Faculty of Science

Bachelor of Science (B.Sc.)

SUBJECT: PHYSICS

B.Sc. I Semester

Paper-Major

NANOTECHNOLOGY

Course Outcome

CLO No.	Course Outcomes	Cognitive Level*
CO -I	Students will be able to Solve the homogeneous and non-homogeneous linear differential equations of second order with constant coefficients.	U, R
CO -II	Students will be able to explain fundamentals of atomic structure.	U, R, Ap, E
CO -III	Students will be able to understand the basic elements of crystal structure of material and classification of solids according to energy band.	R, U, Ap, An, E
CO -IV	Students will recognize the history background and the nature of nano science and nano technology.	R, U
CO -V	Students will understand the origin and use of basic concepts of quantum physics.	U, R ,Ap,C,E

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory + Tutorial	6	40	60	**100**
Total	**6**	**100**		

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)

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	**Mathematical tools for NanoScience** Differential equation: Order and degree of differential equation, ordinary and partial differential equations, Linear differential equation ;1st order homogeneous differential equations, 2nd order homogeneous and non-homogeneous differential equations with constant coefficients and its solutions, Examples Linear Differential equations in Physics, Solution of differential equation using Python / Mathematica.	13
II	**Fundamentals of Atomic Structure and Bonding** Bohr's atomic structure, Bohr's atomic radii, comparative size of nano-materials and atomic size, electronic configuration, energy levels of shells and related numerical problems on excitation of electrons from lower to higher energy level. Concept of quantization of energy. Arrangement of atoms in solids (two dimension crystal structures and three dimension crystal structure). Molecular Orbital Theory, bonding and ant-bonding states. Electronic structure of solids.	13
III	**Crystal Structure** Crystalline and amorphous state of solids, unit cells and space lattices, crystal structures(Simple *bcc*, and *fcc)*, crystal planes and directions, Miller indices, diffraction of X-rays by crystal, Bragg's equation, reciprocal lattice, crystal defects, point, line and surface defects. **Semiconductors and Their Properties** Origin of energy bands in solids, Classification of solids: conductor, insulator and semiconductor Band model of semiconductors, intrinsic and extrinsic semiconductors, Fermi level, variation of conductivity and mobility with temperature.	13
IV	**Introduction of Nano-science:** History of nano- materials, Michael Faraday and divided metals, story of Damascus sword. stained glass windows. How nanoworld is different from world around us, what is nano? Beginning of nano Science; Feynman's "there is plenty of room at the bottom", contribution of India in nano-science and nanotechnology Nanotechnology timeline, Pre-18th, Century, 19th Century, 20th Century and 21st Century. Introduction to Nano-science and Nano-technology, Nano-scale material,	13

	implications for Physics, Chemistry, Engineering & Biology, and Motivation for Nanotechnology study. History & development of Nano-science and Nano-technology with the emphasis on history of Nano-metals.	
V	**V: Basic Concepts of Quantum Theory -I** Importance of Quantum theory, Wave-particles duality, de-Broglie and Fermi Wavelengths, Concept of wave packet and wave functions, Normalized and orthogonal wave function Group velocity and phase velocity , Dynamical operators, expectation values, Uncertainty principle, Quantum numbers, Pauli exclusion principle.	**13**

References

Test/Reference Books:

1. Advanced Engineering Mathematics by Erwin Kreyszig
2. C. Kittle. Introduction to Solid State Physics
2. S.O. Pillai Solid State Physics
3. A.J. Decker, Solid State Physics
4. Solid State Physics Puri & Babber
5. Textbook of Nano-science and Nanotechnology by Murthy Raj Shankar Rath Murd
6. Nanotechnology an Introduction to Synthesis Properties and Applications of Nanomaterials by Thomas Verghese and K.M.Balkrishna.
7. Nanophysics and Nanotechnology by Wolf Edward
8. The Physics and Chemistry of Solids by Stephen Elliott & S. R. Elliott, John Wiley & Sons, 1998.
9. Quantum Mechanics Concept and Applications by Nouredine Zettili

Web Links:

1) NPTEL: Material Science https://nptel.ac.in/courses/112/108/112108150/
2) NPTEL: Quantum Mechanics https://nptel.ac.in/courses/115/101/115101107/