

DEPARTMENT OF CHEMISTRY				CLASS: II B.Sc. Chemistry				
Sem	Course Type	Course Code	Course Title	Credits	Contact Hours/week	CIA	Ext	Total
IV	SBE	20U4CSM2	Nano & Green Chemistry	2	2	25	75	100

Nature of Course			
Knowledge and skill	✓		Employability oriented
Skill oriented			Entrepreneurship oriented

Objectives: The objective of this course is to make the student

- (i) To introduce the students about nanomaterials and its properties
- (ii) To gain the knowledge of preparative methods of nanomaterials
- (iii) To expose the students about the carbon nanotube preparation, properties and its applications
- (iv) To help the students to understand basic principle of green chemistry and atom economy
- (v) To enable the students to study various green chemistry reactions

Unit	Description	Hours	K-Level	CLO
I	Introduction to Nanomaterials Nano material: Introduction – definition- types -0D, 1D, 2D, and 3D Nanomaterial and examples. Properties: Size effect, Optical, electrical and magnetic properties.	6	K2	CLO-1
II	Preparation of Nanomaterials Preparation of simple nanomaterials (nanometal, Metal oxide, semiconductor) – Chemical reduction method –Electrochemical methods – Sol-gel method and inert gas condensation.	6	K3	CLO-2
III	Carbon nanotubes Carbon nano structures: Preparation, properties and application of Single-walled carbon nanotube and Multi-walled carbon nanotubes	6	K3	CLO-3
IV	Basic concept in Green Chemistry Green Chemistry - Definition, need and twelve basic principles of green chemistry – Atom economy with an example – green chemistry & eco efficiency – Green synthesis - Aqueous phase reactions, reactions in ionic liquids.	6	K4	CLO-4
V	Green synthesis Solid supported synthesis, Solvent free reactions (solid phase reactions), - Green catalysts - Phase transfer catalysts (PTC) and Biocatalysts. Microwave and Ultrasound assisted green synthesis-green chemical synthesis of Paracetamol.	6	K3	CLO-5

Books for Study

1. Nanoscience and Nanotechnology: Fundamentals of Frontiers - Shubra Singh M.S. Ramachandra Rao, 2013.
2. Sanghi, R., Srivastava, M. M. "Green Chemistry" Narosa Publishing House, 2012.
3. An introduction to green chemistry V. Kumar, Vishal Publishing Co.2020

Books For references:

1. Textbook of Nanoscience and Nanotechnology - BS Murthy P Shankar, Baldev Raj, BB Rath, and James Murday - Orient Black swan Private Limited - New Delhi, 2013.
2. An Introduction to Nanomaterials and Nanoscience A. Das – CBS

Web Resources:

1. https://en.wikipedia.org/wiki/Carbon_nanotube
2. https://www.google.com/search?q=nanomaterials+preparation+methods&sxsrf=ACYBGNQjifDydTXtPbsVUznP6Y1kttYw:1576222370982&tbm=isch&source=iu&ictx=1&fir=8SvCwKnfu7cggM%253A%252Cvsf-t8SrrKIpeM%252C_&vet=1&usg=AI4_-kQHRgp4DR-7Podk-ipgwqbMuRFhg&sa=X&ved=2ahUKEwiMqYn0jbLmAhUJyDgGHQgECZgQ9QEwAXoECAcQAw#imgrc=8SvCwKnfu7cggM
3. <https://www.degruyter.com/view/j/ntrev.2018.7.issue-1/ntrev-2017-0160/ntrev-2017-0160.xml?lang=en>
4. <https://www.intechopen.com/books/green-chemistry/introductory-chapter-principles-of-green-chemistry>
5. <http://advancinggreenchemistry.org/green-chem-101/what-is-gc/>

Rationale for Nature of the course

This course will enable the students to enriching the understanding fundamental principles of nano and green chemistry. Students will learn preparation, properties and applications of nanomaterial and carbon nanotubes. Ensure the student to learn green chemical reaction and synthesis.

Activities having direct bearing on Skill development/ Employability/Entrepreneurship

Fundamental concept of green and nano chemistry will be focused. The preparation, properties and applications of new nanomaterials and carbon nanotubes will be developed. Basic ideas of green chemistry and green chemical reaction involving environmental hazard free reaction carried out.

Pedagogy

- Chalk-Talk class room activities
- Group Discussion
- Seminar/Assignment
- Quiz through ICT- Mode

Lesson Plan

Unit	Descriptions	Hours	Lecture Mode
I	Introduction to Nanomaterials		
	Introduction – definition- types -0D, 1D, 2D, and 3D Nanomaterial and examples.	3	BB /PPT
	Properties: Size effect – Colour – Magnetic properties	3	
II	Preparation of Nanomaterials		
	Preparation of simple nanomaterials (nanometal, Metal oxide, semiconductor) – Chemical reduction method	2	BB/ PPT/Animated Videos
	Electrochemical methods	1	
	Sol-gel method and inert gas condensation.	3	
III	Carbon nanotubes		
	Preparation, properties and application of Single-walled carbon nanotube	3	BB BB/PPT
	Preparation, properties and application of Multi-walled carbon nanotube	3	
IV	Basic concept in Green Chemistry		
	Green Chemistry - Definition, need and basic principles of green chemistry	2	BB/PPT
	Atom economy with an example – green chemistry	2	
	Eco efficiency – environmental protection laws.	2	
V	Green synthesis		
	Green synthesis - Aqueous phase reactions, reactions in ionic liquids, Solid supported synthesis, Solvent free reactions (solid phase reactions),	2	BB/PPT/Animated Videos
	Green catalysts - Phase transfer catalysts (PTC) and Biocatalysts.	2	
	Microwave and Ultrasound assisted green synthesis- green chemical synthesis of Paracetamol.	2	
Total Hours		30	

BB-Block board/Chalk and Talk

PPT-Power point presentation

Course outcome:

After complete successful of this course, the student will be able to

CLOs	CLO statement	Knowledge level
CLO1	To outline the concept of nanomaterials, types and its properties	Up to K2
CLO2	Know the various synthetic methods of nanomaterials	Up to K3
CLO3	Plan the preparation, properties and applications of carbon nanotube	Up to K3
CLO4	Inspect the basic principle of green chemistry and atom economy	Up to K4
CLO5	To apply ionic liquids, green catalysis and phase transfer catalysis in green synthesis	Up to K3

PO and CLO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5
CLO1	3	2	-	1	1
CLO2	3	2	1	2	1
CLO3	3	2	2	1	1
CLO4	3	2	-	-	1
CLO5	3	2	-	1	-

PLO and CLO Mapping

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7
CLO1	1	2	-	3	-	3	-
CLO2	1	2	-	3	-	3	-
CLO3	1	2	-	3	-	3	-
CLO4	1	2	-	3	-	3	-
CLO5	1	2	-	3	-	3	-

3-Advance application;

2-Intermediate level;

1-Basic level

Learning Outcome Based Education(LOBE) & Assessment

Formative Examinations I & II -Blue Print

Articulation Mapping - K Levels with Course Outcomes (CLOs)

Sl. No	CLOs	K- Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)	Total
			MCQs		Short Answers				
			No. of Questions	K- Level	No. of Questions	K- Level			
1	CLO _x	Up to K2/K3	2	K1& K2	2	K1,K2	2 (K2&K2)	1(K2/K3)	
2	CLO _y	Up to K3/K4	2	K1& K2	1	K2	2 (K3&K3)	2 (K3, K3/ K4)	
No. of Questions to be asked			4		3		4	3	14
No. of Questions to be answered			4		3		2	2	11
Marks for each question			1		2		5	10	
Total Marks for each section			4		6		10	20	40

Learning Outcome Based Education(LOBE) & Assessment
Summative Examination -Blue Print
Articulation Mapping - K Levels with Course Outcomes (CLOs)

S. No.	CLOs	K- Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K- Level	No. of Questions	K- Level		
1	CLO 1	Up to K 2	2	K1 & K2	1	K1	2 (K2&K2)	1(K2)
2	CLO 2	Up to K 3	2	K1 & K2	1	K1	2 (K3&K3)	1(K3)
3	CLO 3	Up to K 3	2	K1 & K2	1	K2	2 (K1&K1)	1(K2)
4	CLO 4	Up to K 4	2	K1 & K2	1	K2	2 (K4&K4)	1(K4)
5	CLO 5	Up to K 3	2	K1 & K2	1	K2	2 (K3&K3)	1(K3)
No. of Questions to be asked			10		5		10	5
No. of Questions to be answered			10		5		5	3
Marks for each question			1		2		5	10
Total Marks for each section			10		10		25	30

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

Distribution of Section-wise Marks with K Levels

K levels	Section A (No choice)	Section B (No choice)	Section C (Either/or)	Section D (Open choice)	Total Marks	% of marks without choice	Consolidated
K1	5	4	10	-	19	15.83	42
K2	5	6	10	10	31	25.83	
K3	-	-	20	30	50	41.67	42
K4	-	-	10	10	20	16.67	16
Total Marks	10	10	50	50	120	100.00	100

Name of the course Designer

- Dr. P. Gajendran