Subject Name: **INTRODUCTION TO NANO SCIENCE AND TECHNOLOGY**
(Pre-midsem Common + Post-midsem different modules)

Subject Number: (To be filled up **later** for a new course, include for an Existing Course)

Credits (proposed): 4-0-0

Pre-Midsem

Chapter	Topics	No. of Lectures
I	Introduction to Nanostructures and Nanomaterials	
	• Dimensionality (3, 2, 1, 0)	**2**
	• Physics & Chemistry of Surfaces and Nanoparticles	**2**
	• Top Down and Bottom Up Approaches	**2**
	• Nucleation and Growth	**3**
II	Electron Transport in Reduced Dimensions	
	• Density of States in 3-, 2-, 1-, and 0-D	**2**
	• Quantization of Electron Transport in Quantum Wells and Dots	**2**
	• Tunneling in Nanostructures	**1**
III	Characterization Techniques	
	• Microscopic Techniques (TEM, SEM, etc.)	**3**
	• Spectroscopic Techniques (XPS, UV-VIS, etc.)	**3**
Total:		**20**

Suggested Text Books:

- *Nanophysics and Nanotechnology; Edward L. Wolf; © 2006 Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim*
- *Nanomaterials and Nanochemistry; C. Br´echignac P. Houdy M. Lahmani (Eds.) © Springer-Verlag Berlin Heidelberg 2007*
- *Nanoscience: Nanobiotechnology and Nanobiology; P. Boisseau• P. Houdy• M. Lahmani (Eds.); © Springer-Verlag Berlin Heidelberg 2010*
- *Mesoscopic Physics and Electronics; T. Ando et al (Eds.); © Springer 1998*

Proposed teachers :

1. S.K. Ray
2. S.K. Srivastava

Post-Midsem

Module I: Physical, Electrical and Materials Sciences

Chapter	Topics	No. of Lectures
I	Fabrication of Nanostructures	
	• Nanolithography (Optical, e-beam, FIB)	**2**
	• Soft Lithography	**1**
	• Growth by Bottom-up Approach	**3**
II	Magnetism in Nanomaterials	
	• Superparamagnetism	**1**
	• Magnetic Order in Nanoparticles	**2**
	• Spintronics	**1**
III	Optical Properties and Energy Conversion	
	• Surface Plasmon Resonance	**1**
	• Surface Enhanced Optical Properties and their Applications in Lasers and Photodetectors	**2**
	• Up- and Down Energy Conversion	**2**
IV	Electrical Nanodevices	
	• Resonant Tunnel Diodes	**1**
	• Nanophotovoltaics	**2**
	• Single Electron Transistors and Nanosensors	**2**
Total:		**20**

Pre-requisite (if any): To be decided.
Limit on the No. of Students (if any): None

Suggested Text Books:

- *Nanophysics and Nanotechnology; Edward L. Wolf; © 2006 Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim*
- *Nanomaterials and Nanochemistry; C. Br´echignac P. Houdy M. Lahmani (Eds.) © Springer-Verlag Berlin Heidelberg 2007*
- *Nanoscience: Nanobiotechnology and Nanobiology; P. Boisseau• P. Houdy• M. Lahmani (Eds.); © Springer-Verlag Berlin Heidelberg 2010*
- *Mesoscopic Physics and Electronics; T. Ando et al (Eds.); © Springer 1998*

Proposed teachers :

1. S.K. Ray
2. T.K. Bhattacharya
3. T.K. Nath

Post-Midsem

Module II: Chemistry and Biology

Chapter	Topics	No. of Lectures
I	Periodic Table with special emphasis to nanomaterial synthesis	**1**
II	Photocatalysis and catalysis by nanomaterials with hetero-junction under high pressure and ambient conditions	**1**
III	Size and shape selective catalysis	**1**
IV	Composite material synthesis and applications	**1**
V	Metal organic frame (MOF) work for nanomaterial synthesis	**2**
VI	Selectivity, sensitivity, precision, accuracy in sensing applications	**2**
VII	Spectroscopic (UV-Visible, IR, Raman and Luminescence) application	**2**
VIII	Environmental remediation by using nanomaterials	**2**
IX	Different types of inorganic materials used for the synthesis of hybrid nano-bio assemblies	**1**
X	Interaction between biomolecules and nanoparticle surfaces	**1**
XI	Nanobiosensors	**1**
XII	Nanosized drug delivery systems	**2**
XIII	Applications of nano in biotechnology, medical diagnostics and therapeutics	**2**
XIV	Ethical concerns and regulatory issues of nano-biotechnology and nano-medicine	**1**
Total:		**20**

Pre-requisite (if any): To be decided.
Limit on the No. of Students (if any): None

Suggested Text Books:

1. Optical properties of metal clusters, Volume 25, Uwe Kreibig, Michael Vollmer
2. Metal Nanoparticles: Synthesis, Characterization, and Applications, Daniel L. Fedlheim and Colby A. Foss

Teachers are:
1. T. Pal (Chemistry)
2. C R Raj (Chemistry)
3. Anjali Pal (Civil Eng.)
4. Koel Choudhury (SMST)

Post-Midsem

Module III: Metallurgy and Mechanical Engineering

Chapter	Topics	No. of Lectures
I	Processing of Nanostructured Materials: Technological Aspects • Chemical synthesis of particulates and films • Processing by inert gas condensation methods • Electrodeposited coatings • Thermal sprayed coatings • Processing of metallic, ceramic and composite materials by solid state processing routes • Consolidation of particulates	**6**
II	Properties of Nanostructured MaterialsSuperparamagnetism • Diffusion in nanocrystalline materials • Gas reactive applications • Mechanical behaviour • Thermal properties • Electrical properties • Magnetic properties • Optical properties • Acoustic Properties	**6**
III	Structural Characterization of Nanostructured Materials • Brief introduction to XRD • Brief introduction to SEM, TEM and EDS • Brief introduction to AFM • Brief introduction to Auger, XPS and SIMS	**4**
IV	Design Environments and Product Forms • Several Case Studies	**4**
Total:		**20**

Pre-requisite (if any): To be decided.
Limit on the No. of Students (if any): None

Suggested Text Books:

- *Carl C. Koch, ed., Nanostructured Materials, 2nd Edition, William Andrew, 2007.*
- *M. F. Ashby, P. J. Ferreira, and D. L. Schodek, Nanomaterials, Nanotechnologies and Design, Elsevier, 2009.*

Post-Midsem

Module IV: Micro and Nano Scale Transport and Patterning

Chapter	Topics	No. of Lectures
I	Introduction to Nano Scale Flow and Transport, Thin Films, Hydrophobicity, Surface and Interfacial tensions, Laplace pressure etc.	**2**
II	Molecular level understanding of surface tension, dispersion	**1**
III	Young Laplace Equation for an axi-symmetric surface	**1**
IV	Van der Waal's interaction between two surfaces, multilayer systems, concept of effective Hamaker Constant	**3**
V	Concept of surface energy driven and External field mediated flows and other types of transport processes	**2**
VI	Stokes flow, Thin Film equation, Linear stability Analysis, Spontaneous instability in a thin film	**3**
VII	Basics of Digital micro-fluidcs, Electro Wetting, Eletrophoresis, Electro-kinetics, Concepts of Electric Double layer, stern layer, zeta potential etc.	**3**
VIII	Concept of Soft Lithography	**2**
IX	Basic Concepts of Atomic Force Microscopy	**3**
Total:		**20**

Pre-requisite (if any): To be decided.
Limit on the No. of Students (if any): None

Suggested Text Books:

5. *Mechanics over micro and Nano Scales, Springer, Editor: SumanChakraborty, ISBN: 978-1-4419-9600-8*
6. *Soft Matter Physics, Oxforf, by Masao Doi, ISBN: 978-0-19-965295-2*