SECOND SEMESTER 2018-2019
COURSE HANDOUT

Date: 16-01-2021

In addition to part I (General handout for all courses appended to the timetable) this portion gives further details regarding the course.

Course No. : **CHEM F336**
Course Title : **Nanochemistry**
Instructor-in-charge : **INAMUR RAHAMAN LASKAR**

1. Course Description: Introduction, importance of nanoscience, chemistry behind nano; Instruments to be used for characterizing nanomaterials; Diversity in nanosystems: chemical aspects of metallic, semiconducting nanomaterials, nanocomposites, carbon nanotubes and fullerenes, self-assembled monolayers, monolayer protected metal nanomaterials, core-shell nanomaterials; Applications of nanomaterials in nanobiology, nanosensors and nanomedicines, hands on experience in laboratory.

2. Course Objectives: This is an elective course for chemistry discipline. Throughout the semester we will discuss the properties of nanomaterials and its dependence on shape, size, and functional groups, which enable us to employ nanomaterials for device applications. Applications are limited in the fields of biology, sensors, medicine, and machines. However, in this course we will try to address the most important concepts and applications of Nanochemistry in recent research.

By the end of the semester, you will be able to:
- Learn the importance and properties of nanomaterials
- Gain the idea of synthesis and characterization of nanomaterials
- Study semiconductor nanoparticles and nanocomposite materials
- Investigate different nano systems, carbon nanotube, fullerenes etc.
- Learn various application of nanomaterials in catalysis, biological, and device application
- Learning of laboratory techniques of central importance to explore the idea of nanosystem
    - Synthesis of mono- and bimetallic nanoparticles
    - Synthesis of magnetic (Fe_3O_4) nanoparticle
    - Role of a stabilizer during the synthesis of nanoparticle

3. TextBook: T. Pradeep, Nano: The Essentials, Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.

4. Reference Book: (1) T. Pradeep, A Textbook of Nanoscience and Nanotechnology, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2012.

(2) G. Cao and Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and

Applications, 2nd edition, World Scientific Series in Nanoscience and Nanotechnology, Vol 2, 2011
(3) C. P. Poole Jr. and F. J. Owens, Introduction to Nanotechnology, Wiley Int. science 2003.
(4) Nanomaterials, B. Viswanathan Narosa Publishing House, New Delhi

5. Course plan:

Module No.	Lecture Session	Topics to be covered	Learning outcomes	Reference
1	Introduction	Nano the beginning, concept, importance	• Why nano? • Historical landmark in nanoscience and nanotechnology	T1 and R1 (Will be announced in the class)
2-7	Metal nanoparticles: syntheses, characterization, and properties	Syntheses, properties of monolayer and polymer capped metal nanoparticles, Mie theory, controlling the size and composition of the metallic cores of nanoparticles, Anisotropic metal nanoparticle, Nanostructure: 2D array, 3D Superlattice, Bimetallic nanoparticles	• Different methods to make nanomaterials • Principle properties to explore nanomaterials • Size and Shape-dependent nanomaterials • Core-shell and alloy nanomaterials	T1 and R1 (Will be announced in the class)
8-11	Instruments for the characterization of nanomaterials	Electron microscopes, Scanning probe microscope, X-ray diffractometer	• Identification of objects in the nano domain • Modern advances in the techniques to characterize nanomaterials	T1 and R1

12-16	Semiconducting nanoparticles: Syntheses, properties, and characterization	Quantum dots, Electronic structure, Semiconductor nanoparticle, Optical properties	• Discovered properties of quantum dots and quantum confinement • Optical, photophysical, photochemical, and biological properties of quantum dots	T1 and R1
17-21	Nanocomposite materials	What are composite materials; Classification of nanocomposites: Nonpolymer based nanocomposites; Polymer based composites; Biocomposites	• Development of supported nanomaterials • Stabilization of nanoscale material using polymer	T1 and R1
22-25	Sell-assembled monolayers	Monolayers on gold, patterning monolayers, Langmuir Blodgett films, Applications of films in LED, Non-linear optical properties	• Various kinds of monolayers • Properties and application in nanotechnology	T1 and R1
26-28	Carbon nanotubes	Syntheses, Structures, physical properties, Electronic properties, Mechanical Properties and applications	• Different properties of carbon nanotube • How to fill and use of carbon nanotube	T1 and R1
29-31	Fullerenes	Syntheses and purification, Properties, Nanostructured fullerene films, Applications in electrocatalytic aspects and photoelectrical conversion of light energy	• Discovery of fullerens and relation to the development of nanoscience • Usual and unusual properties of fullerens	T1 and R1

32-35	Nanoparticles in catalysis	Introduction of nanoparticles in catalysis, Methods of preparation of supported metal nanoparticles, Applications of nanomaterials in various fields of catalysis, sensoric and photoelectrochemical applications	• Recent advancement in nanoscience and nanotechnology in catalysis, photocatalysis, and sensoric application	T1 and R1
36-41	Nanoparticles in Biological and biomimetic applications	Colloidal gold bioconjugates, Metal cluster conjugates, DNA and nanoparticles, DNA recognition, Biomimetic applications: Carbohydrate-protein interactions, Nanomaterials in drug delivery systems	• Interaction between biomolecules and nanonanoparticles • Nanosystems used for diagnostic and therapeutic application	T1 and R1

6. Evaluation Scheme:

Component	Duration	Weightage %
Mid Semester Test	90 min	30
Tutorial test	10 -15 min	20
Seminars		10
Comprehensive Exam	120 min	40

7. Chamber Consultation Hour: To be announced in the class.

8. Make-Up: Make up would be considered only for **regular students having genuine reasons. No make-up will be given for seminar.**

9. Notice: Notices, if any, concerning the course will be displayed on the **in Nalanda website only.**

10. Note (if any): NIL

INAMUR RAHAMAN LASKAR
Instructor-In-Charge
CHEM F336