

COURSE CODE	NANOMATERIALS AND APPLICATIONS	L	T	P	C
1152ME114		3	0	0	3

1. Preamble

This course provides insight into the fundamental and basic principles of nano materials.

2. Prerequisite

Engineering Materials and Metallurgy

1151ME117

3. Links to other courses

Project Work

4. Course Educational Objectives

- To understand the fundamentals of nanomaterial strength and its mechanical behavior.
- To understand the analysis involved in zero dimensional, one dimensional nano structured materials and characterization.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Enumerate various types of nano materials and their comparisons with conventional materials.	K2
CO2	Describe the theory involved in zero dimensional nanomaterials	K2
CO3	Explain the principle analysis of one-dimensional nanomaterials.	K2
CO4	Describe the super hard coatings and nano structured materials.	K2
CO5	To study the characterization of nanomaterials.	K2

(K3 – Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L											L	L	
CO2	L						L					L	L	
CO3	L											L	L	
CO4	L											L	L	
CO5	L				L							L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION TO NANOMATERIALS

L-9

Amorphous, Crystalline, microcrystalline, quasicrystalline and nanocrystalline materials- historical development of nanomaterials – Nanomaterials classification (Gleiter’s Classification) – properly changes done to size effects, Hall – petch, inverse Hall- petch effects - polymeric nanostructures

UNIT II ZERO DIMENSIONAL NANOMATERIALS

L-9

Nanoparticles – Properties – Processing – Liquid state processing - Sol-gel process, wet chemical synthesis – Vapour state processing , Aerosol processing, solid state processing – mechanical, mechanochemical synthesis – Application of nanoparticle. Quantum Dots – Quantum confinement – Pauli’s Exclusion Principle – Processing – Optical lithography – MOCVD – Droplet epitaxy - Applications.

UNIT III ONE DIMENSIONAL NANOMATERIALS

L-9

Carbon nanotubes – Old and new forms of carbon – Structure of CNT and classification – Processing – Solid carbon based production techniques – Gaseous carbon based production technique - growth mechanisms – Applications. Nanowire – processing – Laser ablation – Oxide assisted growth – carbo thermal reactions – Thermal evaporation – Temperature based synthesis – Electro spinning – Vapour–Solid growth (VS growth) - vapour – liquid – solid growth (VLS technique) – Applications.

UNIT IV SUPER HARD COATINGS AND BULK NANOSTRUCTURED MATERIALS

L-9

Superhard coating – types – characteristics – thermal stability – case studies – Applications. Bulk nanostructure formation – Equal Channel Angular pressing (ECAP) –High Pressure Torsion(HPT), Accumulative roll bending – Reciprocating extrusion - compression, cyclic close die forging – Repetitive corrugation and straightening – Grain refinement mechanisms.

UNIT V CHARACTERIZATION OF NANOMATERIALS

L-9

Nano indentation – Types of nanoindenter – Force actuation-Displacement measurement- factors affecting nanoindentation- Atomic Force Microscope (AFM) – Scanning Tunneling Microscope (STM) – Electrostatic Force Mode (EFM) – Magnetic Force Mode (MFM) – Scanning Electron Microscope (SEM) – Transmission Electron Microscope (TEM).

TOTAL: 45 periods

8. Text Books

1. Carl C. Koch (ed.), "Nanostructured Materials", Processing, Properties and Potential Applications, Noyes Publications, Norwich, New York, U.S.A.
2. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd Edition, 2007.

9. References

1. Mark Ratner and Daniel Ratner, "Nano Technology", Pearson Education, New Delhi, 2003.
2. Charles P. Poole Jr., Frank J. Ownes, 'Introduction to Nanotechnology", WileyInterscience, 2003.
3. G. Wilde, "Nanostructured Materials", Elsevier, 2008.
4. Bamberg, D., Grundman, M. and Ledentsov, N.N., "Quantum Dot Heterostructures", Wiley, 1999.
5. G Timp (ed), "Nanotechnology", AIP press/Springer, 1999.