BSP702					Introduction to Nanomaterials					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide the understanding of fabrication techniques of nanomaterials
- To introduce the characterization techniques of nanomaterials
- To bring out different optical, magnetic, electrical and mechanical properties of nanomaterials
- To provide the knowledge about quantum transport, fundamental concepts and working principle of nano devices and related applications

UNIT 1 Nanomaterials fabrication **15 Hrs.**

Thin-Film Deposition: Homogeneous and heterogeneous film Growth Mechanism, Physical Vapour Deposition (PVD): Thermal deposition, electron beam, SputteringChemical Vapour Deposition (CVD), MOCVD, Molecular beam epitaxy (MBE), Photolithography, Nanolithography**:** Nanoimprint Lithography (NIL), AFM Lithography, Sol-gel method, Langmuir-Blodgett (LB) films.

UNIT 2 Nanomaterials characterizations **15 Hrs.**

X-Ray Diffraction, Electron Microscopy: Interaction Between Electron Beams and Solids, Transmission Electron Microscope (TEM), TEM electron energy loss spectroscopy (EELS), Scanning Electron Microscope (SEM) etc., Surface Analysis: X-Ray Photoelectron Spectroscopy (XPS), Brunauer-Emmett-Teller (BET), Atomic Force Microscopy, Scanning tunneling microscope (STM).

UNIT 3 Nanomaterials properties **10 Hrs.**

Electrical properties: Hall effect measurements, work function, and energy level measurements, Optical Properties: Photoluminescence, Electroluminescence, Cathodoluminescence, surface plasmons, Magnetic properties: Diamagnetic, Paramagnetic, Ferromagnetic, Antiferromagnetic, Nanomagnetic, etc., Mechanical Properties..

UNIT 4 Nano devices, charge transport and applications **20 Hrs.**

Coulomb Blockade, Single Electron Transistor (SET), Charge flow in a nano-transistor/quantum dot, Conductance Formula, Drude Formula, Quantum diffusive transport, Classical and quantum ballistic transport and Landauer-Büttiker formalism, Mesoscopic Superconductivity, Introduction to NEGF formalism, Carbon Nanotubes, Spintronics, applications in cancer imaging and therapy, drug targeting and drug delivery.

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Develop a fundamental knowledge of fabrication techniques of nanomaterials
CO2 - Demonstrate an understanding of characterization methods of nanomaterials
CO3 - Understanding of various transport properties of nanomaterials
CO4 - Ability to understand the key principles of nano devices
CO5 - Discuss the applications of nanomaterials in various fields like spintronics, carbon nanotubes and mesoscopic superconductivity
CO6 - To get an insight about the unique quantum transport phenomena of nanomaterials

TEXT/REFERENCE BOOKS

1. Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Guozhong Cao, Imperial College Press (2004).
2. Solid State Physics, S.O. Pillai, New Age International publishers, (2006) (New revised sixth edition).
3. Nano: The Essentials Understanding nanoscience and nanotechnology, T. Pradeep, Tata McGrawHill Publishing Company Limited NEW DELHI, (2007).
4. Nanomaterials Synthesis, Properties and Applications, A S Edelstein and R C Cammarata, IOP Publishing Ltd (1996).
5. Nanotechnology: Principles and Practices, Sulabha K. Kulkarni, Springer (2014) (Third Edition).
6. Electronic Transport in mesoscopic systems, Supriyo Dutta, Cambridge University Press (2013).
7. "Quantum Transport", Lecture Notes by Yuri M. Galperin, Lund University (1998).
8. Mesoscopic Physics: An introduction, by C. Harmans, TU Delft, (1997).
9. Materials Characterisation: Introduction to Microscopic and Spectroscopic Methods, Y. Leng, John Wiley & Sons (Asia), 2013.(2nd Edition)
10. Experimental techniques materials and mechanics, C. Suryanarayana, Boca Raton: CRC Press (2011).
11. Materials characterization techniques, Sam Zhang, L. Li & Ashok Kumar, Boca Raton: CRC Press, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Part A/Question: 3 Questions of each unit carrying 3 marks each	36 Marks
Part B/Question: 2 Questions of each unit carrying 8 marks each	64 Marks