Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2022-2023

Course Handout Part II

Date: 06-08-2022

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. **: CHE G528**
Course Title **: Introduction to Nanoscience and Technology**
Instructor-in-Charge **: Dr. Satyapaul A. Singh**

Course Description : Introduction to nano-science, Basic idea of solid state physics and quantum mechanics, Quantum wells, Wires and dots, Properties of nanomaterials, Carbon nanotubes, Nanosynthesis, Characterisation methods, Application of nano-materials to various fields like electronics, medical, MEMS, photonics, molecular switches and others, Special reference to Chemical Engineering as in catalysis, heat transfer and special additive and performance materials (nanofluids, nanocomposites), Future of nano science and technology, Large scale manufacture and technological issues.

Scope and Objective of the Course:

As a part of this course students get exposure to nanoscience, nanotechnology, scientific understanding of nanomaterial properties, characterization and analysis. This course targets majorly to improve the student's knowledge by synthesizing nanoparticles, further sharing the interesting topics in the form of presentations. The writing report and project presentations would give a chance to improve the communication and writing skills of a student that may be beneficial at later stages of his/her's academic program.

At the end of the course, the student should be able to:

- Understand the importance of nanoscience and its applications
- Design a synthesis protocol for metal oxide systems
- Synthesize metal oxides and composites with different synthesis routes
- Understand the characterization methods and tuning the properties of nanomaterials for the desired application
- Improve the presentation and writing skills

Textbooks:

T1 – T. Pradeep, "Nano: The essentials; Understanding nanoscience and nanotechnology", McGraw Hill Publishing Company Ltd, New York (2008).

T2 – Charles P. Poole, Jr., Frank J. Owens, "Introduction to nanotechnology", John Wiley & Sons, New York (2003).

Reference books:

R1 – T. Pradeep, "A textbook of nanoscience and nanotechnology", Tata McGraw Hill Educational Private Ltd, New Delhi (2003).

R2 – Donald A. Neamen, "Semiconductor physics and devices", McGraw Hill Publishing Company Ltd, 3rd Edition (2007).

R3 – Zhong Lin Wang, “Nanowires and nanobelts: Materials, properties and devices”, Volume 1, Kluwar Academic Publishers, Dordecht (2003).
R4 – Peter Rodgers, “Nanoscience and technology: A collection of reviews from nature journals”, World Scientific, London (2010).
R5 – Ke Liu, Chunshan Song, Velu Subramani, “Hydrogen and syngas production and purification technologies”, John Wiley & Sons, New Jersey (2010).

Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
1 – 3	Introduction to nanoscience	What is nanoscience and technology, Nanoscience in nature	Ch.1 of T1 Ch.1 of R1
4 – 5	Solid state physics	Understanding crystal structures, energy bands, lattice vibrations, fermi levels, localized particles and its mobility; Applications in characterization techniques	Ch. 2 of T2
6 – 8	Quantum mechanics	Energy quanta, wave-particle duality, wave equations, boundary conditions, statistical mechanics	Ch. 1 and 2 of R2
9 – 12	Quantum wells, wires and dots	Synthesis of quantum dots, wires; Electronic structure of nanocrystals; Size and dimensionality effect	Ch. 7 of T1 Ch.1 of R3 Ch.9 of T2
13 – 16	Properties of nanomaterials	Metal nanoclusters, semiconducting nanoparticles, physical properties	Ch. 4 of T2
17 – 20	Carbon nanotubes	Synthesis, Mechanism of growth, Transport properties, mechanical and electrical properties	Ch.4 of T1
21 – 24	Synthesis and characterization methods	Diffraction techniques, electroanalytical techniques, spectroscopic techniques and etc	Ch. 5 – 8 of R1
25 – 29	Applications of nanomaterials in various fields	Molecular machines and devices, nanoelectronics, nanophotonics, nanobiotechnology and medicine, nanosensors, lab-on-chip technologies	R4
30 – 33	Catalytic applications	Nanoparticles applications in gas-solid and liquid-solid reaction systems	R5
34 – 38	Special performance materials	Composite materials, Metal organic frameworks, core-shell nanostructures	Review Articles
39 – 42	Future of nanoscience and technology	Nanotechnology: How far world can own nanotechnology?	Review Articles and R4

Laboratory component:

Experiment No	Lab name	Experiment Name
Expt-1	Materials science lab	ZnO synthesis using solution combustion synthesis with glycine/urea and ODH as fuels (separate fuel for every batch)
Expt-2	CAL	Sample preparation for SEM and analysis with XRF
Expt-3	CAL & D228	Analysis with XRD and pattern analysis
Expt-4	D314	ZnO material design using DFT tool
Expt-5	D228	Temperature Programming Reduction for ZnO material and effect

		of the fuel used
Expt-6	D228	Microscopic analysis of coated surfaces (dropcasted nanoparticles on silicon vafor, sputtered surface and Natural surfaces)
Expt-7	Materials science lab	Role of Ligand to metal ration to obtain MOFs (Zn) and morphology analysis using reduction
Expt-8	CAL & D228	Sample preparation for SEM and analysis with XRF
Expt-9	CAL	Analysis with XRD and pattern analysis
Expt-10	D228	CO_2 capture studies using
Expt-11	D228	Photocatalytic degradation of dye solution
Expt-12	MCSEE or CAL	FTIR analysis for pristine and spent ZnO catalysts

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Mid exam	90 min.	20	01/11 3.30 - 5.00PM	Closed Book
Project work (Seminar and report)		20	TBA	Open Book
Laboratory sessions (Report and/or Presentations)		20	TBA	Open Book
Comprehensive	3 hrs.	30	21/12 AN	Closed Book
Surprise tests/quizzes		10		Closed Book

Chamber Consultation Hour: Will be announced in classroom (Chamber: **D 204**)

Notices: Will be updated in CMS

Make-up Policy: Make-up will be granted only for genuine cases with valid justification and only with prior permission of Instructor-in-charge.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable

Dr. Satyapaul A. Singh

INSTRUCTOR-IN-CHARGE
CHE G528