPR spectroscopy and NQR spectroscopy in different scientific and industrial applications.	E	1,2,10
4	Assess the utility of Mössbauer spectroscopy, Fluorescence spectroscopy and X-ray spectroscopy in various fields.	E	1,2
5	Describe the fundamental principles of AAS, AES and FES.	U	1,2
6	Compare and contrast the advantages and limitations of AAS, AES, and FES in elemental analysis.	U	1,2
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

<b>Module</b>	<b>Units</b>	<b>Course description</b>	<b>Hrs</b>	<b>CO No.</b>
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<b>Instrumentation in Electronic, IR and NMR Spectroscopic Techniques</b>				
<b>1</b>	1.1	Instrumentation in UV/ Visible Spectroscopy: Light sources, wavelength dispersion (gratings, prisms, interference filters, lasers). Sample holders, detection of signals (photocells, photo multipliers, and diode arrays), Sensitivity and S/N ratio. Single and double beam instruments.	5	1
	1.2	Instrumentation in IR Spectroscopy: Light sources, infrared detectors, sample preparation techniques; liquids, solids. Dispersive I R spectrometer. (FTIR-basic idea only)	5	1
	1.3	Instrumentation in NMR Spectroscopy: Magnet: Types of magnets used in NMR (permanent, resistive, superconducting), Probes and RF coils. Sample handling and temperature control.	5	1
<b>Raman and EPR Spectroscopic Techniques</b>				
<b>2</b>	2.1	Raman Spectroscopy: Scattering of light, polarizability and classical theory of Raman spectrum, rotational and vibrational Raman spectrum, Stokes and anti-Stokes lines: their intensity difference, complementarities of Raman and IR spectra, mutual exclusion principle, applications of Raman spectroscopy.	8	2,3
	2.2	EPR Spectroscopy: Electron spin in molecules, interaction with magnetic field, g factor, factors affecting g values, fine structure and hyperfine structure, Kramers' degeneracy, applications of ESR spectroscopy.	7	2,3
<b>NQR, Mossbauer and Fluorescence Spectroscopic techniques</b>				
<b>3</b>	3.1	Theory and important applications of NQR Spectroscopy.	3	2,3
	3.2	Mossbauer Spectroscopy: Principle, Doppler effect, recording of spectrum, chemical shift, factors determining chemical shift, application to complexes of iron.	6	2,4

	3.3	Fluorescence Spectroscopy. Instrumentation: light source, monochromator, optical filters, photo multiplier tube, polarizers, application- fluorescence sensing.	6	2,4
4	<b>Atomic Spectroscopic Techniques</b>			
	4.1	Atomic absorption spectroscopy (AAS), principle of AAS, absorption of radiant energy by atoms, measurement of atomic absorption, instrumentation: Radiation Sources, Atomizers, Detectors. Analytical Applications of AAS.	5	5,6
	4.2	Atomic emission spectroscopy (AES), advantages and disadvantages of AES, origin of spectra, principle and instrumentation, applications.	5	5,6
	4.3	Flame emission spectroscopy (FES), flames and flame temperature, spectra of metals in flame, instrumentation, applications.	5	5,6
5		<b>Teacher Specific content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions and demonstrations, to engage students actively and visual aids like presentations and videos to enhance understanding. Utilize case studies from various scientific fields (like environmental science, pharmaceuticals, forensics) to illustrate how spectroscopy is applied practically. Form study groups to discuss concepts, compare approaches, and explain concepts to one another.</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Total marks: 30</b></p> <p>Assignment</p> <p>MCQ</p> <p>Class test</p>

	Viva
	<p><b>B. Semester end examination ( 70 marks)- 2 hrs.</b></p> <p>i) Short answer 5 questions (out of 7): 5 X 4 =20</p> <p>ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>iii) Essay 1 question (out of 2): 1 X 15 = 15</p>

## References

1. Aruldhas, *Molecular Structure and Spectroscopy*, 2<sup>nd</sup> Edn. Prentice Hall India, 2007.
2. C N Banwell, E M McCash, *Fundamentals of Molecular Spectroscopy*, 4<sup>th</sup> Edn. McGraw-Hill Publishing Company, 2017.
3. D A. Skoog, D M. West, F. J Holler and S R. Crouch, *Fundamentals of Analytical Chemistry*, 9<sup>th</sup> Edn. Brooks/Cole, 2014.
4. D A. Skoog, F. J Holler and S R. Crouch, *Principles of Instrumental Analysis*, 7<sup>th</sup> Edn. Brooks/Cole, 2020.
5. F A Settle, *Handbook of Instrumental Techniques for Analytical Chemistry*, Prentice Hall, 1997.
6. J W. Robinson, E M S Frame and G M. Frame II, *Undergraduate Instrumental Analysis*, 7<sup>th</sup> Edn. CRC Press, 2014.
7. J W. Robinson, E M S Frame, and G M. Frame II, *Instrumental Analytical Chemistry*, CRC Press, 2021.
8. P. Gupta, S. S. Das and N. B. Singh, *Spectroscopy*, Jenny Stanford Publishing, 2023.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Fundamentals of Biochemistry</b>
<b>Type of Course</b>	DSE
<b>Course Code</b>	<b>UC6DSECHE304</b>

<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course covers structure and biological functions of amino acids, proteins, enzymes, carbohydrates, nucleic acids and lipids and general features of metabolism.					
<b>Semester</b>	VI	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Explain fundamental features of biochemistry such as functions of subcellular organelles, membranes and membrane transport,	U	1,2
2	Analyse the classification, properties and functions of amino acids, proteins, enzymes, lipids and carbohydrates.	An	1,2
3	Describe the catalytic activity of enzymes and enzyme inhibition	U	1,2
4	Examine the functions of DNA and RNA	E	1,2
5	Analyse various metabolic pathways and phases.	An	1,2
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Foundations of Biochemistry</b>			
	1.1	Introduction to biochemistry: scope of biochemistry, historical development and significance	2	1
	1.2	Subcellular organelles: nucleus, endoplasmic reticulum, golgi apparatus, lysosomes, peroxisomes and mitochondria. Marker enzymes.	5	1
	1.3	Plasma membrane and membrane proteins.	2	1
	1.4	Membrane transport: active and passive transports and pumps. Ion channels, ligand-gated channels, voltage-gated channels, ionophores. Sodium pump and calcium pump.	6	1
<b>Amino acids and Proteins</b>				
2	2.1	Amino acids Classification-based on structure, side chain, metabolism and nutritional requirements. Physical properties of amino acids, isoelectric point, optical activity and peptide bond formation. Colour reactions of amino acids and proteins- ninhydrin, biuret and xanthoproteic tests.	6	2
	2.2	Peptides and proteins. Primary structure and numbering of amino acids in proteins. Secondary structure- alpha helix and beta pleated sheets. Tertiary structure- relationship between structure and function of proteins. Quaternary structure of proteins.	5	2
	2.3	Classification of Proteins based on function, composition, shape and nutritional value.	2	2
	2.4	Physical properties and precipitation reactions of proteins. Quantitative estimation of proteins by Kjeldahl's method.	2	2
3	<b>Enzymes</b>			
	3.1	Enzymes; Characteristics, six major classes of enzymes, IUMB system of classification of enzymes- explanation with one example. Coenzymes- Classification, nicotinamide adenine dinucleotide (NAD <sup>+</sup> ) and coenzyme A. Cofactors.	6	2

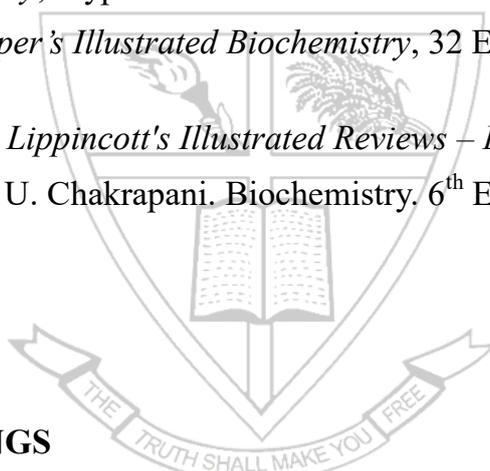
		Metallo-enzymes.		
	3.2	Catalytic power and specificity of enzymes. Mode of action of enzymes- active site, substrate binding, lock and key principle, induced-fit model, entropy effect and stabilisation of transition state. Coupled reactions.	7	3
	3.3	Enzyme inhibition- types.	2	3
4	<b>Carbohydrates, Nucleic acids, Lipids and Metabolism</b>			
	4.1	Carbohydrates- Biological functions of mono, di and polysaccharides. Regulation of Blood Glucose; insulin and diabetes mellitus.	4	2
	4.2	Nucleotides and nucleic acids, DNA and RNA, functions of DNA and RNA.	4	4
	4.3	Lipids- classification of lipids and fatty acids and functions of lipids.	3	2
	4.4	Metabolism: types of metabolic pathways, phases of metabolism, metabolic profile of brain, skeletal muscles and liver.	4	5
5		<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<p style="text-align: center;"><b>Classroom Procedure (Mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions and demonstrations, to engage students actively and visual aids like presentations and videos to enhance understanding.</p>
<b>Assessment Types</b>	<p style="text-align: center;"><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>C. Continuous Comprehensive Assessment (CCA)</b></p> <p style="text-align: center;"><b>Total marks : 30</b></p> <p>Assignments</p> <p>MCQ</p> <p>Class test</p> <p>Viva</p>

	<p><b>B. Semester end examination ( 70 marks) -2hrs.</b></p> <p>i) Short answer 5 questions (out of 6): 5 X 4 =20</p> <p>ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>iii) Essay 1 question (out of 2): 1 X 15 = 15</p>
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## References

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. *Biochemistry*. 9<sup>th</sup> Edn. W.H. Freeman and Co., 2019.
2. D M Vasudevan, S Sreekumari, *Textbook of Biochemistry for Medical Students*, Jaypee Brothers Medical Publishers, 2023.
3. H. P. Gajera, S. V. Patel, B. A. Golakiya, *Fundamentals of Biochemistry*, IBDC, 2000.
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8. U. Satyanarayana, U. Chakrapani. *Biochemistry*. 6<sup>th</sup> Edn. Elsevier India, 2021.



## SUGGESTED READINGS

1. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. *Harper's Illustrated Biochemistry*. XXVIII edition. Lange Medical Books/ McGraw-Hill, 2009.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Data Analysis using Python and Soft skills</b>
<b>Type of Course</b>	SEC
<b>Course Code</b>	<b>UC6SECCHE300</b>
<b>Course Level</b>	<b>300- 399</b>
<b>Course Summary</b>	This interdisciplinary course provides a comprehensive exploration of scientific investigation, statistical analysis, and python programming in the context of chemistry.

<b>Semester</b>	VI	<b>Credits</b>			3	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
<b>Pre-requisites, if any</b>	Nil					

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply scientific methods for designing experiments systematically	A	1,2,3
2	Interpret data using various statistical tools.	U	1,2,3
3	Understand the basics of Python	U	1,2,3
4	Utilize Python in data visualization and analysis	A	1,2,3
5	Develop ideas in chemistry that can be grown into startups	C	4,5,9,10
6	Develop comprehensive scientific communication skills	C	4,10

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1		<b>Data Analysis</b>		
	1.1	<b>The Investigative Approach:</b> Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.	3	1
	1.2	<b>Analysis and Presentation of Data:</b> Descriptive statistics. Choosing and using statistical tests.	4	1,2

	1.3	<b>Chemometrics.</b> Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r, and its abuse. Basic aspects of multiple linear regression analysis.	8	2
<b>Introduction to Python</b>				
2	2.1	Introduction to Python Programming Defining numbers, Variables, Strings, Lists and Loops, Comparisons of flow control, functions, data structures, file input/output, Basic Numpy	9	3
	2.2	Data Visualization with Python Matplotlib, drawing line plots with a single line, line plots with multiple line, adding legend, drawing bar plots, scatter plots, plot title and axis labels. Saving plots,	6	4
<b>Soft skills for chemists</b>				
3	3.1	<ul style="list-style-type: none"> <li>● Presentation on a hypothetical start-up idea incorporating chemistry background.</li> <li>● Review of recent research articles (writing)</li> <li>● Poster design and presentation skills</li> <li>● Plotting of data using different software (excel, origin etc.)</li> <li>● Fitting of data</li> </ul>	15	5,6
4		<b>Teacher-Specific content</b>		

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b>  <b>Lectures, demonstrations, discussions, hands-on training, seminars, presentations and assignments.</b>
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b>  <b>Continuous Comprehensive Assessment (CCA)</b>  <b>Total marks: 25 marks</b>  Presentation

	writing skills Data analysis skill Examination
	<b>Semester end examination</b> <b>Total marks:50 marks-1.5 hrs</b> Short answer questions – 20 marks (2 marks each – 10 out of 12 nos) Long answer questions – 30 marks (5 marks each – 6 out of 8 nos)

## References

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6. Lamport, Leslie (1994). *LaTeX: A Document Preparation System, User's Guide and Reference Manual* (2nd ed.). Pearson Education. Indian Reprint.
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8. *Python Crash Course- A Hands-on, Project Based Introduction to Programming*, Eric Matthes, no starch Press, 2016 edition

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Intellectual Property Rights</b>
<b>Type of Course</b>	VAC
<b>Course Code</b>	<b>UC6VACCHE300</b>
<b>Course Level</b>	<b>300-399</b>
<b>Course Summary</b>	This course covers various aspects of intellectual property law, including patents, trademarks, and copyrights.

<b>Semester</b>	VI	<b>Credits</b>			3	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse the fundamental principles of intellectual property rights, distinguishing between patents, copyrights, and trademarks.	An	1,2
2	Interpret the ethical and legal implications of intellectual property infringement in diverse contexts.	U	1,2
3	Evaluate the criteria for patentability, including novelty, non-obviousness, and utility.	E	1,2
4	Identify the fundamental concepts and legal framework surrounding trademarks.	U	1,2
5	Analyse and interpret the fundamental principles and theories underlying copyright law.	An	1,2

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>INTRODUCTION TO IPR</b>			
	1.1	Meaning of property, origin, nature, meaning of intellectual property rights	4	1
	1.2	Kinds of Intellectual property rights—copy right, patent, trade mark, trade secret and trade dress, design, layout design, geographical indication, plant varieties and traditional knowledge.	7	1,2,4

	1.3	Significance of IPR and their protection	3	1,2
2	<b>INTERNATIONAL ORGANIZATIONS &amp; TREATIES</b>			
	2.1	Paris Convention for the Protection of Industrial Property, Patent Cooperation Treaty (PCT), World Trade Organization (WTO)	5	1,2,3
	2.2	Trade Related Aspects of Intellectual Property TRIPS, TRIMS, WIPO	5	1,2,3
	2.3	Budapest treaty on the international recognition of the deposit of microorganisms for the purpose of patent procedure, international convention for the protection of new varieties of plants (UPOV)	5	1,2,3
3	<b>PATENT RIGHTS AND COPYRIGHTS</b>			
	3.1	Types of patents, inventions which are not patentable, the patent's act 1970- patentable invention, registration procedure, rights and duties of patentee, assignment and licence, restoration of lapsed patents, surrender and revocation of patents, infringement, remedies & penalties.	10	1,2,3
	3.2	Types of copyright, registration procedure, assignment & licence, terms of copyright, piracy, infringement, remedies, copy rights with special reference to software	5	1,2,5
4	<b>Teacher-Specific content</b>			

<b>Teaching and Learning Approach</b>	<p style="text-align: center;"><b>Classroom Procedure (Mode of transaction)</b></p> <p>Lectures, discussions, group activities and presentations by students.</p>
<b>Assessment Types</b>	<p style="text-align: center;"><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p style="text-align: center;"><b>Total marks: 25</b></p>

	Assignments Examination Viva Classroom participation (participation in class activities)
	<p style="text-align: center;"><b>B. Semester end examination</b></p> <p style="text-align: center;"><b>Total marks: 50-1.5 hrs.</b></p> i) MCQ 9 questions : 9 X 1 = 9 ii) Short answer 5 questions (out of 7): 5 X 4 =20 iii) Short essay 3 questions (out of 5): 3 X 7 = 21

## References

1. B.L.Wadehra, *Law relating to Intellectual Property*, Universal Law Publishing Co, 2017.
2. G.B. Reddy, *Intellectual Property Rights and the Law*, Gogia Law Agency, 2017.
3. P. Narayanan, *Intellectual Property Law*, Eastern Law House, 3<sup>rd</sup> Edn. 2023.
4. R K Singh. A Banerjee, *Intellectual Property Rights*, Gogia Law Agency, 2022.
5. S.R. Myneni, *Law of Intellectual Property*, Asian Law House, 2019.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Research Methodology for Chemistry</b>
<b>Type of Course</b>	VAC
<b>Course Code</b>	<b>UC6VACCHE301</b>
<b>Course Level</b>	<b>300-399</b>
<b>Course Summary</b>	This course covers a wide range of topics aimed at preparing students to conduct a scientific project in chemistry. The aim is to equip students with the skills and knowledge necessary to design, conduct, analyse, and communicate scientific research effectively in the field of chemistry.

<b>Semester</b>	VI	<b>Credits</b>				3	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others		
<b>Pre-requisites, if any</b>							
		3				45	

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply the tools for literature survey in chemistry in doing and reporting a chemistry project.	A	1,2
2	Describe the methodology of scientific research.	U	1,2
3	Apply the knowledge of scientific writing in preparing a project report.	A	1,2
4	Discuss the ethical aspects of chemistry research.	U	1,2
5	Apply the basic principles of research methodology in the conducting, reporting and presenting a chemistry project.	A	1,2

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Literature Survey</b>			
	1.1	Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, textbooks, current contents, Introduction to Chemical Abstracts, Subject Index,	6	1

		Substance Index, Author Index, Formula Index, and other Indices with examples		
	1.2	Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, Beilstein, SciFinder, Scopus. Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.	9	1
	<b>Methods of Scientific Research and Writing Scientific Papers</b>			
	2.1	Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.	5	2,3
2	2.2	Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work.	5	2,3
	2.3	Ethical challenges in chemistry research, Responsible conduct of research, Writing Ethics, Avoiding plagiarism.	5	4
	<b>Training on writing a project report</b>			
3	3.1	<ul style="list-style-type: none"> <li>❖ Project selection</li> <li>❖ Literature Survey</li> <li>❖ Conducting the project</li> <li>❖ Preparing a report</li> <li>❖ Preparing and displaying a poster</li> <li>❖ ICT enabled oral presentation</li> </ul>	15	1,2,3,4,5
4		<b>Teacher-Specific content</b>		

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> Lectures, discussions, group activities and presentations by students.
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b>  <b>A. Continuous Comprehensive Assessment (CCA)</b>  <b>Total marks : 25</b>  Poster presentation  Oral presentation  Project report  Classroom participation (participation in class activities)
	<b>B. Semester end examination</b> <b>Total marks : 50-1.5 hrs.</b>  i) MCQ 9 questions : $9 \times 1 = 9$ ii) Short answer 5 questions (out of 7): $5 \times 4 = 20$ iii) Short essay 3 questions (out of 5): $3 \times 7 = 21$

## References

1. A T Tyowua, *A Practical Guide to Scientific Writing in Chemistry: Scientific Papers, Research Grants and Book Proposals*, CRC Press. 2023.
2. F. H. Jardine, *How to do your Student Project in Chemistry*, Springer, 1994.
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4. V Bairagi, M V. Munot, *Research Methodology: A Practical and Scientific Approach*, CRC Press, 2019.
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6. D Angelo, G John, *Ethics in Science: Ethical Misconduct in Scientific Research*, Chapman and Hall/CRC, 2018.
7. <https://www-library.ch.cam.ac.uk/list-useful-databases>
8. <https://fordham.libguides.com/Chemistry/Databases>



<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Coordination and Organometallic Chemistry</b>
<b>Type of Course</b>	DCC
<b>Course Code</b>	<b>UC7DCCCHE400</b>
<b>Course Level</b>	<b>400-499</b>
<b>Course Summary</b>	This course provides a comprehensive understanding of the structure, bonding, and reactivity of coordination complexes, electronic spectral properties, synthesis, and catalytic applications of organometallic compounds.

<b>Semester</b>	VII	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
<b>Pre-requisites, if any</b>		Inorganic Chemistry-2				

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Compare the stability of metal complexes.	E	1,2
2	Examine the structure and bonding in coordination and organometallic compounds using the concepts of crystal field theory and molecular orbital theory.	An	1,2
3	Construct correlation diagrams and explain the spectral properties of metal complexes.	A	1,2
4	Analyse the reactions of organometallic compounds.	An	1,2
5	Examine the catalytic properties of various organometallic compounds and their applications.	An	1,2,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Structure and Bonding in Coordination Complexes</b>			
	1.1	Classification of complexes based on coordination numbers and possible geometries, $\sigma$ and $\pi$ bonding ligands such as CO, NO, $\text{CN}^-$ , $\text{R}_3\text{P}$ , and $\text{Ar}_3\text{P}$ .	2	1

	1.2	Stability of complexes, kinetic and thermodynamic aspects of complex formation - Irving William order of stability.	2	1
	1.3	Splitting of $d$ orbitals in octahedral, tetrahedral, square planar, square pyramidal and triangular bipyramidal fields.	2	1
	1.4	Crystal Field Stabilization Energy (CFSE) and $Dq$ values, Jahn Teller (JT) distortion ( $d^1 - d^{10}$ systems), static and dynamic JT distortion, consequences of JT distortion, theoretical failure of crystal field theory, Ligand Field Stabilization Energy (LFSE) and evidence of covalency in the metal-ligand bond.	4	1
	1.5	Ligand field theory and molecular orbital theory - diagrams for octahedral and tetrahedral complexes without and with $\pi$ -bonding, experimental evidences for $\pi$ -bonding.	5	2
	<b>Electronic Spectral Properties of Metal Complexes</b>			
2	2.1	Electronic spectra of complexes: term symbols and microstates of $d^n$ systems, Racah parameters, splitting of terms in weak and strong octahedral and tetrahedral fields, selection rules for electronic transitions - effect of spin-orbit coupling and vibronic coupling.	5	3
	2.2	Correlation diagrams: Orgel and Tanabe – Sugano diagrams.	3	3
	2.3	Electronic spectra of metal complexes and their interpretation. Charge transfer spectra, luminescence spectra.	5	3
	2.6	Electronic spectra of lanthanide and actinide complexes.	2	3
	<b>Organometallic Compounds-Synthesis, Structure and Bonding</b>			
3	3.1	Ligands and their bonding with metals: CO, CN, NO, N <sub>2</sub> , H <sub>2</sub> , alkene, alkyne, PR <sub>3</sub> , arenes, dienes, allyl, carbenes – carbynes (Fischer and Schrock) and alkyl.	5	1

	3.2	Preparation of metal nitrosyl, dinitrogen, alkyl, aryl, alkene, alkyne, carbenes - carbynes (Fischer & Schrock), arene and phosphine complexes.	3	1
	3.3	18 electron rule.	1	1
	3.4	Bridging and non-bridging (polynuclear) metal carbonyls, IR spectra of metal carbonyls, carbonyl clusters, Wade-Mingos rules.	3	1
	3.5	Isolobal analogy.	1	1
	3.6	Cyclopentadienyl complexes - fluxionality.	1	1
	3.7	Ferrocene: structure and bonding.	1	1
	<b>Reactions of Organometallic Compounds and Catalysis</b>			
4	4.1	Unique reactions in organometallic chemistry: oxidative addition (concerted and stepwise, C <sub>aryl</sub> -H activation – orthometallation), reductive elimination, migratory insertion (1,1 and 1,2), $\beta$ -hydride abstraction/elimination. Agostic interactions, $\sigma$ -bond metathesis (Zr(IV) and Lu(III)).	6	4
	4.2	Homogeneous/heterogeneous catalysis: Tolman catalytic loops, hydrogenation by Wilkinson catalyst, olefin isomerization, Wacker process, hydroformylation (Co & Rh), Monsanto & Cativa acetic acid process, Ziegler-Natta polymerization including metallocene based Zr catalyst, water gas shift reaction and the Fischer-Tropsch reaction (synthesis of gasoline).	7	5
	4.3	Grubbs (I generation & II Generation) and Schrock catalysts – preparation and characteristics, olefin metathesis, ROMP.	2	5
5	<b>Teacher Specific Content</b>			

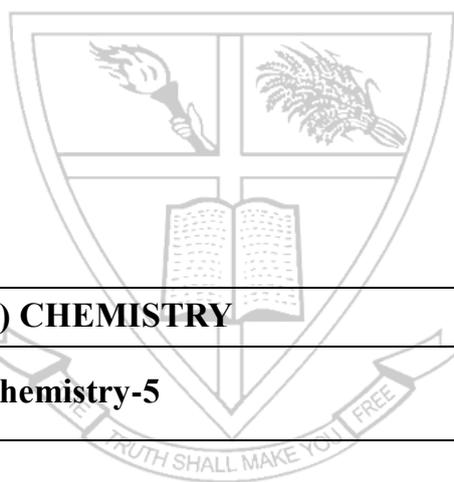
<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> </ul>
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b>  <b>A. Continuous Comprehensive Assessment (CCA)</b>  <b>Marks: 30</b>  Quiz  <b>Assignment</b>  Class Test (MCQ/written)
	<b>B. Semester end examination</b>  <b>Theory: Written examination (70 Marks)- 2hrs.</b>  i) <b>Short answer 5 questions (out of 6): 5 X 4 =20</b>  ii) <b>Short essay 5 questions (out of 7): 5 X 7 = 35</b>  iii) <b>Essay 1 question (out of 2): 1 X 15 = 15</b>

### References

1. B.E. Douglas, D.H. McDaniel, J.J. Alexander, *Concepts and Models of Inorganic Chemistry*, 3<sup>rd</sup> Edn. Wiley-India, 2007.
2. B.N. Figgis, M.A. Hitchman, *Ligand Field Theory and its Applications*, Wiley-India, 2010.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Organic Chemistry-5</b>					
<b>Type of Course</b>	DCC					
<b>Course Code</b>	<b>UC7DCCCHE401</b>					
<b>Course Level</b>	<b>400-499</b>					
<b>Course Summary</b>	This course delves into the concepts of organic chemistry, focusing on reactive intermediates and the underlying physical principles governing their behaviour. It also investigates concerted reactions and advanced stereochemical aspects of organic reactions.					
<b>Semester</b>	VII	Credits			4	Total Hours
<b>Course Details</b>	Learning approach	Lectur	Tutoria	Practic	Others	
		<b>3</b>		<b>1</b>		<b>75</b>

<b>Pre-requisites, if any</b>	
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### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Predict the reaction mechanism and rationalize the outcome of various organic reactions and obtain practical experience.	A	1, 2, 4, 10
2	Illustrate and practice the transformations and rearrangements of reactive intermediates.	An	1, 2, 4, 10
3	Correlate the reactivity of organic molecules to HSAB concept and various kinetic and thermodynamic conditions and obtain hands-on experience in this area.	An	1, 2, 4, 10
4	Distinguish and predict the stereoselectivity, regioselectivity, and feasibility of pericyclic reactions and their applications.	E	1, 2, 3, 4, 10
5	Master in determining and differentiating chirality, topicity of organic molecules and explore the chemical consequences and applications of conformational equilibria.	C	1, 2, 4, 9, 10
6	Perform raw mechanisms and schemes using chemistry software.	A	1, 2, 4, 10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		<b>Organic Reactivity and Mechanistic Insights: Exploring Reactive Intermediates and Physical Principles</b>		

	1.1	Mechanical aspects of $S_N1$ , $S_N2$ , $S_NAr$ , $S_{RN}1$ , $S_{Ni}$ , $S_E1$ , $S_E2$ , effect of substrate, reagent, leaving group, solvent and neighbouring group on nucleophilic substitution ( $S_N2$ and $S_N1$ ).	5	1
	1.2	Reactive Intermediates: non-classical carbocations. Structure, generation and reactions of carbenes and nitrenes: insertion reaction of carbene. Simmons-Smith reaction, Lossen reaction, Curtius reaction, Wolff rearrangement and Hoffmann rearrangement.	5	2
	1.3	Physical organic chemistry: kinetic versus thermodynamic control of product formation Hammond postulate, Hammett equation, hard and soft acids and bases – HSAB principle and its applications (organic reactions only).	5	3
	<b>Symmetry and Molecular Transformations: Insights into Concerted Reactions</b>			
<b>2</b>	2.1	Classification: electrocyclic, sigmatropic, cycloaddition, chelotropic, ene and diotropic reactions. Woodward - Hoffmann rules - frontier orbital and orbital symmetry correlation approaches - PMO method (for electrocyclic and cycloaddition reactions only).	5	4
	2.2	Pericyclic reactions in organic synthesis such as Claisen, Cope, Wittig, and Mislow-Evans rearrangements. Diels-Alder and ene reactions (with stereochemical aspects), dipolar cycloaddition (introductory).	5	4
	2.3	Unimolecular pyrolytic elimination reactions of acetates, xanthates and tertiary amine oxides, cheletropic elimination.	5	4

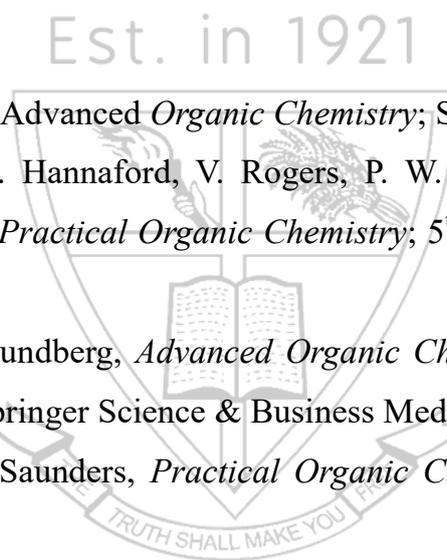
<b>Advanced Stereochemistry &amp; Conformational Stability and Reactivity</b>				
<b>3</b>	3.1	Axial, planar and helical chirality with examples, stereochemistry and absolute configuration of allenes, biphenyls and binaphthyls, ansa and cyclophanic compounds, spiranes, exo-cyclic alkylidenecycloalkanes.	5	5
	3.2	Topicity and prostereoisomerism, topicity of ligands and faces as well as their nomenclature, NMR distinction of enantiotopic /diastereotopic ligands.	5	5
	3.3	Conformation and reactivity of cyclohexane systems: dehalogenation, dehydrohalogenation, semipinacolic deamination and pyrolytic eliminations, Grob fragmentation. Chemical consequence of conformational equilibrium - Curtin Hammett principle.	5	5
<b>Organic Chemistry-5 Practical</b>				
<b>4</b>		(i) Practice Chemdraw (Use ChemDraw / other software to draw and manipulate different organic chemistry structures and reactions) (ii) Virtual Synthesis of aspirin (enable students to undertake an aspirin synthesis, perform recrystallization, Thin Layer Chromatography and calculation of yield using a digital resource). iii) Synthesis of aspirin iv) Experiment on Hammett equation (Experimentally determine the acid dissociation constant ( $K_a$ ) of a series of substituted benzoic acids, correlate the $K_a$ values with known substituent constants ( $\sigma_x$ ) and use the correlation		6

	generated above to calculate the substituent constants for 'unknown' substituted benzoic acid compounds.		
<b>5</b>	<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture using powerpoint presentation</li> <li>● Google classroom</li> <li>● Group learning</li> <li>● Laboratory work</li> </ul>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p style="text-align: center;"><b>Theory : 25 marks</b></p> <p>Pop quizzes</p> <p>Problem based assignments</p> <p>Written/MCQ Tests</p> <p style="text-align: center;"><b>Practical : -15 Marks</b></p> <p>Quiz</p> <p>Lab involvement</p>

	<p style="text-align: center;"><b>B. Semester end examination</b></p> <p>Theory (50 Marks): Written examination - 50 Marks- 1.5 hrs.</p> <p style="margin-left: 40px;">i) Short answer 7 questions (out of 9): 7 X 3 =21</p> <p style="margin-left: 40px;">ii) Short essay 2 questions (out of 3): 2 X 7 = 14</p> <p style="margin-left: 40px;">i) Essay 1 question (out of 2): 1 X 15 = 15</p> <p>Practical (35 Marks): Viva voce-10 Marks-1 hr.</p> <p style="margin-left: 100px;">Written test of practical procedures-15 Marks</p> <p style="margin-left: 100px;">Certified report of lab works done -10Marks</p>
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## References

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1. A. Bahl, B. S. Bahl, *Advanced Organic Chemistry*; S. Chand, 2010.
  2. B. S. Furniss, A. J. Hannaford, V. Rogers, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*; 5<sup>th</sup> Edn., Pearson Education, 2005.
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  7. J. McMurry, *Organic Chemistry*; 7<sup>th</sup> Edn. Cengage Learning, 2013.
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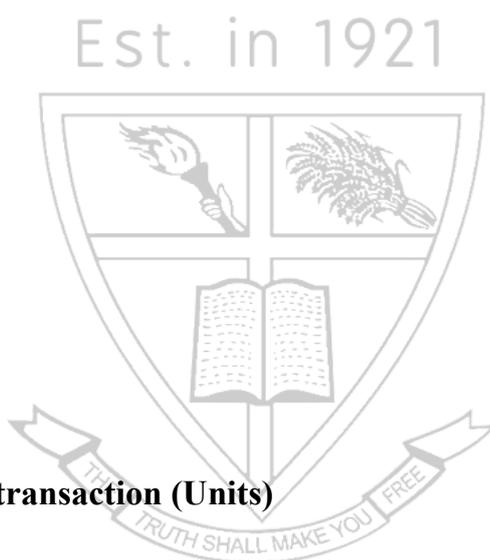
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Molecular Spectroscopy</b>					
<b>Type of Course</b>	<b>DCE</b>					
<b>Course Code</b>	<b>UC7DCCCHE402</b>					
<b>Course Level</b>	<b>400-499</b>					
<b>Course Summary</b>	This course deals with structure elucidation of organic compounds by means of combined spectral techniques such as IR, UV, NMR and mass spectrometry.					
<b>Semester</b>	<b>VII</b>	<b>Credits</b>			<b>4</b>	<b>Total Hours</b>
<b>Course Details</b>	<b>Learning Approach</b>	<b>Lecture</b>	<b>Tutorial</b>	<b>Practical</b>	<b>Others</b>	
		<b>4</b>				<b>60</b>
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Outline the theoretical aspects of various spectroscopic techniques.	U	1,2

2	Illustrate the basic concepts of infrared spectroscopy.	U	1,2
3	Apply the principles of electronic spectroscopy to organic compounds.	A	1,2
4	Demonstrate the underlying principles of NMR spectroscopy.	U	1,2
5	Explain the concepts of mass spectrometry.	U	1,2
6	Deduce the structure of organic compounds by means of combined spectral techniques such as IR, UV, NMR and mass spectrometry.	E	1,2,4,10
<i>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</i>			



## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Infrared and Electronic Spectroscopic Techniques</b>			
	1.1	Hooke's law, bond properties and absorption trends, fundamental vibrations, characteristic regions of the spectrum (fingerprint and functional group regions), influence of substituent, ring size, hydrogen bonding & solvent effect.	3	1,2
	1.2	IR spectra of O-H bonds (alcohols and carboxylic acids), C=C bonds (olefins and arenes), C=O bonds	4	1,2

		(acids, aldehydes, ketones, and esters) and C-H bonds (alkanes, alkenes and alkynes). Spectral interpretation and problems.		
	1.2	Nature of electronic transitions, chromophore, auxochrome, representation of electronic spectra, bathochromic shift, hypsochromic shift, hyperchromic shift and hypochromic shift.	2	1,3
	1.3	Influence of substituents, solvent effect, conjugation, ring size and strain on spectral characteristics.	2	1,3
	1.4	Calculations of $\lambda_{max}$ of enones, aromatic hydrocarbons and conjugated polyenes based on Woodward-Fieser and Fieser-Kuhn rules. Spectral interpretation and problems.	4	1,3
	<b>Nuclear Magnetic Resonance Spectroscopy</b>			
<b>2</b>	2.1	NMR phenomena based on $^1\text{H}$ & $^{13}\text{C}$ nuclei, $^1\text{H}$ & $^{13}\text{C}$ NMR spectra, relaxation processes.	3	1,4
	2.2	Chemical shift, magnetic anisotropy and shielding/deshielding, chemical equivalence and number of NMR signals. Population densities of nuclear spin states- intensity of the signal.	3	1,4
	2.3	Spin-spin splitting, coupling constant, geminal coupling, Karplus curve, Pople notation - AX, AX <sub>2</sub> , A <sub>2</sub> X <sub>3</sub> , AB, AB <sub>2</sub> type coupling, first order and non-first order spectra, homotopic, enantiotopic and diastereotopic protons.	4	1,4
	2.4	Simplification of non-first order spectra to first order spectra: spin decoupling and double resonance, off resonance decoupling, NOE and cross polarization and DEPT. Spectral interpretation and problems.	5	1,4

<b>Mass Spectrometry</b>				
<b>3</b>	3.1	<i>Basic principles. Ionization methods: Gas phase ionization methods– electron impact ionization (EI) and chemical ionization (CI); desorption ionization methods – SIMS, FAB and MALDI. Electrospray ionisation (ESI). Comparison between EI and CI. Mass analysers - time of flight analyser and quadrupole analyzer. Nitrogen and ring rules. Determination of molecular weight and molecular formula. HRMS. Tandem mass spectrometry (MS-MS) (concept only).</i>	7	1,5
	3.2	Fragmentation and structural analysis: types of peaks involved (molecular ion, quasi molecular ion, isotopic peak, base peak, parent ion, daughter ion, fragment ion, metastable ion). Fundamental fragmentation processes – Stevenson’s rule, $\alpha$ cleavage, two-bond cleavage, retro Diels- Alder cleavage and McLafferty rearrangements. Fragmentation pattern of hydrocarbons, alcohols, phenols, ethers, carbonyl compounds and amines. Mass spectral analysis and problem solving.	8	1,5
<b>Structure Elucidation of Organic Compounds</b>				
<b>4</b>	4.1	Identification of structures of organic compounds based on the data from mass spectrometry, UV-Vis, IR, $^1\text{H}$ NMR and $^{13}\text{C}$ NMR spectroscopy. Interpretation of the given UV-Vis, IR and NMR spectra.	15	6
<b>5</b>	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> Lecture (chalk & board, powerpoint presentation, flipped classroom) Group discussion – thought problems; mind mapping Peer interaction Demonstration using simulations / models
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b>  <b>A. Continuous Comprehensive Assessment (CCA)</b> <b>Total Marks: 30</b> Quiz Assignment Problem based test - Open book Test
	<b>B. Semester End examination</b> <b>Total Marks: 70 - 2 hrs.</b> MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

## References

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11. L. D. S. Yadav, *Organic Spectroscopy*, Springer, 2005.
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13. W. Kemp, *Organic Spectroscopy*, 2<sup>nd</sup> Edn. Macmillan, 2019.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Drug Therapy and Drug Design</b>					
<b>Type of Course</b>	DCE					
<b>Course Code</b>	<b>UC7DCECHE400</b>					
<b>Course Level</b>	<b>400-499</b>					
<b>Course Summary</b>	This course explores the fundamental concepts of drug therapy, drug discovery and design, drug delivery systems and computer aided drug design.					
<b>Semester</b>	VII	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial 1	Practical	Others	
		4				60
<b>Pre-requisites, if</b>						

any	
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### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the principles of drug therapy.	U	1,2,3
2	Analyse the concepts of drug design, leads, analogues, prodrugs and combinatorial synthesis.	An	1,2,3
3	Develop the concepts of enzymes and receptors as targets of drug design.	A	1,2,3,10
4	List the importance of various drug delivery systems.	U	1,2,3
5	Discuss the principles of computer aided drug design.	U	1,2,3,10

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Principles of Drug Therapy</b>			
	1.1	Introduction to drugs. General Principles of drug therapy. Relationship between chemical structure, lipid solubility and biological activity of drugs. Stereochemistry and biological activity. The importance of water solubility.	6	1
	1.2	Drug action: the pharmacokinetic phase- ADME of the drug. The pharmacodynamic phase.	2	1
	1.3	Drug metabolism: sites of drug metabolism and phase I and phase II reactions. Prodrugs.	4	1

	1.4	Classification of drugs: based on chemical structure, pharmacological action and physiological classification.	3	1
2	<b>Drug discovery and design</b>			
	2.1	Historical outline, rational drug design. The general stages in modern-day drug discovery and design.	2	2
	2.2	Leads and analogues: bioavailability, solubility, structure and stability.	2	2
	2.3	Sources of leads and drugs. Approaches to lead optimisation.	4	2
	2.4	Prodrug design and applications: prodrug forms of various functional groups, prodrugs and intellectual property rights.	4	2
	2.5	Combinatorial Chemistry: introduction, solid-phase and solution phase strategies.	3	2
3	<b>Enzymes, Receptors and Drug Delivery Systems</b>			
	3.1	Enzymes as targets of drug design: enzyme inhibition and activation, approaches to the rational design of enzyme inhibitors.	3	3
	3.2	Receptors as targets of drug design: receptor theory, receptor complexes and allosteric modulators, molecular biology of receptors, receptor models and nomenclature, receptor binding assays, lead compound discovery of receptor agonists and antagonists.	7	3
	3.3	Drug delivery systems: general consideration, macromolecular drug carrier systems, bioprecursor prodrugs, oxidative activation and reductive activation.	5	4
4	<b>Computer-Aided Drug Design</b>			
	4.1	Basic concepts of CADD, molecular modelling: energy minimization, geometry optimization, conformational analysis, global conformational minima determination; approaches and problems; bioactive vs. global minimum conformations. Automated methods of conformational search.	5	5
	4.2	Molecular docking and dynamics: rigid docking, flexible docking, manual docking; advantages and disadvantages of flex-X, flex-S, autodock and	5	5

		dock softwares with suitable examples; Monte Carlo simulations and molecular dynamics in performing conformational search and docking.		
	4.3	QSAR: changing size and shape and introduction of new substituents, lipophilicity, electronic and steric effects, Hansch analysis. Structure activity relationships and pharmacological activity. CoMFA analysis, 3D-QSAR.	5	5
5	<b>Teacher Specific Content</b>			

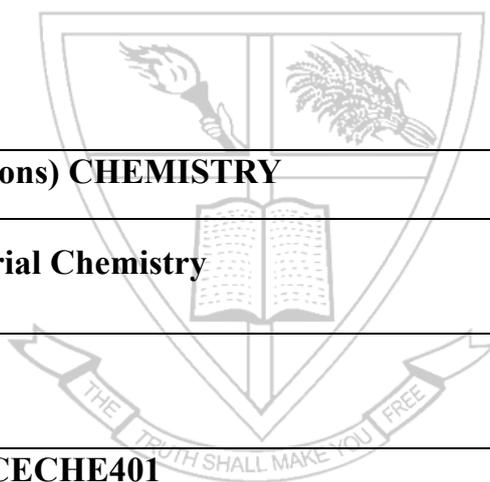
<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <p>Lecture Sessions, interactive sessions including discussions</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Total marks : 30</b></p> <p>Assignments</p> <p>MCQ</p> <p>Class test</p> <p>Viva</p>
	<p><b>B. Semester end examination</b></p> <p><b>Total Marks : 70- 2 hrs.</b></p> <p>i) Short answer 5 questions (out of 7): 5 X 4 =20</p> <p>ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>iii) Essay 1 question (out of 2): 1 X 15 = 15</p>

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1. Alagarsamy V., *Text Book of Medicinal Chemistry*, CBS Publishers, 2022.
2. D. B. Singh, *Computer-Aided Drug Design*, Springer, 2020.
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7. J. M. C. Rosa, M. E. C. Quesada, *Drug Design and Action*, De Gruyter, 2017.
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12. T. D. A. Kumar, *Drug Design: A Conceptual Overview*, CRC Press, 2022.
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Est. in 1921



<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Industrial Chemistry</b>					
<b>Type of Course</b>	DCE					
<b>Course Code</b>	<b>UC7DCECHE401</b>					
<b>Course Level</b>	<b>400-499</b>					
<b>Course Summary</b>	This course covers the manufacture and applications of inorganic and organic chemicals, petroleum refining, industrial safety and pollution prevention.					
<b>Semester</b>	VII	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lectur	Tutoria	Practical	Others	

		e	l			
		4				60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the manufacture and uses of common inorganic and organic chemicals.	U	1,2
2	Describe various processes involved in petroleum refining.	U	1,2
3	Discuss safety aspects of the chemical industry.	U	1,2
4	Analyse various aspects of industrial pollution prevention.	An	1,2
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Inorganic Chemicals</b>			
	1.1	Manufacture and applications of sulphuric acid, phosphoric acid, lime, soda ash, titanium dioxide and sodium chloride.	7	
	1.2	Manufacture and uses of syn gas, nitrogen, oxygen, hydrogen and ammonia.	4	

	1.3	Production of potable water: break-point chlorination and ozonation, flocculation and sedimentation, filtration, removal of dissolved inorganic impurities, activated charcoal treatment. Production of deionized water. Production of freshwater from seawater and brackish water.	4	
2	<b>Petroleum Refining</b>			
	2.1	Primary raw materials for petrochemicals- natural gas, crude oil (composition, properties and classification), coal, oil shale, tar sand and gas hydrates.	5	
	2.2	Introduction to petroleum refining, desalting, distillation, hydrotreating or hydroprocessing, cracking or hydrocracking, coking, visbreaking, steam cracking, alkylation, catalytic reformers, removal of the natural gas fraction, sulfur recovery.	7	
	2.3	Hydrocarbon intermediates and liquid petroleum fractions, chemicals based on methane.	3	
3	<b>Organic Chemicals</b>			
	3.1	Manufacture and uses of methanol, formaldehyde, formic acid and hydrocyanic acid.	5	
	3.2	Manufacture and uses of ethylene, propene and acetylene.	3	
	3.3	Hydroformylation of olefins, industrial hydroformylation.	2	
	3.4	Manufacture and uses of ethanol, acetaldehyde and acetic acid.	3	
3.5	Chemicals based on benzene, toluene and xylenes.	2		
4	<b>Safety Considerations and Industrial Pollution Prevention</b>			
	4.1	OSHA (Occupational Safety and Health Administration) and PSM (Process Safety Management).	2	
	4.2	Types of hazards in industries: heat and temperature, pressure, electrical, and mechanical hazards, toxic materials, fire and explosion, radiation, noise and vibrations. risk management plan	6	
	4.3	Types of industrial wastes, public concern over pollution, legislation to waste management, industrial pollution prevention. Waste management: recycling, waste treatment and disposal.	7	

5	<b>Teacher Specific Content</b>
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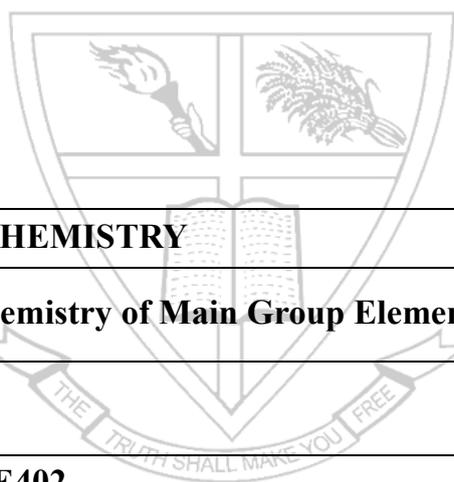
<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (mode of transaction)</b> Lecture Sessions, interactive sessions including discussions
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b>  <b>C. Continuous Comprehensive Assessment (CCA)</b> <b>Total marks : 30</b> Assignments MCQ Class test Viva
	<b>D. Semester end examination</b> <b>Total marks: 70- 2 hrs.</b> iv) Short answer 5 questions (out of 7): 5 X 4 =20 v) Short essay 5 questions (out of 7): 5 X 7 = 35 vi) Essay 1 question (out of 2): 1 X 15 = 15

### References

1. B. K. Sharma, *Industrial Chemistry Part 1 & 2*, Krishna Prakashan, 2023
2. J. A. Tyrell, *Fundamentals of Industrial Chemistry*, John Wiley & Sons, 2014.
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Est. in 1921



<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Advanced Chemistry of Main Group Elements</b>					
<b>Type of Course</b>	DCE					
<b>Course Code</b>	<b>UC7DCECHE402</b>					
<b>Course Level</b>	<b>400-499</b>					
<b>Course Summary</b>	This course explores the advanced aspects of properties and chemistry of main group elements.					
<b>Semester</b>	VII	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

## COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the advanced chemistry of main group elements.	U	1,2
2	Analyse the coordination and aqueous chemistry of group 1 and 2 metals.	An	1,2
3	Analyse the compounds and coordination complexes of group 13 and 14 elements.	An	1,2
4	Analyse the properties and chemistry of group 15 and 16 elements.	An	1,2
5	Compare the chemistry of halogens, and noble gases.	An	1, 2

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Group 1 and Group 2 Metals</b>			
	1.1	Aqueous solution chemistry of group 1 metal compounds, complex formation of group 1 metals with crown ethers, sandwich complexes with crown ethers, cryptates of group 1 metal ions, sodide ion in cryptates, alkalide ions of higher alkali metals, uses of alkali metal cryptands.	5	1,2
	1.2	Non-aqueous coordination chemistry of alkali metals. Zintl phases containing alkali metals. Compound formation with aromatic compounds, sodium and potassium alkyls.	4	1,2
	1.3	Complex ions of group 2 metals in aqueous solution, complexes of group 2 metal ions with EDTA, $[P_3O_{10}]^{5-}$ , crown ethers and cryptands. Complexes of group 2 metal ions with amido and alkoxy ligands.	6	1,2

<b>Group 13 and 14 Elements</b>				
<b>2</b>	2.1	Biological aspects of boron, toxicity of aluminium, aqua ions of Al, Ga, In and Tl, coordination complexes of $M^{3+}$ ions of Al, Ga and In. Metal borides- synthesis, structure and applications.	4	1, 3
		Zintl phases of group 13 elements. Spinel and tricalcium aluminate. Chalcogenides of Al, Ga, In and Tl.	4	1, 3
	2.2	Complexes containing a naked carbon atom, complexes containing naked dicarbon ligands. Carbides, silicides, germides, stannides and plumbides. Zintl ions containing Si, Ge, Sn and Pb. Polyatomic anions of Ge, Sn, and Pb. Sila- and germa-aromatic compounds.	7	1,3
<b>Group 15 and 16 Elements</b>				
<b>3</b>	3.1	Hydrogen azide and azide salts. Nitrides, phosphides, arsenides, antimonides and bismuthides. Organometallic compounds of arsenic, antimony, and bismuth. $\pi$ - Coordination complexes of phosphorus-carbon compounds.	7	1,4
	3.2	Polyanions and polycations of sulfur, selenium, and tellurium. Polysulfides, polyselenides and polytellurides. Compounds of sulfur and selenium with nitrogen.	4	1,4
	3.3	Allotropes of selenium and tellurium. Polyatomic cations and anions of selenium and tellurium. Biological aspects of oxygen, sulphur and selenium.	4	1,4
<b>Group 17 and 18 Elements</b>				
<b>4</b>	4.1	Industrial extraction of fluorine, fluoridation of water. Polyhalogen cations, polyhalide anions, oxofluorides of chlorine, bromine and iodine.	4	1,5
	4.2	Aqueous solution chemistry of chlorine, bromine and iodine. Biological aspects of fluorine, chlorine, bromine and iodine. Chemistry of astatine.	4	1,5
	4.3	Chemistry and uses of helium. Synthesis, structure and reactions of xenon insertion compounds, organoxenon compounds and compounds containing metal-xenon bonds.	4	1,5
	4.4	Compounds of argon, krypton and radon and coordination compounds of noble gases. Biological aspects of noble gases.	3	1,5

<b>5</b>	<b>Teacher Specific Content</b>
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<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>E. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Total marks : 30</b></p> <p>Assignments</p> <p>MCQ</p> <p>Class test</p> <p>Viva</p>
	<p><b>F. Semester end examination</b></p> <p><b>G. Total Marks ; 70- 2hrs.</b></p> <p>i) Short answer 5 questions (out of 7): 5 X 4 =20</p> <p>ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>iii) Essay 1 question (out of 2): 1 X 15 = 15</p>

### References

1. E. Housecroft, A. G. Sharpe, *Inorganic Chemistry*, 5<sup>th</sup> Edn., Pearson, 2018.
2. D. Shriver, M. Weller, T. Overton, J. Rourke, F. Amstrong, *Inorganic Chemistry*, 7<sup>th</sup> Edn., Oxford University Press, 2018.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Statistical Thermodynamics and Bioenergetics</b>					
<b>Type of Course</b>	DSE					
<b>Course Code</b>	<b>UC7DCECHE403</b>					
<b>Course Level</b>	<b>400-499</b>					
<b>Course Summary</b>	This course covers the principles of statistical thermodynamics and applications of thermodynamics and statistical thermodynamics to various biological processes.					
<b>Semester</b>	VII	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

## COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the basic principles of statistical thermodynamics.	U	1,2,3
2	Apply the principles of statistical thermodynamics to biological processes.	A	1,2,3
3	Analyse the energy changes associated with various biological processes.	An	1,2,3
4	Apply the principles of thermodynamics to various biological processes.	An	1,2,3

*\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Statistical Thermodynamics -1</b>			
	1.1	Probability, Stirling's approximation, macrostates and microstates, ensemble, types of ensembles.	3	1
	1.2	Boltzmann distribution law, partition function and its physical significance, relation between molecular partition function and molar partition function, distinguishable and indistinguishable particles, partition function and thermodynamic functions, separation of partition function-translational, rotational, vibrational, and electronic partition functions. The equipartition theorem.	7	1
	1.3	Thermodynamic properties: internal energy, heat capacity, entropy, enthalpy and Gibbs free energy. Statistical basis of chemical equilibrium.	5	1
2	<b>Statistical Thermodynamics -2</b>			

	2.1	Need for quantum statistics, bosons and fermions, Bose-Einstein statistics:, Bose-Einstein distribution law, Bose-Einstein condensation, first order and higher order phase transitions, liquid helium, Fermi- Dirac statistics:, Fermi- Dirac distribution law, application in electron gas, thermionic emission. Comparison of three statistics.	10	1
	2.2	Applications of statistical mechanics to biological processes: helix–coil Transitions, cooperative transitions, internal energy and heat capacity of biological macromolecules, protein heat capacity functions.	5	2
	<b>Bioenergetics</b>			
3	3.1	Bioenergetics, standard free changes in biochemical reactions, coupled reactions, ATP and its role in bioenergetics, high energy bond, free energy and entropy change in ATP hydrolysis.	8	3
	3.2	Thermodynamics of synthesis of ATP, thermodynamic aspects of metabolism and respiration, glycolysis, biological redox reactions and citric acid cycle.	7	3
	<b>Thermodynamic Aspects of Biological Processes</b>			
4	4.1	Thermodynamic aspects of photosynthesis, osmosis, dialysis, enzyme-substrate interactions, binding of oxygen to myoglobin and haemoglobin, cooperativity, allostery and proton binding by biomolecules.	8	4
	4.2	Thermodynamic aspects of transport of ions across biological membranes, biosynthesis of proteins, buffer action in blood, protein structure, mechanisms of protein folding and unfolding and DNA melting.	7	4
5	<b>Teacher Specific Content</b>			
<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (mode of transaction)</b> Lecture sessions, interactive sessions including discussions			
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>Continuous Comprehensive Assessment (CCA)</b> <b>Total marks: 30</b> Assignments			

	MCQ Class test Viva
	<p align="center"><b>Semester end examination</b></p> <p align="center"><b>Total Marks: 70- 2hrs.</b></p> iv) Short answer 5 questions (out of 7): 5 X 4 =20 v) Short essay 5 questions (out of 7): 5 X 7 = 35 vi) Essay 1 question (out of 2): 1 X 15 = 15

## References

1. D. T. Haynie, *Biological Thermodynamics*, 2<sup>nd</sup> Edn. Cambridge University Press, 2008.
2. G. G. Hammes, S. H. Schiffer, *Physical Chemistry for the Biological Sciences*, Wiley, 2015.
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5. L.K. Nash, *Elements of Classical and Statistical Mechanics*, 2<sup>nd</sup> Edn. Dover Books, 2006.
6. M.C. Gupta, *Statistical Thermodynamics*, New age international, 2007.
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10. P. S. Kalsi, N. Mahanta, *Biophysical Chemistry*, 2<sup>nd</sup> Edn. New Academic Science Limited, 2014.
11. T. Engel, P. Reid, *Thermodynamics, Statistical Thermodynamics & Kinetics*, 3<sup>rd</sup> Edn. Pearson, 2013.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Novel Inorganic Solids</b>
<b>Type of Course</b>	DCE
<b>Course Code</b>	MG7DCECHE404
<b>Course Level</b>	<b>400-499</b>

<b>Course Summary</b>	This course covers the synthetic route to novel inorganic solids, properties and applications of inorganic nanomaterials, engineering materials, composite materials and speciality polymers.					
<b>Semester</b>	VII	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

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### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe different types of novel solids.	U	1,2
2	Discuss synthetic methods of inorganic solids.	U	1,2
3	Explain the synthesis, properties and applications of novel inorganic nanomaterials.	U	1,2
4	Analyse various inorganic engineering materials and composite materials.	An	1,2
5	Describe the synthesis, properties and applications of inorganic polymers.	U	1, 2
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	<b>Types of Novel Inorganic Solids and Synthetic Methods</b>			
<b>1</b>	1.1	Solid electrolytes – cationic, anionic and mixed. Inorganic pigments – coloured solids. Molecular material and fullerides, one-dimensional metals, molecular magnets, inorganic liquid crystals.	7	1
	1.2	Synthetic methods: conventional heat and beat methods, co-precipitation, sol-gel, chemical vapour deposition, ceramic, alloying, hydrothermal, electrochemical and intercalation methods. Microwave synthesis.	8	2
	<b>Nanomaterials</b>			
<b>2</b>	2.1	Metal oxide nanostructures: synthesis-sol-gel and electrochemical deposition, applications in photovoltaics, lithium ion batteries, catalysis, gas sensing and biomedical applications.	4	3
	2.2	Magnetic nanomaterials for energy storage: synthesis-co-precipitation and chemical oxidation, applications of Fe <sub>2</sub> O <sub>3</sub> and Fe <sub>3</sub> O <sub>4</sub> nanomaterials for energy storage.	4	3
	2.3	Transition metal dichalcogenide nanomaterials: Synthesis- chemical vapour deposition, doping, applications in electronics, photonics and gas sensing.	3	3
	2.4	Inorganic nanotubes: general synthetic methods- sol-gel and hydrothermal methods, applications.	2	3
	2.5	Inorganic nanowires: synthesis-vapour phase growth, properties and applications.	2	3
	<b>Engineering Materials for Mechanical Construction and Composite Materials</b>			
<b>3</b>	3.1	Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes, cutting tool materials, super alloys, thermoplastics, thermosets and composite materials.	7	4
	3.2	Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.	8	4

<b>Speciality Polymers</b>				
<b>4</b>	4.1	Pre-ceramic inorganic polymers: carbon Fiber, silicon carbide (SiC), silicon nitride (Si <sub>3</sub> N <sub>4</sub> ), boron nitride (BN), boron carbide (B <sub>4</sub> C), aluminum nitride (AlN), phosphorus nitride. Poly(ferrocenylsilanes) as ceramic precursors.	8	5
	4.2	Sulfur-based inorganic polymers: polythiazyl and polythiol.	3	5
	4.3	Ferrocene based polymers: synthetic methods, Fc-based polypyrrole and cyclodextrin- synthesis and applications.	4	5
<b>5</b>	<b>Teacher Specific Content</b>			

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<b>Teaching and Learning Approach</b>	<p style="text-align: center;"><b>Classroom Procedure (Mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions</p>
<b>Assessment Types</b>	<p style="text-align: center;"><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>Continuous Comprehensive Assessment (CCA)</b></p> <p style="text-align: center;"><b>Total marks: 30</b></p> <p>Assignments</p> <p>MCQ</p> <p>Class test</p> <p>Viva</p>
	<p style="text-align: center;"><b>Semester end examination</b></p> <p style="text-align: center;"><b>Total Marks : 70- 2 hrs.</b></p> <p>vii) Short answer 5 questions (out of 7): 5 X 4 =20</p> <p>viii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>ix) Essay 1 question (out of 2): 1 X 15 = 15</p>

## References

1. B. D. Fahlman, *Material Chemistry*, Springer, 2018.
2. B. Sharma, C. K. Sarkar, *Advanced Nanomaterials and Their Applications*, CRC Press, 2024.
3. C M. Lukehart, *Nanomaterials: Inorganic and Bioinorganic perspectives*, John Wiley & Sons Ltd, 2008.
4. C. N. R. Rao, A. Muller, A. K. Cheetham, *The Chemistry of Nanomaterials*, Wiley, 2004.
5. D. M. Adam, *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*, Wiley–Blackwell, 1974.
6. D. Sangeeta, J. R. LaGraff, *Inorganic Materials Chemistry Desk Reference*, CRC Press, 2005.
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8. J. N. Lalena, D. A. Cleary, E. E. Carpenter, N. F. Dean, *Inorganic materials synthesis and fabrication*, John Wiley & Sons, 2008.
9. M. A. Benvenuto, *Metals and Alloys*, de Gruyter, 2016.
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12. P. W. Alkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, *Inorganic Chemistry*, 5<sup>th</sup> Edn. Oxford University Press, 2012.
13. S. M. Bhagyaraj, O. S. Oluwafemi, K. Nandakumar, S. Thomas, *Synthesis of Inorganic Nanomaterials*, Elsevier, 2018.
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15. W. D. Callister Jr., *Fundamentals of Materials Science and Engineering*, Wiley, 2001.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>			
<b>Course</b>	<b>Analytical Chemistry</b>			
<b>Type of Course</b>	DSE			
<b>Course</b>	UC7DSECHE400			
<b>Course</b>	<b>300-399</b>			
<b>Course Summary</b>	This course covers the fundamentals of analytical chemistry and discusses topics such as precision, accuracy and errors. Additionally, it encompasses qualitative analysis techniques, safety protocols, titrimetric analysis, and the principles and applications of chromatography.			
<b>Semester</b>	VII	Credits	4	Total

Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Hours
		4		0		60
Pre-requisites, if						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain fundamental measurement concepts, and errors in analytical chemistry.	U	1, 2,3,10
2	Develop safe laboratory methods of chemical analysis.	An	1,2,3
3	Develop a comprehensive knowledge of titrimetric analysis including redox titrations, complexometric titrations, conductometric titrations and	A	1, 2,3
4	Apply the principles of gravimetric analysis.	A	1, 2,3
5	Analyse various separation and purification techniques of compounds.	An	1, 2,3
6	Distinguish between different chromatographic methods based on their principle and mechanism.	An	1, 2,3,10
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO
1		Introduction		

	1.1	The role of analytical chemistry, qualitative and quantitative analysis, general features of a typical quantitative analysis- choosing a method, acquiring the sample, processing the sample, eliminating interferences, calibration and measurement, calculation and evaluation of results. Case study illustrating the use of analytical chemistry to solve a problem.	6	1
	1.2	Calculations used in analytical chemistry: units of measurement- mass and weight, the mole, concentrations of solutions, p-functions, density and specific gravity. Chemical stoichiometry and stoichiometric calculations.	5	1
	1.3	Errors in chemical analysis: mean and median, precision and accuracy, absolute error and relative error. Random, systematic and gross errors. Sources and effects of systematic errors. Minimising systematic errors.	4	1
	<b>Chemicals apparatus and unit operations of analytical chemistry</b>			
2	2.1	Selecting and handling reagents and other chemicals.	2	2
	2.2	Cleaning and marking of laboratory ware.	2	2
	2.3	Evaporating liquids, measuring mass, equipment and manipulations associated with weighing, measuring volume, calibrating volumetric glassware.	3	2
	2.4	The laboratory notebook.	1	2
	2.5	Sampling, standardization, and calibration.	4	2
	2.6	Safety in the laboratory- the four principles of safety, personal protective equipment: eye protection, lab coat, shoes and long pants, gloves, respiratory protection and masks, hair, lead apron and shields.	3	2
3	<b>Titrimetric and Gravimetric Analysis</b>			

	3.1	Titrimetric analysis – basic concepts of redox reactions, redox titrations involving $\text{KMnO}_4$ , and $\text{K}_2\text{Cr}_2\text{O}_7$ , titration curves, redox indicators.	4	3
	3.2	Complexometric titrations – direct, indirect, back and replacement titrations, EDTA titrations. Precipitation titrations - methods of argentometric titration-indicators.	6	3
	3.3	Conductometric and potentiometric titrations – principle, examples and graphical representation.	2	3
	3.4	Gravimetric analysis: unit operations in gravimetric analysis - illustrations using iron and barium estimation.	3	4
	<b>Separation and Purification of compounds</b>			
	4.1	Separation and purification techniques: filtration, recrystallization, precipitation, distillation, fractional distillation, solvent extraction and sublimation.	4	5
	4.2	Chromatography- principle and classification. Chromatographic techniques: paper chromatography, thin layer chromatography, $R_f$ -values.	3	6
	4.3	Principle and applications of column chromatography, high-performance liquid chromatography (HPLC), gas chromatography, gel permeation chromatography (GPC), ion exchange chromatography, and reverse phase chromatography.	8	6
<b>5</b>	<b>Teacher Specific content</b>			

<b>Teaching and Learning Approach</b>	<p style="text-align: center;"><b>Classroom Procedure (Mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Demonstration of experiments</li> </ul>
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	<ul style="list-style-type: none"> <li>● Hands-on training</li> </ul>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Total marks: 30</b></p> <p>Assignments</p> <p>MCQ</p> <p>Class test</p> <p>Viva</p>
	<p><b>Semester end examination</b></p> <p><b>Total Marks : 70- 2 hrs.</b></p> <p>i) Short answer 5 questions (out of 7): <math>5 \times 4 = 20</math></p> <p>ii) Short essay 5 questions (out of 7): <math>5 \times 7 = 35</math></p> <p>iii) Essay 1 question (out of 2): <math>1 \times 15 = 15</math></p>

### References

1. A. Gupta, *Analytical Chemistry*, Pragati Prakashan, 2020.
2. A. Lee, *Scientific Endeavor*, Addison Wesley Longman, 2016.
3. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry* 9<sup>th</sup> Edn. Cengage Learning, 2013.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Biophysical Chemistry</b>					
<b>Type of Course</b>	DSE					
<b>Course Code</b>	UC7DSECHE401					
<b>Course Level</b>	<b>300-399</b>					
<b>Course Summary</b>	This course explores how the principles of thermodynamics, chemical equilibrium, chemical kinetics and quantum mechanics are applied to biological processes.					
<b>Semester</b>	VII	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Apply the principles of thermodynamics to life processes	A	1,2
2	Analyse biological equilibrium processes.	An	1,2
3	Examine kinetic aspects of biological processes.	An	1,2
4	Apply the principles of quantum mechanics to simple chemical and biological systems	A	1,2
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

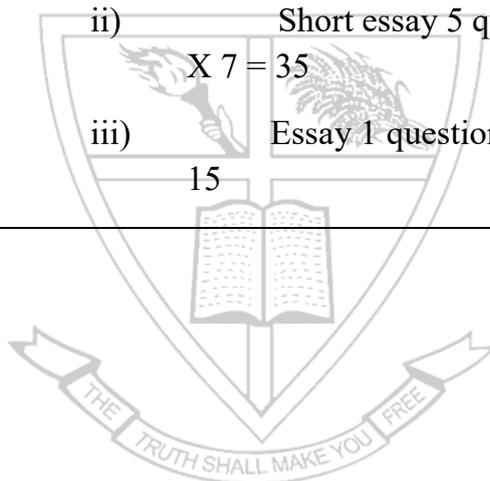
### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Thermodynamics</b>			
	1.1	Work, heat, internal energy, enthalpy, heat capacity. The first law of thermodynamics. The enthalpy of phase transition- case study- thermal denaturation of a protein.	5	1
	1.2	The second law of thermodynamics, entropy and entropy change. Entropy change and life. The Third Law of thermodynamics.	4	1
	1.3	Spontaneity and Gibbs free energy. Free energy as maximum work. Proteins- primary, secondary, tertiary and quaternary structures. Gibbs energy change of protein assembly. Basic idea of metabolism and free energy changes of metabolic cycles.	6	1
2	<b>Equilibrium</b>			
	2.1	Molar free energy of reaction. Reactions at equilibrium and Gibbs free energy change. Relationship between the Gibbs energy and equilibrium constant. Acid–base equilibria. Catalysts and equilibrium	6	2
	2.2	Temperature and equilibrium, coupled reactions. Active transport. Binding of oxygen to myoglobin and haemoglobin- thermodynamic aspects, cooperativity and allosteric effect. Standard Gibbs energy of formation and calculation of standard reaction Gibbs energy.	9	2
3	<b>Chemical Kinetics</b>			

	3.1	Rate of reaction, rate laws and rate constants, order of a reaction, first order and second order reactions. The temperature dependence of reaction rates- the Arrhenius equation and Arrhenius parameters. Reaction rates near equilibrium.	7	3
	3.2	Enzymes as biological catalysts- substrate binding, active site and lock and key principle. Enzyme catalysis: the Michaelis–Menten mechanism. The catalytic efficiency of enzymes. Enzyme inhibition. Pharmacokinetics. Fast events in protein folding.	8	3
<b>4</b>	<b>Quantum Mechanics</b>			
	4.1	Basics of quantum mechanics, electromagnetic radiation, wave properties of matter, quantization of energy and fundamentals of spectroscopy. Types of spectroscopy. The uncertainty principle.	7	4
	4.2	The particle in a box- the electronic structure of $\beta$ -carotene. Quantum mechanical tunnelling- Scanning probe microscopy (STM and AFM). Particle on a ring- the electronic structure of phenylalanine.	8	4
<b>5</b>	<b>Teacher Specific content</b>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <p>Lecture sessions, interactive sessions including discussions</p>
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<b>Assessment Types</b>	<p style="text-align: center;"><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>Continuous Comprehensive Assessment (CCA)</b></p> <p style="text-align: center;"><b>Total marks: 30</b></p> <p>Assignments</p> <p>MCQ</p> <p>Class test</p>
	<p style="text-align: center;"><b>Semester end examination</b></p> <p style="text-align: center;"><b>Total Marks : 70- 2 hrs.</b></p> <p style="text-align: center;">i) Short answer 5 questions (out of 7): 5 X 4 = 20</p> <p style="text-align: center;">ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p style="text-align: center;">iii) Essay 1 question (out of 2): 1 X 15 = 15</p>



## References

1. A. Cooper, *Biophysical Chemistry*, RSC, 2004.
2. D. T. Haynie, *Biological Thermodynamics*, 2<sup>nd</sup> Edn. Cambridge University Press, 2008.
3. G. G. Hammes, S. H. Schiffer, *Physical Chemistry for the Biological Sciences*, Wiley, 2015.
4. G. G. Hammes, *Thermodynamics and kinetics for the biological sciences*, Wiley, 2000.
5. J. L. Burgot, *Thermodynamics in Bioenergetics*, CRC Press, 2020.
6. J. P. Allen, *Biophysical Chemistry*, Blackwell Publishing, 2008.
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8. P. Atkins, J. Paula, *Physical Chemistry for the Life Sciences*, Oxford University Press, 2006.

9. P. Nelson, *Biological Physics: Energy, Information, Life*, www.physics.upenn.edu/~pcn/, 2002.
10. P. R. Bergethon, *The Physical Basis of Biochemistry*, 2<sup>nd</sup> Edn. Springer, 2010.
11. P. S. Kalsi, N. Mahanta, *Biophysical Chemistry*, 2<sup>nd</sup> Edn. New Academic Science Limited, 2014.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>				
<b>Course Name</b>	<b>Nanochemistry and Technology</b>				
<b>Type of Course</b>	DSE				
<b>Course Code</b>	UC7DSECHE402				
<b>Course Level</b>	<b>300-399</b>				
<b>Course Summary</b>	This course explores fundamental concepts of nanotechnology covering synthesis, characterisation, properties and applications of				
<b>Semester</b>	VII	Credits			Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others
		3		1	
<b>Pre-requisites, if any</b>					

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the fundamental concepts of	U	1,2
2	Compare bottom-up and top-down approaches in nanomaterial synthesis.	C	1,2
3	Describe various characterisation techniques of nanomaterials.	An	1,2

4	Explain the properties of different types of nanomaterials.	U	1,2
5	Analyse the applications of nanomaterials in various fields.	An	1,2,3,10
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
<b>Introduction</b>				
<b>1</b>	1.1	Feynman's hypothesis- scales of nanosystems- Moore's law.	2	1
	1.2	Different types of nanomaterials. Classification of nanomaterials based on dimensions and origin.	3	1
	1.3	Nano in nature: lotus-leaf effect, Gecko's feet, butterfly wings, and magneto-tactic bacteria.	2	1
	1.4	Bottom-up techniques for the synthesis of nanomaterials: chemical vapour deposition, reduction techniques, solvothermal, sonochemical, biomimetic, molecular self-assembly and sol-gel methods.	4	2
	1.5	Top-down techniques: mechano-chemical, laser ablation, arc-discharge, sputtering, etching, lithography and electrospinning methods.	4	2
<b>Characterisation of Nanomaterials</b>				
<b>2</b>	2.1	Imaging through electron microscopy: interaction of electron beam with sample. Scanning electron microscope and transmission electron microscope-	4	3

		comparison, advantages, applications and basic instrumental features.		
	2.2	Scanning probe microscopy: scanning tunneling microscope and atomic force microscope- comparison, applications and basic instrumental features.	4	3
	2.3	Characterisation through spectroscopy: UV-visible, IR, X-ray photoelectron and Auger electron spectroscopy. Secondary ion mass spectrometry. X-ray diffraction, dynamic light scattering and zeta potential analysis methods.	7	3
	<b>Properties of Nanomaterials</b>			
<b>3</b>	3.1	Size effects: quantum confinement, the density of states and high surface area.	2	4
	3.2	Thermal properties: surface energy, thermal conductivity and melting of nanomaterials.	3	4
	3.3	Electronic and electrical properties: one dimensional conduction-ballistic conduction, the Coulomb blockade effect, the electron density of states and superconductivity.	4	4
	3.4	Magnetic properties: giant magnetoresistance, finite-size effects and surface effects.	3	4
	3.5	Optical properties: colour of quantum dots, surface plasmon resonance and quantum fluorescence.	3	4
<b>4</b>	<b>Applications of Nanoparticles</b>			

	4.1	Medicine and healthcare: applications of nanomaterials in medical diagnosis, advanced drug delivery systems, targeted drug delivery and therapy.	4	5
	4.2	Applications of nanotechnology in integrated circuits, data storage and displays.	2	5
	4.3	Applications of nanotechnology in water purification and air pollution control.	2	5
	4.4	Piezoelectric nanomaterials, hydrogen generation and storage, batteries and solar energy harvesting.	2	5
	4.5	Chemical and biosensors using nanomaterials and defence applications of nanotechnology.	2	5
	4.6	Applications of grapheme, carbon nanotubes and fullerenes.	3	5
<b>5</b>	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (Mode of transaction)</b></p> <ul style="list-style-type: none"> <li>· Interactive instruction (chalk &amp; board method, multimedia presentation)</li> <li>· Group discussion</li> <li>· Peer teaching</li> <li>· Experimental demonstrations</li> <li>· Practical training</li> </ul>
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<b>Assessment Types</b>	<p style="text-align: center;"><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>Continuous Comprehensive Assessment (Total 30 marks)</b></p> <p style="text-align: center;"><b>Total marks: 30</b></p> <p>Assignments</p> <p>MCQ</p> <p>Class test</p> <p>Viva</p>
	<p style="text-align: center;"><b>Semester end examination</b></p> <p style="text-align: center;"><b>Total marks : 70- 2hrs.</b></p> <p>i) Short answer 5 questions (out of 7): 5 X 4 =20</p> <p>ii) Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>iii) Essay 1 question (out of 2): 1 X 15 = 15</p>

### References

1. A. Sengupta, C. K. Sarkar, *Introduction to Nano: Basics to Nanoscience and Nanotechnology*; Springer Berlin Heidelberg, 2015.
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## SEMESTER 8

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course</b>	<b>Advanced Coordination and Organometallic Chemistry</b>
<b>Type of</b>	DCC
<b>Course Code</b>	<b>UC8DCCCHE400</b>
<b>Course Level</b>	<b>400-499</b>
<b>Course Summary</b>	This course offers a comprehensive exploration of advanced topics in inorganic chemistry, covering magnetic properties, substitution mechanisms,

	organometallic catalysis including asymmetric catalysis, practical gravimetric analysis, and the separation and identification of cation mixtures.					
<b>Semester</b>	VIII	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
<b>Pre-requisites, if any</b>		<b>Basic Knowledge in Coordination and Organometallic Chemistry</b>				
		2		2		90

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Analyse and explain the magnetic properties of coordination complexes.	An	1,2
2	Evaluate the kinetics and mechanism of ligand substitution reactions in coordination complexes.	E	1,2
3	Analyse the applications of organometallic compounds in organic synthesis and catalysis.	An	1,2
4	Explain the properties and utility of polyferrocenylsilanes.	U	1,2
5	Apply gravimetric analysis techniques in estimating metal ions, including nickel (II), copper, iron, and aluminum.	A	1,2
6	Apply qualitative analysis techniques to distinguish and confirm the presence of specific cations, showcasing a comprehensive understanding of cation separation.	A	1,2
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Magnetic Properties and Ligand Substitution Mechanisms in Coordination Complexes</b>			
	1.1	Magnetic properties of complexes - paramagnetic and diamagnetic complexes, molar susceptibility, Gouy method for the determination of magnetic moment of complexes, spin only magnetic moment.	3	1
	1.2	Temperature dependence of magnetism- Curie's law, Curie-Weiss law, temperature independent paramagnetism (TIP).	2	1
	1.3	Kinetics and mechanism of octahedral substitution-water exchange, dissociative, associative and interchange mechanisms, acid hydrolysis, base hydrolysis, SN <sub>1cB</sub> mechanism.	4	2
	1.4	Electron transfer reactions: outer sphere mechanism – Marcus' theory, inner sphere mechanism- Taube mechanism, mixed outer and inner sphere reactions, two electron transfer and intramolecular electron transfer.	4	2
	1.5	$\Delta$ and $\Lambda$ isomers, linkage isomerism: electronic and steric factors affecting linkage isomerism.	2	2
2	<b>Organometallic Homogeneous Catalysis &amp; Asymmetric versions</b>			
	2.1	Organometallic reagents in organic synthesis – Petasis, Schwartz reagents for organic transformations. Reppe reaction, Dötz reaction	4	3
	2.2	Hydrogenation reactions- H <sub>2</sub> hydrogenation and isopropanol transfer hydrogenations catalyzed by Ru(II) complexes, ionic hydrogenation, hydrosilylation	3	3
	2.3	Asymmetric catalysis- chiral phosphine ligands (structure only) - P-chiral ligands, BINAP, DIOP, ferrocene based ligands - Josiphos, asymmetric hydrogenation, Noyori hydrogenations, Shvo catalyst, transfer hydrogenation of ketones and imines, metal-ligand bifunctional catalysis-cooperative effect.	5	3
	2.4	Preparation of L-DOPA drug, Matalachlor herbicide	1	3

	2.5	Organometallic polymers: synthesis, properties and applications of polyferrocenylsilanes.	2	4
<b>Inorganic Practical -4</b>				
3		<b>Part-1</b> <b>Gravimetric Analysis:</b> i. Estimation of nickel (II) using dimethylglyoxime (DMG). ii. Estimation of copper as CuSCN iii. Estimation of iron as Fe <sub>2</sub> O <sub>3</sub> by precipitating iron as Fe(OH) <sub>3</sub> . iv. Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine) <sub>3</sub> (aluminium oxinate).	30	5
4		<b>Part-2</b> Separation and identification of a mixture of four cations (a mixture of two familiar ions such as Ag <sup>+</sup> , Hg <sup>2+</sup> , Pb <sup>2+</sup> , Cu <sup>2+</sup> , Bi <sup>2+</sup> , Cd <sup>2+</sup> , As <sup>3+</sup> , Sn <sup>2+</sup> , Sb <sup>3+</sup> , Fe <sup>2+</sup> , Fe <sup>3+</sup> , Al <sup>3+</sup> , Cr <sup>3+</sup> , Zn <sup>2+</sup> , Mn <sup>2+</sup> , Co <sup>2+</sup> , Ni <sup>2+</sup> , Ca <sup>2+</sup> , Sr <sup>2+</sup> , Ba <sup>2+</sup> , Mg <sup>2+</sup> , Li <sup>+</sup> , Na <sup>+</sup> , K <sup>+</sup> and NH <sub>4</sub> <sup>+</sup> and two less familiar metal ions such as Tl, W, Se, Mo, Ce, Th, Ti, Zr, V, U and Li). Minimum four mixtures to be given.	30	6
5	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer teaching</li> <li>● Demonstration of experiments</li> <li>● Hands-on training</li> </ul>
<b>Assessment Types</b>	<b>Mode of Assessment</b>  <b>A. Continuous Comprehensive Assessment</b>  <b>Theory: 15 marks</b>  Quiz  Theory: Test for each unit (MCQ/Written)

	<p align="center"><b>Practical: 15 marks</b></p> <p>Lab involvement/report /Lab test</p>
	<p align="center"><b>B. Semester-end Examination</b></p> <p>Theory: Written examination (35 Marks) – 1 hr.</p> <p>i) Short answer 5 questions (out of 7): 5 X 3 = 15 marks</p> <p>ii) Short Essay 2 questions (out of 3) : 2 X 10 = 20 marks</p> <p><b>Practical: Certified report + procedure + viva voce (10+15+10=35 Marks) - 1 hr.</b></p>

### References

1. Astruc, D., *Organometallic Chemistry and Catalysis*, Springer Verlag, 2007.
2. B.D. Gupta, A.J Elias, *Basic Organometallic Chemistry*, Universities Press, 2010.
3. B.E. Douglas, D.H. McDaniel, J. J. Alexander, *Concepts and Models of Inorganic Chemistry*, 3<sup>rd</sup> Edn. Wiley-India, 2007.
4. Catherine E. Housecroft, Alan G. Sharpe C. E. Barnes, *Inorganic Chemistry* 4<sup>th</sup> Edn. Journal of Chemical Education, 2003.
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6. J. G. de Vries, C. J. Elsevier, *Handbook of Homogeneous Hydrogenations*, 3 Volumes, Wiley-VCH, 2006.
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9. P. Powell, *Principles of Organometallic Chemistry*, 2<sup>nd</sup> Edn. Chapman and Hall, 1988.
10. Robert H. Crabtree, *The Organometallic Chemistry of the Transition Metals*, 4<sup>th</sup> Edn. Wiley Interscience, 2005.
11. Sumit Bhaduri, Doble Mukesh, *Homogeneous Catalysis: Mechanism and Industrial Applications*, Wiley Interscience, 2000.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>
<b>Course Name</b>	<b>Physical Chemistry- 4</b>
<b>Type of Course</b>	<b>DCC</b>

<b>Course Code</b>	UC8DCCCHE401					
<b>Course Level</b>	400-499					
<b>Course Summary</b>	This course covers advanced aspects of kinetic theory of gases, chemical kinetics, surface chemistry and physical chemistry practicals.					
<b>Semester</b>	VIII	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	<b>Learning Approach</b>	<b>Lecture</b>	<b>Tutorial</b>	<b>Practical</b>	<b>Others</b>	
		2		2		90
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Explain the molecular velocities of gases, mean free path, collision diameter and effusion.	U	1.2
2	Illustrate the theories of reaction rates and correlate the thermodynamically measurable parameters.	A	1.2
3	Compare the nature of reactions in the gas as well as in the solvent phase.	An	1.2
4	Assess the theories and applications of adsorption with the help of adsorption isotherms.	E	1.2
5	Explain different methods for the molar mass determination of macromolecules.	U	1.2
6	Experiment with three component systems, kinetics, polarimetry and refractometry practicals.	A,S	1,2,9,10

**\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
<b>UNIT 1: KINETIC THEORY OF GASES (10 HRS)</b>				
<b>1</b>	1.1	Derivation of Maxwell's law of distribution of velocities, graphical representation, experimental verification of the law, most probable velocity, derivation of average, RMS and most probable velocities.	5	1
	1.2	Collision diameter, collision frequency in a single gas and in a mixture of two gases, mean free path, frequency of collision, effusion, the rate of effusion, time dependence of pressure of an effusing gas, the law of corresponding states, transport properties of gases.	5	1
<b>UNIT 2: CHEMICAL KINETICS: (10 HRS)</b>				
<b>2</b>	2.1	Theories of reaction rates: potential energy surfaces. Conventional transition state theory, comparison of the collision theory and conventional transition state theories.	4	2
	2.2	Thermodynamic formulation of the reaction rate- Eyring equation. Significance of $\Delta G^\ddagger$ , $\Delta H^\ddagger$ and $\Delta S^\ddagger$ , volume of activation. Effect of pressure and volume on velocity of gaseous reactions. Reactions in solution: Effect of solvent on reaction rate, cage effect. Effect of dielectric constant and ionic strength on reaction rate - Bronsted-Bjerrum equation.	6	2,3
<b>UNIT 3: SURFACE CHEMISTRY (10 HRS)</b>				
<b>3</b>	3.1	Multilayer adsorption-BET theory, use of BET isotherms for surface area determination.	3	4
	3.2	Application of Langmuir adsorption isotherm in surface catalysed reactions,	7	4,5

	<p>the Eley-Rideal mechanism and the Langmuir-Hinshelwood mechanism, flash desorption.</p> <p>Macromolecules: Different averages, methods of molecular mass determination - osmotic, viscosity, sedimentation and light scattering methods.</p>		
<b>Physical Chemistry IV- Practicals</b>			
<b>4</b>	1. Construction of phase diagram of three component system with one pair of partially miscible liquids.	<b>60</b>	6
	2. Kinetics of simple reactions e.g. acid hydrolysis of methyl /ethyl acetate.		6
	3. Kinetics of reaction between $K_2S_2O_8$ and KI.		6
	4. Data analysis of kinetic experiments using spreadsheet program (determination of rate constant).		6
	5. Polarimetry: <ul style="list-style-type: none"> <li>● Kinetics of the inversion of sucrose in presence of HCl.</li> <li>● Determination of the concentration of a sugar solution.</li> <li>● Determination of the concentration of HCl.</li> <li>● Determination of the relative strength of acids.</li> </ul>		6
	6. Refractometry: <ul style="list-style-type: none"> <li>● Identification of pure organic liquids and oils.</li> <li>● Determination of molar refractions of pure liquids.</li> <li>● Determination of concentration of solutions (KCl-water, glycerol—water).</li> <li>● Determination of molar refraction of solids.</li> <li>● Study of complex formation between potassium iodide and mercuric iodide system.</li> </ul>		6
<b>5</b>	<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture sessions (chalk &amp; board, powerpoint presentation)</li> <li>● Interactive sessions and simulations</li> <li>● Visual aids like videos and models to enhance understanding</li> <li>● Peer discussions</li> <li>● Laboratory experiments and hands-on training</li> </ul>
<b>Assessment Types</b>	<b>Mode of Assessment</b> <p style="text-align: center;"><b>A. Continuous Comprehensive Assessment</b></p> <p><b>Theory: 15 marks</b></p> <p>Assignment /Quiz /Theory: Test for each unit (MCQ/Written)</p> <p><b>Practical: 15 marks</b></p> <p>Lab involvement/report /Lab test</p> <hr/> <p style="text-align: center;"><b>B. Semester-end examination</b></p> <p><b>Theory: Written examination (35 Marks)- 1 hr.</b></p> <p>Short answer 5 questions (out of 7): 5 X 3 = 15 marks  Short Essay 2 questions (out of 3) : 2 X 10 = 20 marks</p> <p><b>Practical: Certified report + procedure + viva voce (10+5+20=35 Marks)- 1 hr.</b></p>

### References

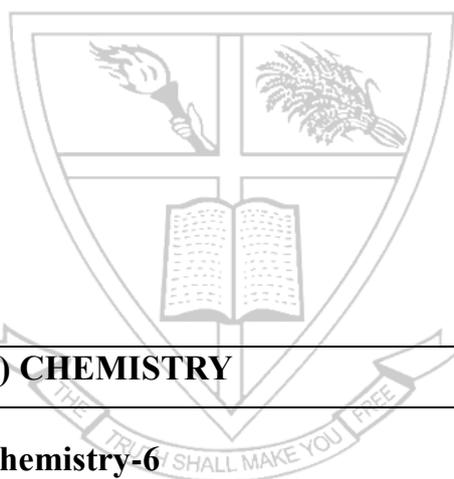
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6. P. Atkins and J Paula, *The elements of Physical chemistry*, 7<sup>th</sup> Edn. Oxford University Press, 2017.
7. Puri, Sharma and Pathania, *Principles of Physical Chemistry*, 48<sup>th</sup> Edition, Vishal Publishing Company, 2020.

8. R. P. Rastogi, R. R. Misra, *An Introduction to Chemical Thermodynamics*, 6<sup>th</sup> Edn. Vikas Pub. Pvt. Ltd., 2003.

### Suggested Readings

1. J. Rajaram, J. C. Kuriakose, *Chemical thermodynamics: classical, statistical and irreversible*, Dorling Kindersley (India), 2013.
2. P W Atkins, *Physical Chemistry*, Oxford University Press, 12<sup>th</sup> Edition, 2022.
3. R J Silby and R. A. Alberty, M G Bawendi, *Physical Chemistry*, 4<sup>th</sup> Edition, John Wiley & Sons, 2021.
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<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Organic Chemistry-6</b>					
<b>Type of Course</b>	DCE					
<b>Course Code</b>	UC8DCECHE400					
<b>Course Level</b>	<b>400-499</b>					
<b>Course Summary</b>	A comprehensive study of organic synthesis.					
<b>Semester</b>	VIII	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75

<b>Pre-requisites, if any</b>	
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### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply the knowledge of synthetic reagents and reactions in organic transformations.	A	1,2,3
2	Summarize the stereoselective transformations in organic synthesis.	U	1,2,3
3	Analyse the structure and formulate a retrosynthetic scheme for the given organic molecule.	An	1,2,3
4	Develop a synthetic route for an organic molecule.	A	1,2,3,6
5	Synthesise biologically important molecules.	A, S	1, 2, 4
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

### COURSE CONTENT

#### Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Synthetic Reagents and Reactions</b>			
	1.1	Phosphorous based- triphenylphosphine-Mitsunobu reaction, Wittig reaction, Staudinger reaction; Sulphur based-sulphonium salts, sulfur ylides- Corey-Cheykovsky reaction; Si based reagents-silyl ethers-TMS, TBDMS, TBDPS,	5	1,4

		TES, TIPS, Julia olefination, Peterson's olefination, - NBS, DDQ and DCC, Gilman reagent.		
	1.2	Carbon-carbon bond formation through coupling reactions - Heck, Suzuki, Stille, Sonogoshira, Negishi, Kumada, Hiyama, Tsuji-Trost, olefin metathesis and McMurry reaction.	5	1,4
	1.3	Baylis-Hillman reaction, Kulinkovich reaction, Ritter reaction, Sakurai reaction, Tishchenko reaction, Tebbe olefination, multi component reactions- Passerini reaction and Biginelli reaction, Click reactions- Huisgen 1,3-dipolar addition.	5	1,4
2	<b>Oxidation and Reduction</b>			
	2.1	Metal based and non-metal based oxidations of (a) Alcohols to carbonyls- Collins oxidation, Sarett oxidation, PCC; Oppeneur oxidation, Swern oxidation. (b) Alkenes to diols- Prevost reaction and Woodward modification.	3	1,4
	2.2	(c) Alkenes to alcohols/carbonyls without bond cleavage hydroboration-oxidation, Selenium/chromium based allylic oxidation. (d) Ketones to ester/lactones- Baeyer-Villiger oxidation.	3	1,4
	2.3	Reduction : (a) Catalytic hydrogenation	4	1,4

		(heterogeneous: Pd, Pt, Rh and Ni; homogeneous: Wilkinson's catalyst)  (b) Metal based reductions -Birch reduction, pinacol formation, acyloin formation  (c) Hydride transfer reagents from group III and group IV in reductions - NaBH <sub>4</sub> , LiAlH <sub>4</sub> and DIBAL-H		
<b>3</b>	<b>Stereoselective and Total Syntheses</b>			
	3.1	Asymmetric induction- Felkin-Ahn model, Zimmerman-Traxler chair-like transition states.	2	2
	3.2	Noyori asymmetric hydrogenation, Sharpless epoxidation, CBS reduction, Brown allylation and crotylation reactions.	4	2
	3.3	Evans aldol reaction, proline based asymmetric aldol reaction, Jacobsen epoxidation, asymmetric Diels-Alder reaction.	4	2
	3.4	Retrosynthesis- basic concepts, Umpolung reactivity – formyl and acyl anion equivalents, protecting group chemistry- protection and deprotection of hydroxy, carboxyl, carbonyl, and amino groups.	4	3,4
	3.5	Retrosynthetic analysis and total synthesis of atropine, papaverine, longifolene and juvabione.	6	3,4

Organic Chemistry-6 Practicals			
4	<p>Synthesis of biologically important molecule</p> <p>I. Preparation of phenytoin: -</p> <ol style="list-style-type: none"> <li>i) Preparation of benzoin using coenzyme catalysed reaction.</li> <li>ii) Preparation of benzil from benzoin.</li> <li>iii) Preparation of phenytoin from benzoin.</li> </ol> <p>II. Preparation of benzocaine</p> <ol style="list-style-type: none"> <li>i) Preparation of <i>p</i>-aminobenzoic acid from <i>p</i>-nitrobenzoic acid.</li> <li>ii) Preparation of benzocaine from <i>p</i>-aminobenzoic acid.</li> </ol> <p>III. Preparation of fluorescein.</p> <p>IV. Preparation of 7-hydroxy- 4-methyl coumarin from resorcinol.</p>	15	4
5	<b>Teacher Specific Content</b>		

<b>Teaching and Learning Approach</b>	<p><b>Classroom Procedure (mode of transaction)</b></p> <ul style="list-style-type: none"> <li>● Lecture (chalk &amp; board, powerpoint presentation)</li> <li>● Group discussion</li> <li>● Peer learning</li> <li>● Demonstration of experiments</li> <li>● Hands-on learning</li> </ul>
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<b>Mode of assessment</b>	<p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p>Theory : <b>25 marks</b></p> <p>Pop quiz</p> <p>Assignment</p> <p>Written tests</p> <p><b>Practical: 15 marks</b></p> <p>Lab involvement/report /Lab test</p>
	<p><b>B. Semester-end examination</b></p> <p>Theory: Written examination - 50 marks- 1.5 hrs.</p> <p>i) Short answer 7 questions (out of 9): <math>7 \times 3 = 21</math></p> <p>i) Short essay 2 questions (out of 3): <math>2 \times 7 = 14</math></p> <p>ii) Essay 1 question (out of 2): <math>1 \times 15 = 15</math></p> <p>Practical (35 Marks): 1 hr.</p> <p>Viva voce-10 marks</p> <p>Written test of practical procedures-15 marks</p> <p>Certified report of lab works done -10 marks</p>

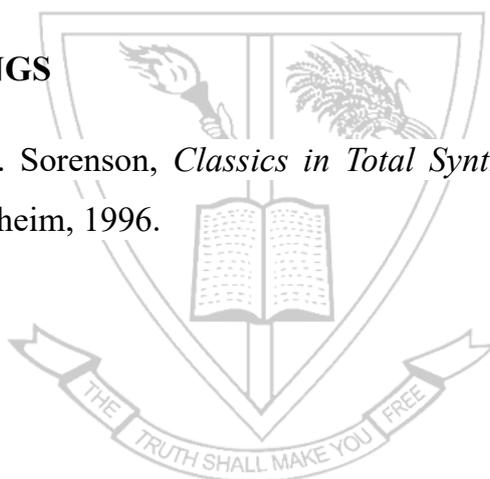
## References

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2. F. A. Carey, R. J. Sundberg, *Advanced Organic Chemistry: Part A. Structure and Mechanisms*; 5<sup>th</sup> ed.; Springer: New York, 2007.
3. F. A. Carey, R. J. Sundberg, *Advanced Organic Chemistry: Part B. Reactions and Synthesis*; 5<sup>th</sup> ed.; Springer: New York, 2007.
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#### SUGGESTED READINGS

1. K. C. Nicolaou, E. J. Sorenson, *Classics in Total Synthesis: Targets, Strategies, Methods*; VCH: Weinheim, 1996.



<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>			
<b>Course Name</b>	<b>Group Theory and Quantum Chemistry</b>			
<b>Type of Course</b>	<b>DCE</b>			
<b>Course Code</b>	UC8DCECHE401			
<b>Course Level</b>	<b>400-499</b>			
<b>Course Summary</b>	This course deals with the applications of quantum chemistry and group theory and fundamental concepts of computational chemistry.			
<b>Semester</b>	<b>VIII</b>	<b>Credits</b>	<b>4</b>	<b>Total Hours</b>

<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Summarize the quantum mechanical principles of translational, vibrational and rotational motion.	U	1,2
2	Identify the principles of spherical harmonics in solving hydrogen and hydrogen-like systems.	E	1,2
3	Evaluate the many-body problem, recognize the necessity of approximation methods in quantum mechanics and to outline the basic concepts of bonding in molecules.	A	1,2
4	Outline the basic concepts of different computational chemistry techniques such as Ab initio, semi empirical, density functional theory and molecular mechanics.	U	1,2
5	Construct the character tables for specific point group based on group theoretical principles	A	1,2
6	Utilise the group theoretical aspects to predict the vibrational modes and electronic transition modes.	A	1,2
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

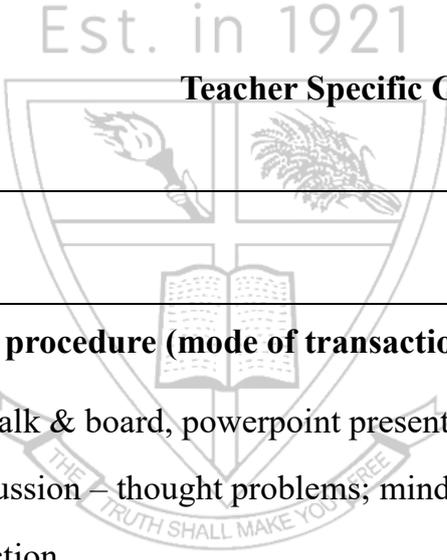
### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
<b>1</b>	<b>Application of Quantum Mechanics to solvable systems</b>			
	1.1	Translational motion: free particle in one-dimension, penetration into and through barriers (a barrier with finite width-tunnelling), wave	4	1

		function in region I, II & III and their plots. Concept of transmittance and reflection.		
	1.2	Vibrational motion: one-dimensional harmonic oscillator (complete treatment), Hermite equation (solving by method of power series), Hermite polynomials, wave functions- their sketch, energies, harmonic oscillator model and molecular vibrations.	5	1
	1.3	Quantization of angular momentum, quantum mechanical operators corresponding to angular momenta ( $L_x$ , $L_y$ , $L_z$ and $L^2$ ).	4	1
	<b>Rotational Motion and Hydrogen Like Atoms</b>			
	2.1	Rotational motion: the particle on a ring and its solution. Rigid rotor and its solution for energies and wave function, polar diagrams of spherical harmonics. Spherical harmonics as eigen functions of angular momentum operators $L_z$ and $L^2$ .	6	1
2	2.2	Quantum mechanics of hydrogen-like atoms: Potential energy of hydrogen-like systems. The wave equation in spherical polar coordinates: separation of variables-r, theta and phi equations and their solutions, wave functions and energies of hydrogen-like atoms. Orbitals: Radial functions, radial distribution functions, angular functions, and their plots.	6	2
	<b>Many Body Systems and Computational Chemistry</b>			
3	3.1	Many-body problem and the need of approximation methods. Born-Oppenheimer approximation. Variation method- illustration of	5	3

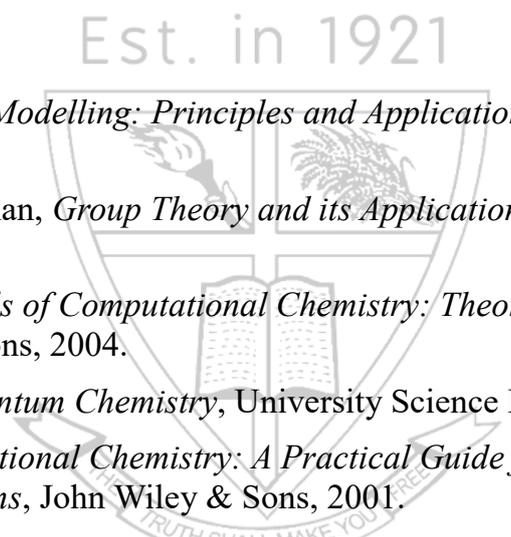
		variation theorem using the trial function $\psi(a-x)$ for particle in a 1D-box and using the trial function $e^{-ar}$ for the hydrogen atom.		
	3.2	Perturbation method: time-independent perturbation method (non-degenerate case only), first order correction to energy and wave function, illustration by application to particle in a 1D-box with slanted bottom.	5	3
	3.3	Chemical bonding: Schrödinger equation for molecules, valence bond (VB) theory, VB theory of $H_2$ molecule (elementary idea only) Molecular Orbital (MO) theory, MO theory of $H_2$ molecule (elementary idea only). Comparison of MO and VB theories.	5	3
	3.4	Introduction to computational chemistry: scope, potential energy surfaces, global minimum, local minima, saddle points. Tools (methods) of computational chemistry: molecular mechanics, semi empirical methods, <i>Ab initio</i> methods, density functional theory – general introduction. Comparison of <i>ab initio</i> , semi empirical and DFT methods	5	4
	<b>Group Theory and its Applications</b>			
4	4.1	Reducible and irreducible representations, statement of great orthogonality theorem (GOT) and properties of irreducible representations.	3	5
	4.2	Character table and description of its layout, construction of character tables for $C_{2v}$ and $C_{3v}$ .	3	5
	4.3	<i>Application to vibrational spectroscopy</i> : Standard reduction formula, normal mode analysis of $H_2O$	4	6

		and NH <sub>3</sub> employing cartesian coordinate method and internal coordinate method. Prediction of IR and Raman activity, rule of mutual exclusion.		
	4.4	<i>Application to electronic spectroscopy:</i> Transition moment integral, direct product, transitions between non-degenerate states – criteria for allowed transitions, prediction of electronic transitions in C <sub>2v</sub> and C <sub>3v</sub> using direct product terms.  Electronic transitions due to the carbonyl chromophore in formaldehyde	5	6
5	 <p>Est. in 1921 <b>Teacher Specific Content</b></p>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b></p> <p>Lecture (chalk &amp; board, powerpoint presentation, flipped classroom)</p> <p>Group discussion – thought problems; mind mapping</p> <p>Peer interaction</p> <p>Demonstration using simulations / models</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p style="text-align: center;"><b>Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory: 30 marks</b></p> <p>Quiz</p> <p>Assignment</p> <p>Problem based test - Open book</p> <p>Examinations</p>

	<p style="text-align: center;"><b>Semester end examination</b></p> <p><b>Theory: 70 marks- 2 hrs.</b></p> <p>MCQ – 10 marks (1 mark each – 10 nos)</p> <p>Short answer questions – 24 marks (3 marks each – 8 out of 10 nos)</p> <p>Long answer questions – 21 marks (7 marks each – 3 out of 5 nos)</p> <p>Essay type question – 15 marks (1 out of 2 nos)</p>
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## References

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1. A. Leach, *Molecular Modelling: Principles and Applications*, 2<sup>nd</sup> Edn. Longman, 2001.
  2. A.S. Kunju, G. Krishnan, *Group Theory and its Applications in Chemistry*, PHI Learning, 2010.
  3. C.J. Cramer, *Essentials of Computational Chemistry: Theories and Models*, 2<sup>nd</sup> Edn. John Wiley & Sons, 2004.
  4. D.A. McQuarrie, *Quantum Chemistry*, University Science Books, 2008.
  5. D.C. Young, *Computational Chemistry: A Practical Guide for Applying Techniques to Real World Problems*, John Wiley & Sons, 2001.
  6. E.G. Lewars, *Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics*, 2<sup>nd</sup> Edn. Springer, 2011.
  7. F. Jensen, *Introduction to computational chemistry*, 2<sup>nd</sup> Edn. John Wiley & Sons, 2007.
  8. F.A. Cotton, *Chemical Applications of Group Theory*, 3<sup>rd</sup> Edn. Wiley Eastern, 1990.
  9. J.H. Jensen, *Molecular Modeling Basics*, CRC Press, 2010.
  10. K.Veera Reddy, *Symmetry and Spectroscopy of molecules*, New Age International (P) Ltd., 1999.
  11. N. Levine, *Quantum Chemistry*, 7<sup>th</sup> Edn. Pearson Education Inc., 2016.
  12. P.W. Atkins, R.S. Friedman, *Molecular Quantum Mechanics*, 4<sup>th</sup> Edn. Oxford University Press, 2005.
  13. R.K. Prasad, *Quantum Chemistry*, New Age International, 2001.

14. S. Swarnalakshmi, T. Saroja, R.M. Ezhilarasi, *A Simple Approach to Group Theory in Chemistry*, Universities Press, 2008.
15. T. Engel, *Quantum Chemistry and Spectroscopy*, Pearson Education, 2006.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>				
<b>Course Name</b>	<b>Instrumental Methods of Chemical Analysis</b>				
<b>Type of Course</b>	<b>DCE</b>				
<b>Course Code</b>	UC8DCECHE402				
<b>Course Level</b>	<b>400- 499</b>				
<b>Course Summary</b>	This course deals with the theory, instrumentation and applications of various chromatographic techniques, and surface and thermal analytical methods.				
<b>Semester</b>	VIII	<b>Credits</b>		<b>4</b>	
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	<b>Others</b>
		4			
<b>Total Hours</b>	<b>75</b>				
<b>Pre-requisites, if any</b>	Nil				

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Describe the basic principles and instrumentation of various chromatographic techniques.	U	1,2
2	Evaluate the efficiency and effectiveness of different chromatographic methods.	E	1,2

3	Analyse the basic principles, instrumentation, limitations and applications of various techniques for surface analysis	An	1,2
4	Analyse the basic principles, instrumentation and applications of various thermal analytical techniques.	An	1,2
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	<b>Introduction to chromatography</b>			
	1.1	Adsorption and partition column chromatography- methodology, advantages, limitations and applications.	3	1,2
	1.2	Thin-layer chromatography- introduction, principle, methodology, Rf values, advantages, limitations, and applications.	4	1,2
	1.3	Paper chromatography- Introduction, methodology, development techniques, advantages, limitations, and applications	4	1,2
	1.4	Electrophoresis-introduction, factors affecting electrophoretic mobility, techniques of paper, gel and capillary electrophoresis and its applications.	4	1,2
2	<b>GC, HPLC and Ion exchange chromatography</b>			
	2.1	Gas chromatography - introduction, theory, instrumentation, derivatization, temperature programming, advantages, limitations and applications, hyphenated GC techniques (GC-MS, GC-IR, GC-GC, or 2D GC).	6	1,2

	2.2	High-performance liquid chromatography (HPLC)-introduction, theory, instrumentation, advantages and applications, hyphenated techniques in HPLC.	5	1,2
	2.3	Ion exchange chromatography-introduction, classification, ion exchange resins, properties, mechanism of the ion exchange process, factors affecting ion exchange, methodology and applications.	4	1,2
	<b>Surface Analysis</b>			
3	3.1	X-Ray photoelectron spectroscopy-instrumentation and sample introduction, applications.	3	3
	3.2	Auger electron spectroscopy-instrumentation and applications.	3	3
	3.3	Secondary ion mass spectrometry-instrumentation, applications, ToF-SIMS.	3	3
	3.4	SEM- basic principles, instrumentation and applications.	2	3
	3.5	STM- basic principles, instrumentation, and applications.	2	3
	3.6	AFM- basic principles, instrumentation, and applications.	2	3
	<b>Thermal Analysis</b>			
4	4.1	Thermogravimetry (TGA)-instrumentation, analytical applications of thermogravimetry , derivative thermogravimetry	3	4
	4.2	Differential Thermal Analysis (DTA) - instrumentation and analytical applications.	3	4
	4.3	Differential Scanning Calorimetry (DSC) - instrumentation and applications.	3	4
	4.4	Hyphenated thermal methods.	1	4

	4.5	Thermometric titrimetry.	1	4
	4.6	Microcalorimetry- basic principles and applications of micro-DSC.	2	4
	4.7	Thermomechanical analysis and Dynamic mechanical analysis- applications of TMA and DMA.	2	4
<b>5</b>	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	Lecture sessions/interactive sessions/ case studies/ from various scientific fields (like environmental science, pharmaceuticals, forensics) to illustrate how different techniques are applied practically.
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b></p> <p><b>A. Continuous Comprehensive Assessment (CCA)</b></p> <p><b>Theory: 30 marks</b></p> <p>Assignments</p> <p>MCQ</p> <p>Viva</p> <p>Class Test</p> <hr/> <p style="text-align: center;"><b>Semester end examination</b></p> <p><b>Theory: 70 marks-2 hrs.</b></p> <p>Short answer 5 questions (out of 6): 5 X 4 =20</p> <p>Short essay 5 questions (out of 7): 5 X 7 = 35</p> <p>Essay 1 question (out of 2): 1 X 15 = 15</p>

## References

1. D A. Skoog, D M. West, F. J Holler, S R. Crouch, *Fundamentals of Analytical Chemistry*, 9<sup>th</sup> Edn. Brooks/Cole, 2014.
2. D A. Skoog, F. J Holler, S R. Crouch, *Principles of Instrumental Analysis*, 7<sup>th</sup> Edn. Brooks/Cole, 2020.
3. E Lundanes, *Chromatography: Basic Principles, Sample Preparations and Related Methods*, Wiley-VCH, 2013.
4. F A Settle, *Handbook of Instrumental Techniques for Analytical Chemistry*, Prentice Hall, 1997.
5. J W. Robinson, E M S Frame, and G M. Frame II, *Instrumental Analytical Chemistry*, CRC Press, 2021.
6. J W. Robinson, E M. Skelly Frame, G M. Frame II, *Undergraduate Instrumental Analysis*, 7<sup>th</sup> Edition, Taylor & Francis, 2014.
7. M D Graef, M E. McHenry, *Introduction to TEM, SEM, and AFM: The Practical Approach to Materials Characterization*, 1<sup>st</sup> Edition, CRC Press, 2018.
8. P. J. Haines, *Principles of Thermal Analysis and Calorimetry*, Royal Society of Chemistry, 2002.
9. R Stafford, *Chromatography: Principles and Instrumentations*, Nyresearch Press, 2020.

<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Molecular Modelling</b>					
<b>Type of Course</b>	<b>DCE</b>					
<b>Course Code</b>	UC8DCECHE403					
<b>Course Level</b>	<b>400-499</b>					
<b>Course Summary</b>	This course provides a comprehensive insight into molecular modelling covering Hartree Fock Method & Post Hartree Fock Methods, various computational chemistry methods and applications of computational chemistry softwares.					
<b>Semester</b>	<b>VIII</b>	Credits			4	Total Hours
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60

<b>Pre-requisites, if any</b>	
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### COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate the need for the approximations to the Hamiltonian.	U	1,2
2	Classify different types of basis sets.	U	1,2
3	Compare and contrast different methods of computational chemistry.	An	1,2,3
4	Utilize GAMESS software to solve molecular systems.	A	1,2,4,9,10
5	Utilize Autodock software to predict protein-ligand interactions.	A	1,2,3,4,9,10
<i>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</i>			

### COURSE CONTENT

#### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	<b>Hartree Fock Method &amp; Post Hartree Fock Methods</b>			
1	1.1	Multi-electron atoms. Hartree method, spin multiplicity, Slater determinant, properties of Slater determinant, Hartree-Fock (HF) equations. Secular determinant, restricted and unrestricted HF models.	5	1

	1.2	The Fock matrix, Roothan Hall equations, elements of the Fock matrix (elementary ideas only), steps for HF calculation, Koopmann theorem.	5	1
	1.3	The need for post HF methods. electron correlation, post HF methods: configuration interaction and Møller Plesset perturbation theory (elementary ideas only)	3	1
	1.4	Roothan's concept of basis functions, Slater type orbitals (STO), Gaussian type orbitals (GTO), sketches of STO and GTO. Differences between STOs and GTOs.	3	2
	1.5	Classification of basis sets – minimal basis sets; Pople basis sets (with polarization and diffuse functions), correlation consistent basis sets; double zeta, triple zeta and quadrupole zeta basis sets, split valence basis set, Hartree Fock limit.	4	2
	<b>Computational Methods</b>			
<b>2</b>	2.1	Semiempirical methods: introduction, neglect of differential overlap method (NDO), complete neglect of differential overlap (CNDO), modified neglect of differential overlap (MNDO); Austin Model 1, parametric method 3 (PM3), zero differential overlap (ZDO) (concepts only). Comparison of semiempirical methods. Software used for semiempirical calculations.	5	3
	2.2	Ab Initio method: introduction, computation of correlation energy, computation of Slater determinant of excited states, Møller-Plesset perturbation and coupled cluster method.	4	3

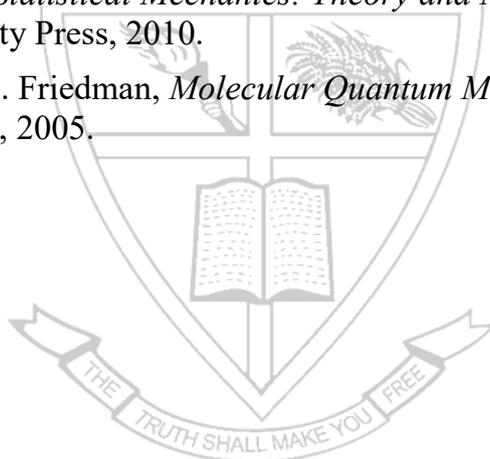
	2.3	Density functional theory: introduction, electron density, development of DFT, The functional, Hohenberg and Kohn theorem, Kohn and Sham method, density functionals – exchange and correlation functionals with examples, DFT methods, applications of DFT, performance of DFT, advantages of DFT in biological chemistry.	6	3
	2.4	Molecular Mechanics (MM): introduction, basic theory- bond stretching, angle bending, torsional strain, non bonded interactions. Force fields – MM2, MM3, MM4, AMBER, CHARMM, merck molecular force field, consistent force field, parameterization.	4	3
	2.5	Comparison between semiempirical, Ab Initio, DFT and MM methods – merits and demerits.	1	3
	<b>Computational Software</b>			
<b>3</b>	3.1	Introduction to GAMESS. Setting up the input file with run type - geometry optimization, frequency calculation and single point energy calculations. \$ groups, format for input file. Hands-on training using the software.	5	4
	3.2	Input for molecule – cartesian coordinates and Z-matrix. Z matrix- rules, z-matrix for linear molecules like diatomic molecules, acetylene, hydrogen cyanide and polyatomic molecules like water, ammonia, boron hydride and methane.	5	4
<b>4</b>	<b>Docking</b>			
	4.1	Introduction to docking (basic ideas only), protein ligand interactions; setting up the protein and	10	5

		ligand using babel and pymol; predicting ADMET of the molecule using PreADMET application; docking procedures using autodock software and result analysis with visualization of interactions using discovery studio. Hands-on training using the software.		
<b>5</b>	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<p><b>Classroom procedure (mode of transaction)</b>  Lecture (chalk &amp; board, powerpoint presentation, flipped classroom)  Group discussion – thought problems; mind mapping  Peer interaction  Demonstration using simulations / models</p>
<b>Assessment Types</b>	<p><b>MODE OF ASSESSMENT</b>  <b>Continuous Comprehensive Assessment (CCA)</b>  <b>Theory: 30 marks</b>  Theory: Quiz  Assignment  Problem based test - Open book  Examinations</p>
	<p><b>Semester end examination</b>  <b>Theory: 70 marks- 2 hrs.</b>  MCQ – 10 marks (1 mark each – 10 nos)  Short answer questions – 24 marks (3 marks each – 8 out of 10 nos)  Long answer questions – 21 marks (7 marks each – 3 out of 5 nos)  Essay type question – 15 marks (1 out of 2 nos)</p>

## References

1. A. Leach, *Molecular Modelling: Principles and Applications*, 2<sup>nd</sup> Edn. Longman, 2001.
2. A. Szabo, N. S. Ostlund, *Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory*, Dover Books on Chemistry, 1996.
3. C.J. Cramer, *Essentials of Computational Chemistry: Theories and Models*, 2<sup>nd</sup> Edn. John Wiley & Sons, 2004.
4. E.G. Lewars, *Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics*, 2<sup>nd</sup> Edn. Springer, 2011.
5. F. Jensen, *Introduction to computational chemistry*, 2<sup>nd</sup> Edn. John Wiley & Sons, 2007.
6. J.H. Jensen, *Molecular Modeling Basics*, CRC Press, 2010.
7. K. I. Ramachandran, G. Deepa, K. Namboori, *Computational Chemistry and Molecular Modeling Principles and Applications*, Springer, 2008
8. M. Tuckerman, *Statistical Mechanics: Theory and Molecular Simulation*, Oxford University Press, 2010.
9. P.W. Atkins, R.S. Friedman, *Molecular Quantum Mechanics*, 4<sup>th</sup> Edn. Oxford University Press, 2005.



<b>Programme</b>	<b>BSc (Hons) CHEMISTRY</b>					
<b>Course Name</b>	<b>Crystallography and Electrochemistry</b>					
<b>Type of Course</b>	DCE					
<b>Course Code</b>	UC8DCECHE404					
<b>Course Level</b>	<b>400-499</b>					
<b>Course Summary</b>	This is an advanced physical chemistry course dealing with crystallography, electrochemistry and electro analytical techniques.					
<b>Semester</b>	VIII	<b>Credits</b>			4	<b>Total Hours</b>
<b>Course Details</b>	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
<b>Pre-requisites, if any</b>						

### COURSE OUTCOMES (CO)

<b>CO No.</b>	<b>Expected Course Outcome</b>	<b>Learning Domains *</b>	<b>PO No</b>
1	Discuss the basic concepts of crystal systems like unit cell, lattice and deduce the crystal structure of NaCl and KCl from XRD patterns.	An	1,2,3
2	Distinguish different diffraction methods and correlate the structure factor with the peak intensity.	A	1,2,3
3	Describe the structure of ionic solution and interpret the laws governing ionic conductivity.	U	1,2
4	Explain the features of concentration cells and fuel cells.	U	1,2
5	Explain the causes of corrosion, prevention methods.	U	1,2
6	Learn the basic principles of voltammetry and describe voltammogram by analysing the peak	U	1,2

	current and peak potential.		
7	Apply the theory behind electroanalytical techniques to quantitative and qualitative analysis.	A	1,2
<b>*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</b>			

## COURSE CONTENT

### Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
<b>UNIT 1: CRYSTALLOGRAPHY (15 HRS)</b>				
1	1.1	Symmetry in crystals: symmetry elements – proper rotation (order of axis = 1, 2, 3, 4 and 6 – derivation), mirror plane, rotary inversion axis. 32 crystallographic point groups (derivation not expected), Hermann-Mauguin notation and corresponding Schoenflies notations, translational symmetry elements - glide planes and screw axes, fourteen Bravais lattices, space groups (concept only). Space groups of triclinic and monoclinic systems.	5	1
	1.2	Miller indices, inter-planar spacing and method of determining lattice types, reciprocal lattices. X-ray diffractometer: single crystal and powder pattern methods (experimental part). Analysis of powder diffraction patterns of NaCl and KCl. Debye-Scherrer equation.	6	1
	1.3	Crystal growth techniques. Structure factor: atomic scattering factor, coordinate expression for structure factor.	4	2
<b>UNIT 2: ADVANCED ELECTROCHEMISTRY (30 HRS)</b>				
2	2.1	Debye-Huckel theory, derivation of Debye-Huckel-Onsager equation, validity of DHO equation for aqueous and non-aqueous solutions, Debye-Huckel limiting law (no derivation) qualitative and quantitative tests of Debye-Huckel limiting law, deviations from DHLL.	10	3

	2.2	Concentration cells – with and without transference, liquid junction potential, electrode double layer, electrode-electrolyte interface, different models of double layer, theory of multilayer capacity, electro capillary, Lippmann equation, membrane potential. Fuel cells- theory and working of fuel cells- methanol fuel cell, H <sub>2</sub> -O <sub>2</sub> fuel cell and solid oxide fuel cells.	10	4
	2.3	Corrosion and methods of prevention, Pourbaix diagram and Evans diagrams. Electrode polarization:- overvoltage: hydrogen and oxygen overvoltage, theories of overvoltage, Tafel equation and its significance.	10	5
<b>UNIT 3: ELECTRO ANALYTICAL TECHNIQUES (15 HRS)</b>				
3	3.1	Electroanalytical techniques: classification – interfacial and bulk methods; idea of static and dynamic methods.	1	6
	3.2	Polarography- decomposition potential, residual current, migration current, supporting electrolyte, diffusion current, polarogram, half wave potential, limiting current density, polarograph, explanation of polarographic waves. The dropping mercury electrode, advantages and limitations of DME, quantitative analysis- pilot ion procedure, standard addition methods, qualitative analysis - determination of half wave potential of an ion, advantages of polarography.	8	6, 7
	3.3	Cyclic voltammetry – basic principles and fundamentals; cyclic voltammogram for a reversible and irreversible redox process, Scan rate. Amperometric titrations: General principles of amperometry, instrumentation, application of amperometry in the qualitative analysis of anions and cations in solution, merits and demerits of amperometric titrations.	6	7
<b>5</b>	<b>Teacher Specific Content</b>			

<b>Teaching and Learning Approach</b>	<b>Classroom Procedure (Mode of transaction)</b> <ul style="list-style-type: none"> <li>● Lecture sessions (chalk &amp; board, powerpoint presentation)</li> <li>● Interactive sessions and simulations</li> <li>● Visual aids like videos and models to enhance understanding</li> <li>● Peer discussions</li> <li>● Laboratory experiments and hands-on training</li> </ul>
<b>Assessment Types</b>	<b>MODE OF ASSESSMENT</b> <b>Continuous Comprehensive Assessment (CCA)</b> <b>Theory; 30 marks</b> Pop quiz Assignment Test for each unit (MCQ/written)
	<b>Semester End examination</b> <b>Theory: Written examination (70 Marks)- 2 hrs.</b> MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

## References

1. A. J. Bard and L. R. Faulkner *Electrochemical methods: Fundamentals and Applications*, Second Edn., Wiley, 2022.
2. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd., 2019.
3. Anthony R. West, *Solid State Chemistry and its Applications*, Wiley Eastern, 2018.
4. G. Raj, *Advanced Physical Chemistry*, Goel publishing house, 2016.
5. N B Hannay, *Solid State Chemistry*, Prentice Hall. 1967.

6. O. Simoska, S. D. Minter, *Techniques in Electroanalytical Chemistry*, American Chemical Society, 2022.
7. R P W Atkins, *Physical Chemistry*, 12<sup>th</sup> Edn. Oxford University Press, 2018.
8. R. J. Silby and R. A. Alberty, M G Bawendi, *Physical Chemistry*, 4<sup>th</sup> Edition, John Wiley & Sons, 2015.
9. S. Glasstone, *An Introduction to Electrochemistry*, East-West Press (Pvt.) Ltd. 2006.

### **Suggested Readings**

1. G. K. Vemulapalli, *Physical Chemistry*, Prentice-Hall of India Pvt. Ltd, 1996.
2. S. Glasstone, D.Lewis, *Elements of Physical Chemistry*, Macmillan, 1963.
3. I. N. Levine, *Physical Chemistry*, Tata McGraw Hill, 2011.
4. G. M. Barrow, *Physical Chemistry*, Tata McGraw-Hill, 2007.



## Internship Evaluation

All students shall undergo summer internship or apprenticeship in a firm, industry or organization; or training in labs with faculty and researchers or other higher education institutions (HEIs) or research institutions after completion of the fourth semester.

Evaluation scheme (total 50 marks)

- 1) Internal Evaluation (15 marks) (Internal marks may be obtained from the organisation/institution where the student is doing internship using the following format)

<p style="text-align: center;"><b>Chemistry Undergraduate Student Evaluation Form for Internship</b></p> <p><b>Internship Details:</b> <b>Student Name:</b> <b>Date of Evaluation:</b> <b>Duration of Internship:</b> <b>Mentor Name:</b> <b>Instructions:</b> Please rate students' performance based on their abilities, skills, and behaviour during the internship. Provide specific examples or comments where applicable to support your ratings.</p> <p><b>1. Technical Skills and Problem Solving (Marks out of 3) :</b> <b>2. Communication Skills and Collaboration (Marks out of 3) :</b> <b>3. Professionalism (Marks out of 3) :</b> <b>4. Adaptability (Marks out of 3) :</b> <b>5. Overall Performance (Marks out of 3) :</b> <b>Total (out of 15) :</b></p> <p><b>Comments and Recommendations:</b> (Provide specific comments on the student's strengths, areas for improvement, and any additional feedback or recommendations for their future development.)</p> <p><b>Mentor Signature: (Insert Mentor's Signature) :</b></p> <p><b>Date: (Insert Date of Evaluation) :</b></p>
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) Final Evaluation (35 marks)

Report (20 marks)

- i) Relevance : 5 marks
- ii) Professionalism & ethical considerations: 5 marks
- iii) Result Analysis : 5 marks
- iv) Conclusions : 5 marks

3) Viva voce (15 marks)

(Student's skills, work ethics, professionalism and contribution to the organisation may be evaluated through viva)

### **Project Evaluation- UC8PRJCHE400**

#### **1. Project with 12 credits (200 marks)**

##### **1) Internal Evaluation (60 marks)**

- i) Initiative and Independence : 10 marks
- ii) Technical Skills : 10 marks
- iii) Problem Solving : 10 marks
- iv) Communication Skills : 10 marks
- v) Professionalism : 10 marks
- vi) Overall Performance : 10 marks

(If the student is doing project in any outside institution, internal marks may be obtained from there (from the project supervisor))

##### **2) Final Evaluation (140 marks)**

- i. Novelty of the work : 20 marks
- ii. Experimental Section : 10 marks
- iii. Results and Discussion : 20 marks
- iv. Conclusion : 10 marks
- v. Literature Survey : 10 marks
- vi. Presentation of the work : 30 marks
- vii. Viva voce : 40 marks

(If the student is doing project in any outside institution, internal marks may be obtained from there (from the project supervisor))

## MODEL QUESTION PAPERS

<b>Union Christian College, Aluva</b>					Code No:
<b>First Semester Exam</b>					
February 2025					
Course Code:		Course Title:			
Faculty in charge:		Max Weightage: 30	Duration: 3 Hours		
Name:		Class No./ Reg No:		Semester: I	
<b>Course Outcome:</b>					
CO1:					
CO2:					
CO3:					
CO4:					
Sl. No	Questions	Bloom's Taxonomy (Revised)	CO	Marks	
<b>Section A</b> Answer <b>any five</b> of the following (1 mark for each question) (1X5=5 marks)					
1					
2					
3					
4					
5					
6					
<b>Section B</b> Answer <b>any three</b> of the following (5 marks for each question) (5X3=15 marks)					
7					
8					
9					
10					
11					
<b>Section C</b> Answer <b>any one</b> of the following (10 marks for each question) (10X1=10 marks)					
12					
13					