MAULANA AZAD
NATIONAL INSTITUTE OF TECHNOLGY, BHOPAL
Department of Physics

Open Elective For
VII Semester
B. Tech. (All Branches)

Name of Program	**B. Tech. All Branches**	**Semester: VII**	**Year 2022 Onwards**
Name of Course	Nanotechnology and Nanoscience **(Offered by the Department of Physics)**		
Course Code	**PHY – 581**		
Core / Elective / Other	**Open Elective**		
Prerequisite:			
1.	Basics of Materials and electronic devices		
2.	Band gap in solids		
Course Outcomes: At the end of the course, the student will be able to			
1.	Understand the theoretical concepts of nanotechnology with the help of different models.		
2.	Conceptualize quantum confinement, types of nanomaterials – 1D,2D,3D nanomarterials		
3.	Understand and use the most important nanomaterial C60 and Fullerene with their special structure and bonding which makes them special		
4.	Understand Different properties like transport thermal and mechanical properties of carbon nano tubes for recent application		
5.	Capable to synthesis and characterize nano materials with controlled structure and tuned band gap		
6.	Synthesis nanomaterials and combine it with advanced technology like Solar Photovoltaic, H2 Production, Gas sensors, NEMS and MEMS.		
7.	This course is useful for Electronics, Electrical, Mechanical and Bio-medical engineering Applications		
Description of Contents in brief:			
1.	Introduction to Nanotechnology and Nanoscience- Historical background and evidences from nature, The length scale; Characteristic scale for quantum phenomena-Quantum Confinement; Nanostructures-Quantum well, quantum dots, quantum wires. Nano-clusters; 0D, ID, 2D and 3D Nanomaterials; Bonding and Band gap tuning; Discovery of C_{60}.Fullerene; Carbon Nano Tubes (CNTs)-types, structures, synthesis of CNTs; Transport, Optical, Thermal and Mechanical Properties of Nanostructures: Synthesis techniques of nanomaterials/ nano-composite - Top down and bottom up; Chemical and physical methods of preparation of nanomaterials- Wet-chemical, Sol-gel, hydrothermal, Solid state reaction and thermal and e-beam routes for preparation of nanostructures; Characterization Techniques: XRD, SEM, TEM, AFM, UV-Vis & FTIR Spectroscopy, AFM; Applications of nanomaterials- Energy harvesting, Environmental control, Conducting polymers, Display devices, NEMS and MEMS		
List of Text Books:			
1.	D.Bimberg, M.Grundman, N.N. Ledenstov: Quantum Dot Heterostructure (World Scientific Singapore)		
2.	Dresselhaus M.S. & Avouris: CNT Synthesis, Structure (Springer)		

3.	Nanoscience and Nanotechnology:Shubra Singh M.S. Ramachandra Rao (Wiley –VCH)
List of Reference Books:	
1.	Advances in Nanomaterials: Balasubramanian, Ganesh (Springer)
2.	Nanoscience and Nanotechnology: Advances and Developments in Nano-sized Materials: Marcel Van de Voorde (De Gruyter Publishers)
URLs:	
1.	http://www.physics.dcu.ie/~jpm/PS407/dot.pdf
2.	https://www.nanotech-now.com/
3.	https://nptel.ac.in/courses/113/106/113106040/
4.	http://stanford.edu/~oas/SI/QM/papers/QMGreensite.pdf

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1.	Recall bonding and band gap in solids
2.	Introduction to Nanotechnology and length scale
3.	Nanotechnology in Nature
4.	Historical evidence Nanotechnology
5.	Properties of solids depending on band gap
6.	Characteristic scale of quantum phenomena
7.	Quantum confinement
8.	0D, 1D, 2D and 3d structure of materials
9.	Energy state and bandgap in 0D, 1D, 2D and 3d structure
10.	Effect of confinement on properties of materials
11.	Quantum well, quantum dots, quantum wires
12.	Bnadgap tuning and split of energy levels
13.	Nanoparticles and clusters
14.	Synthesis of nanomaterials with desired bandgap
15.	Top down and bottom up techniques
16.	Synthesis Parameters to control properties of nanoparticles
17.	Characterization techniques for nanoparticles
18.	Carbon structure, bonding and hybridization
19.	Carbon based materials
20.	Diamond, graphite, Graphene
21.	Fullerene: Evolution and evidence
22.	Structure of C_{60} Fullerene
23.	Properties of C_{60} Fullerene
24.	Synthesis and application of C_{60} Fullerene
25.	Graphene and Carbon nanotubes (CNTs): Historical evidence
26.	Structure and Types of Carbon nanotubes (CNTs)
27.	Thermal and optical Properties of Carbon nanotubes (CNTs)

28.	Mechanical properties of Carbon nanotubes (CNTs)
29.	Synthesis of Carbon nanotubes (CNTs)
30.	Application of CNTs: Hydrogen storage, display and energy harvesting deices
31.	CNT Interconnect in electronic circuits
32.	Formation of Nanotubes, Nanowires, Nanorods, nanoclustures, nanorings
33.	Application of nanomaterials in recent electronic devices
34.	Application of nanomaterials in agriculture and water purification
35.	Drug delivery and nano catalyses
36.	Application of nanomaterials in energy harvesting and pollution control
37.	Micro Electromechanical Systems MEMS
38.	Nano Electromechanical Systems NEMS.
39.	Future for quantum computing
40.	Nanotechnology: Future market
41.	Safety and hazards of nanomaterials