UNIVERSITY OF DELHI

CNC-II/093/1/Misc./2025/20
Dated: 07.11.2025

NOTIFICATION

Sub: Amendment to Ordinance V

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

The syllabus of Discipline Specific Elective (DSEs) paper titled "Introduction to Nanoscience" offered by the Department of Electronic Science in Semester-VII of BSc. (Hons.) Electronics, has been revised in terms of credit distribution. The same is notified for the information of all concerned as per details below:

Existing	Amended
DSE - "Introduction to Nanoscience" Lecture = 04 Tutorial =0 Practical =0	DSE - "Introduction to Nanoscience" Lecture = 03 Tutorial =1 Practical =0

The revised syllabus is enclosed at Annexure-1.

11/11/25

REGISTRAR

ELDSE7F Introduction to Nanoscience

Credits: Theory-03 **Theory Lectures: 45h**

Course Learning Objectives

This course introduces the student about nanoscience, which includes the fundamental understanding of effect of size and the related physics involved behind it.

Course Learning Outcomes

At the end of this course, Students will be able to

CO1 To develop the fundamental base of nanoscience.
CO2 To acquire knowledge of effect of size and the related physics involved behind it.
CO3 To understand the behavior and properties of nanomaterials.

L-T-P: 3-1-0

Syllabus Contents

Unit I: Introduction to Nanoscience **10 Hours**

Introduction to Nanoscience: Definition and Importance of Nano, Opportunities at nano scale, Scientific revolution- emergence and challenges of nanomaterial and nanotechnology with examples (daily life, health care and energy), Implications of Nanoscience and Nanotechnology on Society, Harnessing Nanotechnology for Economic and Social Development, influence of nano over micro/macro, surface to volume ratio-dangling bonds, chemical activity of nanoparticulates, sensing applications with example of graphene. Size effects-idea about electronic wave function, Population of the conduction and valence bands, Quasi Fermi levels, examples of metal nanoparticles.

Unit II: Introduction to Quantum Theory **12 Hours**

Fundamentals of Quantum Theory: Origins of Quantum Physics, Particle properties of waves: Black body radiation, Photoelectric effect, Compton Effect; Wave properties of particles: De Broglie waves, Wave description, Particle diffraction, The Wave Particle Duality, The Uncertainty Principle, The Wave Packet and the Wave Function, The Schrödinger Equation, The Expectation Value, The Free Particle Solution, The Linear Harmonic Oscillator Problem, The Kronig-Penney Model for Electron in a 1-Dimensional Lattice

Unit III: Quantum Nanoengineering **10 Hours**

Particle in a Box, Quantum Limit: From 3D to 0D, Quantum Confinement in Semiconductors: Potential Step, Potential Barrier, Quantum Well. Atomic structure: Electron orbits, The Bohr atom; Quantum Structure: 2D (Quantum well), 1D (Quantum Wires), 0D (Quantum Dots);

3D Density of States, 2D Model- Energy Eigen values and Density of States, 1D Model- Energy Eigen values and Density of States, Q0D Model- Energy Eigen values

Unit IV: Properties of nanostructures **13 Hours**

Quantum Effect on Properties of Nanomaterials: Melting Point- Variation in bulk vs nanoparticles, nanowires, nanosheets, superheating, liquid drop model (Quantitative); Electronic structure and Optical Properties-band gap dependence on the size of the nanoparticles(quantitative), concept of excitons; Mechanical Properties- ductility, strain hardening, yield stress, dynamic response, creep(qualitative); Dielectric Properties- particle size dependence of refractive constant, extinction coefficient (quantitative), Magnetic Properties-idea about diamagnetism, paramagnetism, ferromagnetism, Curie temperature, remanent magnetization, coercive field; saturated magnetization and its dependence on size and temperature(quantitative)

Size dependent electronic Properties (Classification of materials based on band structures - Brillouin zone – Effect of temperature, Quantized conduction, Ballistic transport, Coulomb blockade).

References/Suggested Readings

1. Introductory Nano science by Masuro Kuno, Garland science (2011)
2. Concepts of Modern Physics by Arthur Beiser, TMH Publications
3. Nanophysics and Nanotechnology by Edward L. Wolf Wiley-VCH-2006
4. Nanotechnology: Principles & Practices, S.K. Kulkarni, Springer, 2015.
5. Introduction to Nanomaterials and Devices : Omar Manasreh (Wiley)
6. Introduction to Nano, Basics to Nanoscience and Nanotechnology, Amretashis Sengupta • Chandan Kumar Sarkar Editors, 2015, Springer, ISBN 978-3-662-47313-9
7. Textbook of Nanoscience and Nanotechnology, B S Murty and others, 2013, Springer, e-ISBN 978-3-642-28030-6

Introduction to Nanoscience Tutorials

Syllabus Contents

Credits: 01 **Lectures: 15h**

Following are the suggested activities unit wise. At least One Activity is to be done from each unit.

Unit-1

Focus: Fundamentals, scope, and societal relevance of nanoscience

Type	Tutorial Activity	Expected learning outcome
Literature review	Recent advancements and challenges in nanotechnology (with focus on graphene sensing applications, surface-to-volume ratio, and size effects).	Understanding of real-world nano applications and challenges
Group Discussion	Discussion on "Nanotechnology: Boon or Bane for Society?"	Critical evaluation of societal implications.
Presentation cum Research	"Emerging Nanotechnologies in Healthcare and Energy"	Explore interdisciplinary relevance.

Unit-2

Focus: Quantum origins and principles governing nano-systems.

Type	Tutorial Activity	Expected learning outcome
Problem Solving exercise	De Broglie wavelength calculations, Schrödinger equation solutions for free particles, and uncertainty principle etc.	Application of quantum formulas to real cases.
Literature Review	"Historical Development of Quantum Theory and Its Influence on Nanoscience."	Connect classical physics to quantum principles.
Presentation cum Research	"The Schrödinger Equation and its Physical Meaning."	Strengthen conceptual clarity of mathematical formalism.

Unit-3

Focus: Quantum confinement and low-dimensional systems.

Type	Tutorial Activity	Expected learning outcome
Problem Solving	Solve numerical problems on energy eigenvalues for quantum wells, wires, and dots	Practical understanding with computational reasoning.
Literature Review	"Quantum Dots in Bioimaging and Electronics."	Real-world application of confinement phenomena.
Presentation cum Research	Design a comparative chart for "Density of States in 3D, 2D, 1D, and 0D structures."	Visual comprehension of electronic structures.

Unit-4

Focus: Quantum size effects on material properties.

Type	Tutorial Activity	Expected learning outcome
Literature review	"Effect of Nanostructuring on Mechanical and Optical Properties."	Understanding of interdependence of size and properties.
Group Discussion	"Can Nanomaterials Revolutionize Magnetism and Electronics?"	Facilitate understanding of application areas
Presentation cum Research	Plot variation of band gap vs particle size for different types of semiconductor nanoparticles such as graphene, TMDs, and Mxenes etc using available data.	Analyze nanoscale trends besides their application areas