Faculty of Science

Bachelor of Science (B.Sc.)

SUBJECT: NANOTECHNOLOGY

B.Sc. II Semester

Paper-Major

INTRODUCTION TO NANOTECHNOLOGY

Course Outcome

CLO No.	Course Outcomes	Cognitive Level*
CLO -I	Students will be able to solve Schrodinger equations for various problems	U, R
CLO -II	Students will be able to calculate surface area to volume ratio of given materials	U, R,
CLO -III	Students will be able to classifydifferent nanostructures and calculate their density of states.	R, U, Ap, An, E
CLO -IV	Students will have a clear understanding about variation of different properties with size.	R, U, An, Ap, E, C
CLO -V	Students will understand different techniques used in nanobiotechnology.	U, R

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	4	40	60	**100**
Practical	2	40	60	**100**
Total	**6**	**200**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 20 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)
Practical	3 Internal Exams (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 4.5 Hrs. per week
Total No. of Lectures: 60 Hrs.+ Tutorials (5 Hrs.)
Maximum Marks: 60

Units	Topics	No. of Lectures
I	**Quantum Theory of Nano-materials-II** Formalism of Schrodinger Equation: Time independent & time independent Schrodinger equation and their general solution , Solution of Schrodinger equation for particle in a box , One-Dimensional Rectangular Barrier and Concept of Tunneling(Theoretical explanation).	13
II	**Area & Volume of Nano-materials** Inter-conversion of units. Introduction to surface area to volume ratio and aspect ratio. Difference between surface area to volume ratio of bulk materials and nano-materials (sphere, hollow sphere, rods, hollow rods, cubes and hollow cubes) and related numerical problems. Difference in aspect ratio of bulk wire and nanowire and related numerical problems. Nano-materials and wavelength of light.	13
III	**Classification of Nano-materials** Introduction to dimensional growth process. Classification of nano-materials into 0D, 1D, 2D and 3D. Relationship between dimension and shape of nano-materials (Quantum dots, quantum wells Quantum wires). Introduction to size effect on electronic and optical properties, Concept of Quantum Confinement, Density of states in 3D, 2D, 1D and 0D solid.	13

IV	**Novel Properties of Nanomaterials and Related Theoretical Background** Classification of Nano-Particles: Organic NPs, Carbon-based NPs, Inorganic NPs , Size and shape dependent optical, emission, electronic, transport, photonic, refractive index, dielectric, mechanical, magnetic, Catalytic and photo-catalytic properties, non-linear optical properties; Mie theory (Conceptual explanation)	**13**
V	**Terminology and Techniques in Nanobiotechnology** Definitions, Scopes and applications of Biotechnology, Nano-biotechnology, Bio-molecular Nanotechnology, Biomedical-Nanotechnology, Green-Nanotechnology. Fundamentals and introduction to techniques such as mechanical extraction, physical methods of homogenization, centrifugation, dialysis, electrophoresis and chromatography techniques for purification of biomolecules.	**13**

References

Test/Reference Books:

1. 1. Edward L. Wolf, Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Wiley-VCH (2006).
2. Arthur Beiser, concepts of modern physics (sie), 7th edn
3. Nanotechnology : Principles and Practices - S. K. Kulkarni (3rd Edition)
4. Quantum Mechanics Concept and Applications by Nouredine Zettili

Web Links:

1) NPTEL: Quantum Mechanics https://nptel.ac.in/courses/115/101/115101107/
2) NPTEL: Introduction to Nanomaterials https://nptel.ac.in/courses/118/104/118104008/
3) NPTEL: Nanostructuresd Materials https://nptel.ac.in/courses/118/102/118102003/

List of Experiments

1. To measure the resistivity of semiconductor crystal with temperature by four -probe method.
2. To determine the type (n or p) and mobility of semiconductor material using Hall-Effect System
3. To determine the Energy Band gap (Eg) of silicon Crystal using energy band gap measurement setup
4. Calculation of total number of atom's and surface atom's present in a nanoparticle of a given size. (Theoretical)
5. Calculation of surface area to volume ratio of 1D solid and hollow nanostructure. (Theoretical)
6. Study of crystal systems
7. Preparation of stock solutions and Buffer Solution, Stock Solution, such as Acetate Buffer pH 4.8, phosphate buffer pH 9.6, Phosphate Buffer saline pH 7.2,