DISCIPLINE SPECIFIC ELECTIVES (DSE-4)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nanomaterials and their Applications ELDSE8D	**4**	**4**	**-**	**-**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**-**

Learning Objectives

This course builds the basic background of nanomaterials, nanostructures and their properties. Classification of nanomaterials and its chemistry is explained and in addition to this, they are made aware of the various applications of nanomaterials.

Learning outcomes

On successful completion of this course, student will be able to:

- To understand classification of nanomaterials.
- To have a broad idea of applications of nanoscience in various fields.
- To understand carbon technology in nanoscience and nanotechnology.
- To have an idea of nano devices and sensors

SYLLABUS OF ELDSE-8D **Total Hours- Theory: 60 Hours**

UNIT – I (14 Hours)
Nanomaterials:
Classification of nanomaterials: Nanosized metals and alloys, semiconductor, Ceramics- a comparison with respective bulk materials, Organic compounds and polymers, carbon age-new form of carbon (CNT to Graphene), Nanocomposites.

Nano ceramics: Dielectrics, ferroelectrics and magneto ceramics, Nanopolymers: Preparation and characterization of diblock Copolymer based nanocomposites, Nanoparticles polymer ensembles; Applications of Nanopolymers in Catalysis.

Classification of conducting polymers: Intrinsic and extrinsic conducting polymers - Chemical and electrochemical methods of the synthesis of conducting polymers.

UNIT – II (16 Hours)
Applications of Nanomaterials for Sustainable Environment:
Nanomaterials in Energy Technology- Introduction: Nanotechnology for sustainable energy- Energy conversion process, indirect and direct energy conversion, use of nanoscale catalysts to save energy and increase the productivity in industry.

Electrochemical Energy Storage Systems: Batteries: Primary, Secondary, Lithium, solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium batteries; Advanced batteries.

Nanomaterials in Energy Storage: Nano-electrochemical systems, nanomaterials for rechargeable batteries, nanomaterials for fuel cells.

Environmental applications of nanomaterials: Mechanism for remediation of aqueous contaminants, photocatalyst; membranes incorporating nanomaterials, transport processes in membrane technology; nanomaterial-based adsorbents for water and wastewater treatment – adsorption at metal oxide surfaces, hybrid adsorbents.

UNIT – III (14 Hours)
Carbon Nanotechnology:
Introduction to carbon nanotubes and their applications in various industries, supercapacitors, hydrogen storage; Nanomaterials for solar power: Solar energy materials, Solar energy devices, silicon solar technology for clean energy, Light Emitting Diodes, LED displays.

UNIT – IV (16 Hours)

Nano Devices and Sensors:

Introduction to Gas sensors; Characteristics of Gas sensors; Types of Gas sensors; Solid State Gas sensors: Chemiresistive Gas sensors (Semiconducting Metal Oxide based sensors, Carbon Nano Tube based nano sensors).

Miscellaneous applications: Microfluidics and Microsystems, Micro-electromechanical systems, ChemFET (NEMs and MEMS based sensors), Optic Gas sensors, Spectroscopic Gas sensors, Chemical Sensors: Electrochemical Gas Sensors.

Nano magnetism

Magnetism and Magnetic Materials, Basics of Magnetism, Magnetic Domains and Anisotropy, Magnetic Nanostructures, Magnetism of Nanosized Materials, Spintronics technology and the challenges, Electron and nuclear spin devices

Practical component (if any) – None

Essential/recommended readings

1. Introduction to Nanomaterials and Devices , Omar Manasreh, Wiley, 1st Edition, 2011
2. Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, Baldev Raj, B.B. Rath, James Murday, 2013, Springer, e-ISBN 978-3-642-28030-6
3. Nano: The Essentials - Understanding Nanoscience and Nanotechnology, T. Pradeep, Tata McGraw-Hill (TMH) Education, 1st Edition, 2007
4. Linden's Handbook of Batteries (and Fuel Cells), Thomas B. Reddy (original: David Linden, Thomas Reddy), McGraw-Hill Education, 5th Edition, 2019
5. Mark R. Wiesner, Jean-Yves Bottero, Environmental Nanotechnology: Applications and Impacts of Nanomaterials, McGraw-Hill, 2nd Edition, 2016

Suggestive readings

1. Diallo, M., Duncan, J., Savage, N., Street, A., and Sustich, R. (Eds). "Nanotechnology Applications for Clean Water" William Andrew. 2008
2. Martin A Green, Solar cells: Operating principles, technology and system applications, Prentice Hall Inc, Englewood Cliffs, NJ, USA, (1981).
3. Nanosensors: Physical, Chemical, and Biological by Vinod Kumar Khanna, Publisher: CRC Press.
4. Novel Nanocrystalline Alloys and Magnetic Nanomaterials- Brian Cantor

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.