

KU8DSECHE404: ADVANCED NANOMATERIAL SYNTHESIS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSECHE404	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 course focuses on different methods used for the synthesis of nanomaterials. The course is divided into four modules. In the first module, different physical methods used for the synthesis of nanomaterials are discussed. The second module deals with different chemical methods and the third one discusses about the biological methods for synthesis of nanomaterials. The module deals with lithographic techniques.

Course Prerequisite: Elementary idea on inorganic chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Synthesize nanomaterials using physical, chemical and biological approaches.	A
2	Understand the functionalization of nanoparticles for specific applications	U
3	Form the nanocomposites for tuning their functional properties.	An
4	Fabricate the device structures using lithographic techniques	A

***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	1	2	2	2	1	1
CO 2	1	2	2	2	1	2	2
CO 3	1	2	1	2	2	2	1
CO 4	1	2	1	2	2	2	1

Course Contents for Classroom Transaction:

M O D U L E	U N I T	DESCRIPTION	HOURS
1		PHYSICAL METHODS FOR SYNTHESIS OF NANOMATERIALS	18
	1	Inert gas condensation-Principle, advantages and disadvantages, arc discharge – synthesis of CNTs and fullerenes, laser ablation-principle, Coloumb explosion.	
	2	Laser pyrolysis- Principle, advantages and disadvantages- layer deposition, ball milling-principle, grinding media, Spray pyrolysis.	
	3	Ion implantation, Physical Vapour deposition - Principle, evaporation and sputtering, molecular beam epitaxy.	
	4	Chemical vapour deposition method- homogeneous and heterogeneous process- transport phenomenon- reaction kinetics- types of CVD- Electrospinning processing parameters- factors affecting the process.	
2		CHEMICAL METHODS FOR SYNTHESIS OF NANOMATERIALS - I	8

	1	Chemical methodologies- their advantages- nanoparticles- 1D-nanostructures-Nanowires, nanotubes and nanorods, Nanoparticles through homogeneous & heterogenous nucleation in solution.	
	2	Precipitation, chemical reduction, hydrothermal synthesis- isothermal and temperature gradient methods, Solvothermal synthesis.	

	CHEMICAL METHODS FOR SYNTHESIS OF NANO - MATERIALS – II		7
3	1	Template based synthesis, Electrochemical synthesis, Sonochemical synthesis cavitation, Polyol method, Sol-gel synthesis- reactions and catalysts.	
	2	Micelles and Microemulsion assisted synthesis- principle and parameters that affect size and shape of nanostructured products, Thermal decomposition, Langmuir Blodgett (LB) method.	

4.	BIOLOGICAL METHODS FOR SYNTHESIS OF NANOMATERIALS		15
	1	Use of bacteria, fungi, actinomycetes and algae for nanoparticle synthesis- natural synthesis of magnetic nanoparticles using magnetotactic bacteria – magnetosomes,	
	2	Viruses as components for the formation of nanostructured materials – common virus types used, scaffolds, specific features of plant viruses, functionalizing scaffolds.	
	3	Role of plant derivatives in nanoparticle synthesis- Nanoparticle synthesis with the help of enzymes- biocatalytic enlargement.	
	4	Cofactor-assisted Nanoparticle synthesis- DNA-assisted synthesis of nanoparticles- Nanomaterial synthesis from industrial or agricultural wastes.	

5	TEACHER SPECIFIC MODULE - LITHOGRAPHIC TECHNIQUES FOR FABRICATION OF NANOMATERIALS		12
	1.	Basics of micro and nano lithography processes- Optical Lithography- Proximity- contact and projection printing- Materials and methods.	
	2.	Electron beam lithography- Rastorscan and vector scan- Pros and cons- proximity effects.	
	3.	X-ray lithography- processes, advantages and disadvantages- geometric effects- Focused ion beam lithography- Near field Scanning.	
	4.	AFM lithography – Bias assisted, and force assisted methods- Dip pen lithography- Diffusive and Liquid Inks.	

Essential Readings:

1. Applications by Guozhong Cao, Imperial college Press, (2006). Publisher: World Scientific Publishing Company.
2. Introduction to Nanoscience and Nanotechnology, Chattopadhyay K.K, Prentice Hall India Learning Private Limited
3. An introduction to Electrospinning and Nanofibers j Seeram Ramakrishna, Kazutoshi Fujihara, Wee Eong Tee, Teck Cheng Lim, Zaveri Ma, World Sci. Pub. Ltd. Singapore, 2005.
4. Springer Handbook of Nanotechnology - Bharat Bhusan Publisher: Springer- Verlag (2006)
5. Nanoscience and Nanotechnology: Fundamentals of Frontiers, Shubra Singh M.S. Ramachandra Rao, Wiley
6. Fabrication And Application of Nanomaterials, S Bandyopadhyay, McGraw Hill.
7. Nanomaterials: Mechanics and Mechanisms, Ramesh K.T Springer (India) Pvt. Ltd.
8. Nanomaterials And Nanocomposite: Synthesis Properties Characterization Techniques And Applications, Rajendra Kumar Goyal, T&F India.

9. An Introduction to Nanomaterials and Nanoscience, Asim K Das and Mahua Das, CBS Publication
10. Nanotechnology: An introduction to synthesis, properties and applications of nanomaterials, Thomas Varghese, K.M. Balakrishna, Atlantic Publishers and Distributors
11. Nanostructure and Nanomaterials, Parthasarathy B.K. Isha Books
12. Advances in Nanomaterials and Composites, Ravindra Singh Rana. Rajesh Purohit Priyanka Verma, Saraswati Rana, Deepen Banoriya, Walnut Publication.
13. A Textbook Of Nanoscience, Rakesh Kumar & Kamala Pati Tiwary, S.K. Kataria & Sons.
14. Textbook of nanosciene and nanotechnology, Murthy Raj, Shankar Rath Murd, Orient Blackswan Private Limited.
15. Springer Handbook of Nanotechnology - Bharat Bhusan Publisher: Springer- Verlag (2006)
16. Introduction to Nanoscience & Nanotechnology, Gabor L. Hornyak, Harry F. Tibbals, Joydeep Dutta, John J. Moore, CRC Press,

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.