SEMESTER-1st
MAJOR COURSE

NTY122J: NANO-TECHNOLOGY (INTRODUCTORY NANOSCIENCE: PHYSICAL, CHEMICAL & BIOLOGICAL CONCEPTS-I)

CREDITS: THEORY: 04; PRACTICALS: 02

Course Objectives:

This course aims to give insights about history and evolution of Nanotechnology, provide basic concepts of materials at different scales, and familiarize students with mathematical concepts in building an understanding of basic physical, chemical and biological concepts and properties of nanoscale materials.

THEORY (04 CREDITS)

Unit-I

Historical background of Nanoscience and Nanotechnology, Feynmann's vision on Nanoscience & Technology, length scales (macro, micro and nano), surface to volume ratio (plane, cylinder, cube and sphere), classification of nanomaterials (2D, ID, OD), examples of nanomaterials.

Unit-II

Basic concepts of differential calculus, derivatives of second and higher order, maxima and minima of a function, most probable velocity from Maxwell distribution. Bohr's model of atom applied to H-atom, energy levels of shells, electronic configuration, numerical problems on excitation of electrons from lower to higher energy levels, molecular orbital theory: postulates, bonding and anti-bonding states.

Unit-Ill

Homogeneous and non-homogeneous system of linear equations and conditions for their solution. Eigen-value problem to understand stability of the system bonding, basic concepts of probability, average value, root square mean value (examples from kinetic theory of gases). Types of solids and arrangement of atoms in solids, bonding in solids, crystal lattice and translation vectors, crystal symmetry, crystal planes and directions, Bravais lattices and their types, simple BCC and FCC crystal structures with examples, Miller indices.

Unit-IV

Biological Principles for Nanoscale Science: Classification, structure & function of biomolecules-(Carbohydrates, Lipids & Proteins). Enzymes: properties and function as biocatalysts. General principles of integrative metabolism: catabolism, anabolism, metabolon concept, energy currency in biological systems.

Learning Outcomes:

Unit - I: After completion of Unit I, student will have a historical perspective of Nanosciences & Nanotechnology and how it has progressed and evolved as a distinct science, besides being able to relate to the terminology and basic fundamentals about nanomaterials.

Unit - II: After completion of Unit II, the student should be able to have a basic understanding of some mathematical concepts, understand atomic structure, get familiarized with almost all the basic chemical concepts and set the foundation for material aspects of inorganic chemistry.

Unit - III: After completion of Unit III, the student will strengthen the mathematical concepts of linear equations, probability, etc., and relate them to kinetic theory of gases, and know about different arrangements of atoms in solids and their properties and understand the role played by the crystalline structures in determining properties of materials. This will lead to an understanding about different types of crystals for selection of existing materials to develop new materials/ nanomaterials.

Unit - IV: After completion of Unit IV, student will be able to develop a basic understanding of biomolecules and their properties to make it coherent with their understanding of disease and applications of nano-biologicals in therapeutics and molecular diagnostics in later semesters.

In particular the student will be able to:

1. *classify carbohydrates, lipids and proteins into different types and know about their structure & functions in the biological system.*
2. *have a fundamental concept of enzymes and their function.*
3. *learn about the basic principles of intermediary metabolism.*

LABORATORY COURSE-I (2 CREDITS)

1. To determine the wavelength of sodium light by measuring the diameters of Newton's rings.
2. Determination of Plank's constant using Photoelectric Effect.
3. Determination of e/m ratio of electron by J.J. Thomson's method.
4. Determination of Rydberg's constant using Hydrogen discharge tube.
5. Numerical approaches for calculation of surface to volume ratio.
6. Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
7. Titrimetric analysis: Calibration and use of apparatus.
8. Preparation of solutions of different Normality/Molarity of titrants.
9. Qualitative tests for carbohydrates, lipids and proteins.
10. Verification of Beer Lambert Law.

Note: Practical exercises will be conducted subject to the availability of necessary equipment and reagents.

REFERENCES:

1. Introductory Nanoscience: Physical & Chemical Concepts, Masaru Kuno, Garland Science.
2. The Science of Small: Nanotechnology, Shah & Shah, Wiley.
3. Mathematical Methods for Scientists and Engineers, D. A. McQuarie, University Science Books, 2003.
4. Chemical Mathematics D. M. Hirst, Longman.
5. Elementary Solid-State Physics-Principles and Applications, M. Ali Omar, Pearson.
6. Crystal and crystal structure by Richard Tilley, Willey Pub.
7. Concepts of Modem Physics, Arthur Beiser-, McGraw Hill
8. Atkins Physical Chemistry by Peter Atkins, Julio de Paula, James Keeler 11th Edition, 2018, John Wiley & Sons, NJ, USA.
9. Basic Inorganic Chemistry by F. Albert Cotton, Geoffrey Wilkinson, et al., 3rd Edition, 1994.
10. Lehninger's Principles of Biochemistry-' by D. L. Nelson and M. M. Cox, CBS Publications, 8th Edition, 2021.
11. B.Sc. Practical Physics, C L Arora, S. Chand & Co. Ltd., New Delhi
12. Advanced Practical Physical Chemistry; J.B. Yadav; Krishna Prakashan Media (P) Limited, 2015.
13. Practical Biochemistry: An Introductory Course by Fiona Frais. University Park Press, 2016
14. A Textbook of Practical Biochemistry by David Plummer McGraw Hill Education; 3 edition 2017.