

KU6DSECHE303: NANO CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSECHE303	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: This Nanochemistry course covers the fundamentals, synthesis, characterization, and applications of nanomaterials. Topics include nanotechnology history, quantum confinement, nanosynthesis methods, and nanomaterial characterization techniques. Applications span environmental remediation, solar energy, drug delivery, and electronics. Students gain comprehensive knowledge of nanomaterials' properties and practical uses.

Course Prerequisite: Preliminary idea on organic and inorganic chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the Fundamentals of nanomaterials	U
2	Demonstrate proficiency in various Nano synthesis methods	A
3	Comprehensive and scientific understanding about the various characterisation techniques of Nanomaterials	U
4	Analyse and apply nanomaterials in environmental remediation, energy conversion and storage, biological imaging, drug delivery, and other complex electronic devices.	An

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	1	0	1	0
CO 2	0	3	2	0	1	0	1
CO 3	0	0	3	0	0	1	0
CO 4	3	3	0	3	0	0	0

Course Contents for Classroom Transaction:

M O D U L E	U N I T	DESCRIPTION	HOURS
1		INTRODUCTION TO NANOMATERIALS	16
	1	Nanotechnology- Definition, Historical milestone-Feynman hypothesis- Surface area to volume ratio- Quantum confinement- Classification of Nanomaterials based on dimensions (0D, 1D, 2D, 3D).	
	2	Different types of nano systems (synthesis and properties)- Carbon nano systems- fullerenes, graphene, carbon nanotubes- Inorganic nano particles-TiO ₂ , ZnO- Organic nano systems- dendrimers, Metal nano particles-quantum dots.	
2		SYNTHESIS OF NANOMATERIALS-I	8

	1	Various methods for the synthesis of nanoparticles: Top-down and Bottom-up approaches.	
	2	Physical methods-Ball Milling, Melt mixing techniques, Physical vapour deposition, Chemical vapour deposition (CVD).	
3	SYNTHESIS OF NANOMATERIALS-II		8
	1	Chemical methods-Chemical precipitation, Sol gel Method, Hydrothermal and Solvothermal synthesis, Microemulsion or Reverse micelle synthesis.	
	2	Microwave synthesis-Electrochemical method- Biological synthesis using plant extract and microorganism- Molecular self-assembly.	

4	CHARACTERISATION OF NANOMATERIALS		16
	1	Important methods for the characterization of nanomaterials–Principles and Applications of Scanning electron microscopy (SEM)- Transmission electron microscopy (TEM), Cryo-TEM.	
	2	Scanning tunnelling electron microscopy (STEM)- Scanning probe microscopies (SPM)-Scanning tunnelling microscopy (STM)- Atomic force microscopy (AFM).	
	3	Photoelectron spectroscopy (UPES and XPES)- Dynamic Light Scattering (DLS) for size measurements- X-ray diffractometer (XRD)- UV-visible and Raman Spectroscopy.	

5	TEACHER SPECIFIC MODULE - APPLICATION OF NANOMATERIALS		12
	<i>Directions: Applications of nanomaterials or any other topic relevant to the course of teacher's choice can be proposed</i>		

1	Nanomaterials for environmental Remediation- Photocatalysis-Water purification using nanomaterials- desalination of water- Heavy metal and oil spill removal	
2	Solar energy conversion: (Dye sensitized solar cells) and storage (Supercapacitors)- Nano catalyst- Biological applications Imaging- labelling- targeted drug delivery- Nanomaterials in electronics and spintronics	
3	Nano sensors- Applications in Self-cleaning surfaces- sports equipment- cosmetics.	

Essential Readings:**Book References:**

1. Poole, Charles P., and Frank J. Owens, Introduction to Nanotechnology, Wiley.
2. Rao, C. N. R., A. Muller, and A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Wiley-VCH.
3. Ratner, Mark, and Daniel Ratner, Nanotechnology: A Gentle Introduction to the Next Big Idea, Prentice Hall.
4. Cao, Guozhong, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Imperial College Press.
5. Kulkarni, Sulabha K., Nanotechnology: Principles and Practices, Capital Publishing Company.
6. Murty, B. S., P. Shankar, Baldev Raj, B. B. Rath, and James Murday, Textbook of Nanoscience and Nanotechnology, University Press.
7. Hornyak, Gabor L., H.F. Tibbals, Joydeep Dutta, and John J. Moore, Introduction to Nanoscience, CRC Press.
8. Shukla, Anubhuti, and Amit Srivastava, Essentials in Nanoscience and Nanotechnology, Jenny Stanford Publishing.

Web References:

1. Royal Society of Chemistry, Nanochemistry, www.rsc.org/nanochemistry
2. Khan Academy, Nanotechnology, www.khanacademy.org/science/nanotechnology
3. Environmental Protection Agency (EPA), Nanotechnology Research, www.epa.gov/nanotechnology-research
4. National Nanotechnology Initiative (NNI), www.nano.gov

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		70
Continuous Evaluation		30
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		100

*Average mark of the best two written tests may be considered for internal mark.

Employability for the Course: Graduates of the Nano Chemistry course are well-prepared for careers in cutting-edge industries such as electronics, pharmaceuticals, and materials science. They can pursue roles in research and development, quality control, and production. Expertise in nanomaterials also opens opportunities in environmental remediation, energy storage, and medical diagnostics, making them valuable assets in both industrial and academic settings.