

## DISCIPLINE SPECIFIC ELECTIVE COURSE – 24 LS (DSE-24 LS)

### Nanomaterials and their Biological Applications

#### 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 Biological Applications (DSE-24 LS)	04	02	--	02	Class12 <sup>th</sup> with Physics, Chemistry Biology	--

#### Course Objectives

The objectives of this course are as follows:

- To study about fundamentals and applications of Advanced Inorganic materials.
- To understand the mechanism of synthesis of hydrogels, composites, mesoporous materials.
- To understand the fabrication of materials for their notable applications in living systems.
- To know how these materials are making life easier in this era and are great sources of industrial growth and technological changes.

#### Learning outcomes

By studying this course, the students will be able to:

- Understand various materials, their synthesis and properties.
- Explain the mechanism of growth of self-assembled nanostructures.
- Explain the importance of hydrogels composites, mesoporous materials and their applications.
- Understand the usage of materials in various fields ranging from modern life to Human health, and environment.
- Develop skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments.

#### Unit1: Nanomaterials

(8 Hours)

Overview of nanostructures and nanomaterials, classification, preparation and optical properties of gold and silver metallic nanoparticles, concept of surface plasmon resonance, carbon nanotubes, inorganic nanowires, Bioinorganic nanomaterials, DNA and its nanomaterials, natural and artificial nanomaterials, self-assembled nanostructures, control of nanoarchitecture, one dimensional control.

#### Unit 2: Composite materials

(7 Hours)

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, bio-nanocomposites, environmental effects on composites, applications of composites.

**Unit 3: Hydrogels: (10 Hours)**

Introduction, natural, synthetic, and hybrid hydrogels, Properties of hydrogels, different methods of synthesis, notable hydrogel systems such as alginate-based, PEGDA, and PVA hydrogels, Applications of hydrogels such as environmental remediation, Food packaging, sensor, and biomedical.

**Unit 4: Nanomaterials for Biomedical Applications (5 Hours)**

**Inorganic nanomaterials:** silica, carbon based, metallic, oxides.

**Biomedical applications:** Quantum dots, gold nanoparticles, and magnetic nanoparticles for imaging, biosensing, therapeutics and diagnostics. Polymeric nanoparticles, dendrimers, and carbon nanotubes applied to drug delivery systems. Nanomaterials such as nanofibers, and nanocomposite materials as scaffold materials for tissue engineering and regeneration. Nanotoxicology.

**Practical: Credits: 02**

1. Synthesis of hydrogels and study of swelling behavior.
2. Preparation of zeolite A and removal of Mg and Ca ions from water samples quantitatively using zeolite.
3. Synthesis of ZnO, NiO nanoparticles by green approach methods and characterization using UV-visible spectrophotometer.
4. Synthesis of Cu doped ZnO nanoparticles.
5. Synthesis of CuS, MnS and CdS nanoparticles and their characterization using UV- visible spectrophotometer.
6. Synthesis of gold and silver nanoparticles and study of their optical properties as a function of size.

**Recommended Texts:**

**Theory:**

1. West, A. R. (2014), Solid State Chemistry and Its Application, Wiley.
2. Smart, L. E.; Moore, E. A., (2012), Solid State Chemistry: An Introduction CRC Press Taylor & Francis.
3. Rao, C. N. R.; Gopalakrishnan, J. (1997), New Direction in Solid State Chemistry, Cambridge University Press.
4. Xu, C.; Zang Y. S.; Begin S.; Thanh N. T. K.; Nanoscale, 2022,14, 7441-7443.
5. Poole Jr.; Charles P.; Owens, Frank J. (2003), Introduction to Nanotechnology, John Wiley and Sons.

**Practical:**

1. Cheng, K.H.; Jacobson, A.J.; Whittingham, M.S. (1981), Hexagonal Tungsten Trioxide and Its Intercalation Chemistry, Solid State Ionics, 5, 1981, 355-358.
2. Ghorbani H.R.; Mehr, F.P; Pazoki, H; Rahmani, B.M.; Synthesis of ZnO Nanoparticles by Precipitation Method, Orient J Chem 2015, 31(2).
3. A.K. Sharma, R. Sharma, B. Pani, A. Sarkar, M. Tripathi, Engineering the Future with Hydrogels: Advancements in Energy Storage Devices and Biomedical Technologies. New Journal of Chemistry, RSC, 2024, 48, 10347-10369.
4. Xu, C.; Zang Y. S.; Begin S.; Thanh N. T. K.; Nanoscale, 2022,14, 7441-7443.

**Assessment Methods:** All examination and assessments methods shall be in line with the University of Delhi guidelines issued from time to time.

**List of Instruments/Software required for Implementation of Fourth year Course of Study for each College**

1. UV- Vis Spectrophotometer
2. Table top IR Spectrophotometer
3. ChemDraw, GaussView6/ GaussView5 and Gaussian 16/Gaussian 09 Software
4. Access to p-XRD NMR Spectrophotometer in Department of Chemistry/USIC
5. Rota Evaporator
6. Sonicator
7. Cyclic Voltammeter/ Potentiostate-Galvanostate