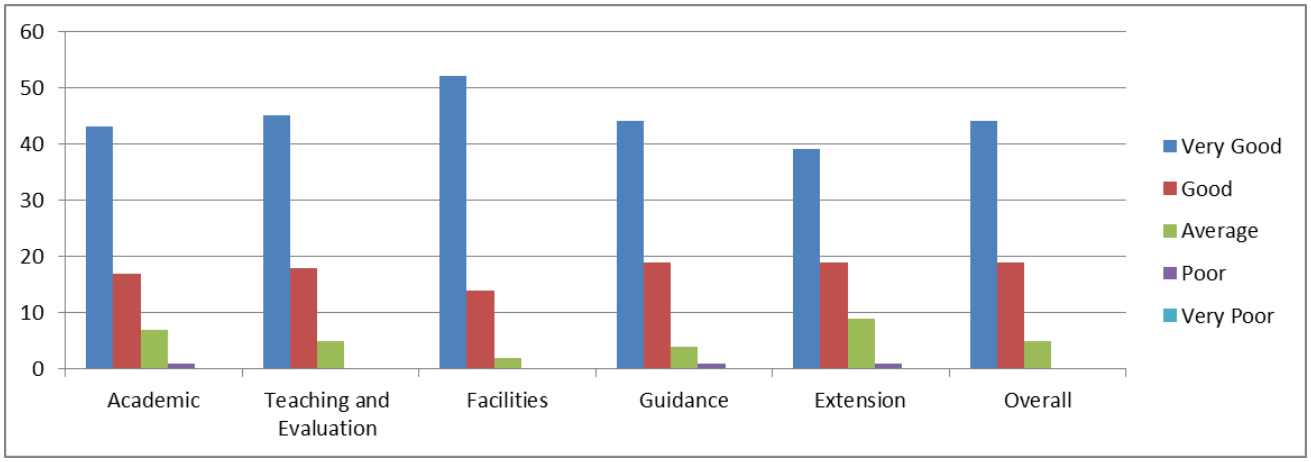
FEEDBACK ANALYSIS

Students Feedback



MINUTES OF MEETING FOR BOARD OF STUDIES CONDUCTED ON 5.12.2015
VENUE: Directors Conference Hall, S & H

Members Present

1. Prof. S.Rajesh, HOD, Dept of Nanosciences and , Karunya University
2. Dr. Muthurajan Harries, Associate Professor, National Centre for Nanoscience and Technology, University of Mumbai – External Expert
3. Dr. Muthu Vijayan Enoch, Dept of Nanosciences and Technology, Karunya University.
4. Dr. A.Sakunthala, Dept of Physics, Karunya University
5. Dr. B.Vidhya, Dept of Nanosciences and Technology, Karunya University
6. Mr. S.K.Suresh Babu, Dept of NanoSciences & Technology, Karunya University
7. Ms .N. Gouthami, Dept of NanoSciences & Technology, Karunya University

- The meeting started with prayer.
- Integrated MSc five year curriculum has been revised and approved by the BOS committee.
- The curriculum structure with new subject codes, subject title and credits is given in the Annexure I.
- The course contents of the curriculum are given in the Annexure II.
- The BOS committee recommends the implementation of the new courses for the 2016-2017 batch.
- The committee recommends implementation of the new courses also for the 2015-2016 admitted batch (present first year- CBCS) from their 2nd year onwards. Similarly the same new courses should be offered for 2014-2015(present 2nd years- CBCS) batch from their 3rd year onwards.

S. Rajesh.
Prof. S.Rajesh

Dr.Muthurajan Harries

Dr. Muthu Vijayan Enoch

Dr. A.Sakunthala

Dr. B.Vidhya

Mr. S.K.Suresh Babu

Ms. N. Gouthami

Division of Nanoscience and Technology
Department of Pre-Engineering Program
MINUTES OF THE MEETING FOR BOARD OF STUDIES CONDUCTED ON 28.04.2017
Venue: Centre for Research in Nanotechnology

Members Present	Name	Signature
Chairman	Dr. Daphy Louis Lovenia Professor	
Internal Members	Dr. S. Rajesh, Professor, Nanoscience and Technology	
	Dr. Muthu Vijayan Enoch, Associate Professor, Nanoscience and Technology	
	Dr. B. Vidhya, Assistant Professor, Nanoscience	
	Mr. S. K. Suresh Babu, Assistant Professor, Nanoscience	
External Members	Dr. Muthu Rajan Harries Associate Professor, National Centre for Nanoscience and Technology, University of Mumbai.	
Alumni Representative	Mr.M. Mohamed Jaffer Sadiq Research Scholar Dept of Chemistry, NIT, Surathkal	

- The Meeting started with Prayer.
- Integrated MSc five-year curriculum has been revised and approved by the BOS committee.
- The curriculum structure with new subject codes, subject title and credits is given in Annexure I.
- The course contents of the curriculum are given in Annexure II.
- The BOS committee recommends the implementation of the revised/new courses from the 2017-2018 batch onwards.

- The list of courses identified with Employability, entrepreneurship, skill development opportunities is given in Annexure III.

Annexure I

M.Sc. (Nanoscience & Technology) – 2017 Batch (220 Credits)

COURSE COMPONENTS

Table 1

S.No.	Course Code	General- 10 credits (to be completed in the first 3 years)	Credits
		Name of the Course	
1	17EN2015	Professional English I	3:0:0
2	17EN2016	Professional English II	3:0:0
3	17EN2012	English Language Practice	0:0:2
4	17VE2002	Value Education	0:0:2
		Total	**10**

Table 2

S.No.	Course Code	Basic sciences-30 credits (To be completed in first 3 years)	Credits
		Name of the Course	
1	17PH2001	Mechanics and Properties of Matter	3:0:0
2	17CH2001	Chemical Bonding and Concepts of Acids and Bases	3:0:0
3	17PH2002	Semiconductor Physics-I	3:0:0
4	17CH2002	Organic Reaction Intermediates and Stereochemistry	3:0:0
5	17MA1003	Basic Mathematics for Sciences	3:1:0
6	17MA1004	Calculus and Transforms	3:1:0
7	17PH2003	Heat and Thermodynamics	3:0:0
8	17BT2004	Cell Biology	3:0:0
9	17PH2015	Properties of matter lab	0:0:2
10	17CH2008	Titrimetric Analysis and Gravimetric Analysis Lab	0:0:2
		Total	**30**

Table 3

S.No.	Course Code	Computer sciences and Technical Arts- 10 credits (To be completed in first 3 years)	Credits
		Name of the Course	
1	17CH1004	Environmental Studies	3:0:0
2	17MS2002	Managerial Skills	2:0:0
3	17CS1001	Fundamentals of Computing and Programming	3:0:0
4	17CS1002	Fundamentals of Computing and Programming Lab	0:0:2
		Total	**10**

Table 4

S.No.	Course Code	Professional Core-86 credits, a full &a part semester project (2 level-50 credits to be completed within first 3 years)	Credits
		Name of the Course	
1	17PH2004	Semiconductor physics II	3:0:0
2	17CH2010	Physical Chemistry Lab - I	0:0:2
3	17CH2009	Organic Qualitative Analysis Lab	0:0:2
4	17NT2004	Materials Science I	3:0:0

5	17CH2003	Atomic Structure, Thermodynamics and Electrochemistry	3:0:0
6	17BT2058	Microbiology and Immunology	3:0:0
7	17PH2005	Semiconductor Physics Lab-I	0:0:2
8	17PH2006	semiconductor physics lab-II	0:0:2
9	17BT2022	Cell biology and Immunology lab	0:0:2
10	17PH2014	Electricity and Magnetism	3:0:0
11	17CH2004	Chemistry of Transition and Inner-transition Elements	3:0:0
12	17BT2001	Basics of Biochemistry	3:0:0
13	17PH2007	semiconductor logic Devices	3:0:0
14	17NT2001	Introductory Nanotechnology	3:0:0
15	17CH2007	Qualitative Analysis and Inorganic Preparations Lab	0:0:2
16	17BT2002	Biochemistry Lab	0:0:2
17	17NT2002	Synthesis of Nanomaterials	3:0:0
18	17NT2003	Properties of Nanomaterials	3:0:0
19	17NT2005	Materials Science II	3:0:0
20	17NT3001	Nanomaterials characterization methods	3:0:0
21	17NT3042	Synthesis of Nanomaterials Lab	0:0:4
22	17NT3006	Nano safety and Environmental Issues	3:0:0
23	17NT3002	Nanoelectronics	3:0:0
24	17NT3003	Nano-lithography	3:0:0
25	17PH3005	Quantum Mechanics-I	3:0:0
26	17NT3004	Magnetic nanoparticles and Nano fluids	3:0:0
27	17NT3005	Functionalization of Nanostructures	3:0:0
28	17NT3007	Biomedical Nanostructures and Nanomedicine	3:0:0
29	17NT3043	Material characterization Lab	0:0:2
30	17NT3044	Advanced Material characterization Lab	0:0:2
31	17NT3045	Nano simulation lab	0:0:2
32	17NT3046	Nano-Bio Lab	0:0:2
		Total	**86**
33	PSP3998	IX Sem. Part Semester project	12
34	FSP3999	X Sem. Full Semester project	20
		Total	**118**

Table 5

S.No.	Course Code	Soft Core - (Min. of 24+12 credits to be earned) (24 credits of 2 level to be in the first 3 years) Name of the Course	Credit
1	17PH2008	Spectroscopy	3:0:0
2	17CH2006	Surface chemistry and Chemical Kinetics	3:0:0
3	17PH2009	Physics of Semiconductor Memories & Microprocessors	3:0:0
4	17PH2010	Physics of linear integrated circuits and VLSI design	3:0:0
5	17PH2011	Photonics	3:0:0
6	17CH2005	Reaction Mechanism and Heterocyclic Chemistry	3:0:0
7	17PH2012	Vacuum and Thin film Technology	3:0:0
8	17PH2013	Condensed Matter Physics	3:0:0
9	17NT2007	Nanotechnology in textiles	3:0:0
10	17PH3032	Heat and Optics Lab	0:0:2
11	17PH3034	Thin Film Lab	0:0:4
12	17CH3024	Analytical Chemistry	3:0:0
13	17NT3008	MEMS and NEMS	3:0:0
14	17NT3010	Nano-biotechnology	3:0:0
15	17NT3012	Luminescent Materials	3:0:0
16	17NT3014	Molecular Machines and Sensors	3:0:0

17	17NT2006	Nanomaterials for Health Care	3:0:0
18	17NT3009	Nanotechnology for cancer diagnosis and treatment	3:0:0
19	17NT3015	Industrial Nanotechnology	3:0:0
20	17CH3023	Polymer Chemistry	3:0:0
		Total	**62**

Table 6

S.No.	Course Code	Electives (min. of 16 credits to be earned)	Credit
		Name of the Course	
1	17CH3026	Supramolecular Chemistry	3:0:0
2	17NT3011	Photovoltaics: Advanced materials and devices	3:0:0
3	17CH3022	Molecular and Material Self Assembly	3:0:0
4	17NT3013	Nanoscale transistors	3:0:0
5	17CH3025	Medicinal Chemistry	3:0:0
6	17NT3016	Nanotechnology in fuel cells and energy storage	3:0:0
7	17PH3024	Nano fluids	3:0:0
8	17NT2007	Nanotechnology in Textiles	3:0:0
9	17PH3017	Renewable energy sources	3:0:0
		Total	**26**

Annexure II

17NT2001 INTRODUCTORY NANOTECHNOLOGY

Credits: 3:0:0

Course objective

To impart knowledge on

- The basics of nanoscience and technology.
- The various process techniques available for nanostructured materials.
- The role of nanotechnology in electronics and biomedicine

Course outcome

Ability to

- Demonstrate the various nanoparticles process methods.
- Relate the various nanoscale processing techniques
- Identify 0D,1D,2D and 3D nanomaterials
- Infer the optical and mechanical properties
- Interpret the magnetic and electrical properties
- Illustrate the use of nanomaterials for different applications

Unit I - History of nanotechnology – conceptual origins –experimental advances – role of Richard Feynman, Eric Drexler and Maxwell – prefixing nano before disciplines – nanochemistry - size effects in nanochemistry – brief explanation on topdown and bottom-up approaches – classification as dry and wet nanotechnology, zero, one, two and three dimensional nanostructures,

Unit II - Lithography, molecular biology, supramolecular chemistry and self-assembly. **:** Allotropies of Carbon, Types of CNT, Introduction on Fullerenes, CNT, Discovery and early years, Synthesis and purification of fullerenes, CNTs -Graphene - introduction, their unusual properties, various synthesis methodologies, present and future applications

Unit III - Mechanism of growth, electronic structure, Transport properties, Mechanical properties, Physical properties, Application of Nanotubes and other materials difference in mechanical properties between bulk and nanomaterials , color, conductivity, plasticity, and magnetic property between bulk and nanomaterials.

Unit IV - Graphene oxide -Modified Hummer's method, Sol gel technique– Co-precipitation hydrolysis – sonochemical method – combustion technique – colloidal precipitation – template process- Solid-state sintering – Grain growth –Electric Arc method – Ion-beam induced nanostructures – grinding – high energy ball milling – material-ball ratio – control of grain size

Unit V - Quantum bits, giant magnetoresistance, spintronics. Purely nanophysical forces. Five elements of nanochemistry. Nano-enabled biomedicine. Nano: dangers and ethical challenges

Optical microscopes - Scanning probe microscopes – Scanning tunneling microscopes - Atomic force microscopes – Electron microscopes - A scanning electron microscope - The transmission electron microscope

References:

1. Mick Wilson, Kamali Kannargare., Geoff Smith, "Nano technology: Basic Science and Emerging technologies", Overseas Press, 2005.
2. Charles P. Poole, Frank J. Owens, "Introduction to Nanotechnology", Wiley Interscience, 2008.
3. Mark A. Ratner, Daniel Ratner, "Nanotechnology: A gentle introduction to the next Big Idea", Prentice Hall P7R:1st Edition, 2002.
4. T. Pradeep, " Nano the Essential Nanoscience and Nanotechnology", Tata McGraw hill, 2007.
5. J. Dutta, H. Hoffmann, "Nanomaterials", Topnano-21, 2003.
6. H. S. Nalwa (Ed.), "Encyclopedia of Nanoscience & Nanotechnology", American Scientific Publishers, California, 2004.
7.

17NT2002 SYNTHESIS OF NANOMATERIALS

Credits: 3:0:0

Course objective

To impart knowledge on

- The different physical methods available for synthesis nanostructured materials.
- The different chemical methods available for synthesis nanostructured materials.
- The nano materials synthesis through thin films techniques

Course outcome

Ability to

- Demonstrate knowledge on various types of nanomaterials
- Choose the different physical methods in preparing nanomaterials
- Utilize the different chemical methods in preparing nanomaterials
- Select the suitable methods for synthesis of different nanomaterials
- Experiment the different technique for nano material coatings
- Appraise the advanced techniques like lithography

Unit I - Synthesis of zero dimensional nanostructures, metallic, semiconductor and oxide nanoparticles, nanoparticles through heterogenous nucleation, kinetically confined synthesis of nanoparticles, epitaxial core-shell nanoparticles

Unit II - One dimensional nanoparticles, spontaneous growth, template based synthesis, Electrospinning, electro spraying, high pressure homogenizer **:** Types of CNTs – preparation of CNTs – arc discharge method – laser ablation method – chemical vapour deposition process – nanotubes made up of metal (silver), metal nitride (SiN), ceramic oxides (ZrO2, TiO2) and metal chalcogenides (S, Se, Te systems) – electrospinning of polymers – nanorods made up of metal (Sn) and semiconductors (ZnO, CdS) – nanosprings – nanorings – ion beam induced nanostructures –atom beam sputtering.

Unit III - Chemical reduction method - sol-gel technique – control of grain size – co-precipitation technique – sonochemical method –combustion technique – colloidal precipitation – template process – growth of nanorods – solidstate sintering – mechanisms of sintering – grain growth.

Unit IV - Two dimensional nanostructures, physical vapour deposition, chemical vapour deposition, atomic layer deposition, superlattices, and self-assembly, pulsed laser deposition, pulsed electron deposition, Micro lithography (photolithography, soft lithography, micromachining, e-beam writing, and scanning probe patterning).

Unit V - Mechanical grinding – high energy ball milling – attrition ball mill – planetary ball mill – vibration ball mill – tumbling ball mill - types of balls – WC and ZrO2 (preparation and properties) – ball to powder ratio (BPR) – medium for grinding – effect of temperature in getting required grain size for materials – severe plastic deformation – melt quenching – annealing

References:

1. G.Cao, “Nanostructures and Nanomaterials: Synthesis, Properties and Applications”, Imperial College Press, 2004.
2. W.Goddard, “Handbook of Nanoscience, engineering and technology”, CRC Press, 2007.
3. K.K.Chattopadhyay and A.N.Banerjee, Introduction to Nanoscience and Nanotechnology, PHI 2012.
4. T.Pradeep, “Nano: The essentials, understanding Nanoscience and Nanotechnology”, Tata Mc Graw Hill, 2007.
5. SV. Gaponenko, “Optical Properties of semiconductor nanocrystals”, Cambridge University Press, 1998.
6. H. S. Nalwa (Ed.), "Encyclopedia of Nanoscience & Nanotechnology", American Scientific Publishers, California, 2004.

17NT2003 PROPERTIES OF NANOMATERIALS

Credits: 3:0:0

Course objective

To impart knowledge on

- The size dependent properties of nanomaterials
- The electrical ,Optical, Mechanical properties of nanostructured materials.
- The dielectric properties of nanostructured materials

Course outcome

Ability to

- Demonstrate the size dependent properties of nanomaterials
- Interpret the electrical properties of nanostructured materials.
- Illustrate the optical properties of nanostructured materials.
- Analyze the mechanical properties of nanostructured materials
- Identify the microstructure of nanostructured materials
- Distinguish the ferroelectric and dielectric properties of nanostructured materials

Unit I - Size dependent properties-comparison of bulk and nanoscale systems, Quantum Confinement-Exciton-Quantum well, quantum wire and quantum dot (metal clusters, & Semiconductor),

Unit II - Physical Properties of Nanomaterials: Melting points- lattice constants- mechanical properties, Aspect ratio-Hardness-Modulus

Unit III - Optical properties: UV-Vis spectrum of nano materials- Blue shift-Multi band through optical absorption-Colour change with size- CdSe quantum dots-Surface plasmon resonance and Quantum size effects,

Unit IV - Band gap of nano materials- Density of states-Step potential-Vanhove singularities-Electrical conductivity: Surface scattering Change of electronic structure, Quantum transport- Quantum mechanical tunneling-Quantum Hall effect

Unit V - Effect of microstructure, - Magnetic properties of nanomaterials- Giant magneto resistance- Colossal magnetic field-Para-Ferro- Ferri electrics - dielectrics.- Superparamagnetism

References:

1. W.Goddard, “Handbook of Nanoscience, engineering and technology”, CRC Press, 2007.
2. G.Cao, “Nanostructures and Nanomaterials: Synthesis, Properties and Applications”, Imperial College Press, 2004.
3. T.Pradeep, “Nano: The essentials, understanding Nanoscience and Nanotechnology”, Tata Mc Graw Hill, 2007.
4. Charles P. Poole, Frank J. Owens, “Introduction to Nanotechnology”, Wiley Interscience, 2003.
5. SV. Gaponenko, “Optical Properties of semiconductor nanocrystals”, Cambridge University Press, 1998.
6. H. S. Nalwa (Ed.), "Encyclopedia of Nanoscience & Nanotechnology", American Scientific Publishers, California, 2004.

17NT2004 MATERIALS SCIENCE –I

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- The atomic structure and bonding in solids
- The crystalline structure of materials
- Defects and Imperfections in solids

Course Outcome:

Ability to

- Define the atomic structure and bonding in solids
- Classify the structure of materials and their properties
- Explain the defects and imperfections in solids
- Summarize the diffusion mechanism in solids
- Analyze the phase diagram and mechanical properties of solids
- Demonstrate the crystal growth techniques

Unit I - Classification of materials, Atomic structure and bonding in materials , unit cells, metallic crystal structures, density computations, polymorphism, atomic packing factor, close packed crystal structures.

Unit II - Crystal systems, space lattices, miller indices of planes and directions, Concept of amorphous, single and polycrystalline structures, anisotropy, Defects and imperfections in solids, Crystal growth techniques-Czochralski, *Float Zone technique*

Unit III - Diffusion, Diffusion Mechanisms, Steady state diffusion, non-steady state diffusion, Factors that influence diffusion, other diffusion paths, application of diffusion in sintering, doping of semiconductors and surface hardening of metals.
Unit IV - Stress-strain diagrams, modulus of elasticity, yield strength, tensile strength, toughness, elongation, plastic deformation, viscoelasticity, hardness, impact strength, creep, fatigue, ductile and brittle fracture.
Unit V - Phase diagrams - Solubility Limit, Phases, Microstructure, Phase Equilibria, One-Component (or Unary) Phase, Diagram, Binary Isomorphous Systems, Interpretation of Phase Diagrams.

Reference Books:

1. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, 2007.
2. C. Kittel, "Introduction to Solid State Physics" Wiley Eastern Ltd, 2005.
3. V. Raghavan, "Materials Science and Engineering: A First Course", Prentice Hall, 2006
4. A.J. Dekker, "Solid State Physics", Macmillan & Co, 2000.
5. Michael Shur, "Physics of Semiconductor Devices", Prentice Hall of India, 1995.
6. Charles P Poole Jr., and Frank J. Ownes, Introduction to Nanotechnology, John Wiley Sons, Inc., 2003
7. H. S. Nalwa (Ed.), "Encyclopedia of Nanoscience & Nanotechnology", American Scientific Publishers, California, 2004.

17NT2005 MATERIALS SCIENCE – II

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- The fabrication and processing of metals, polymers, ceramics and composites
- The thermal properties of materials.
- Mechanical behavior of polymers

Course Outcome:
Ability to

- Demonstrate the fabrication and processing of metals, polymers, ceramics and composites
- Categorize the different types of composites
- Analyze the mechanical behavior of polymers
- Interpret the thermal, dielectric, piezoelectric behavior of materials
- Infer the electrical conduction in ionic ceramics and polymers
- Compare the optical properties of metals and non-metals

Unit I - Types and fabrication of metal alloys- Forming, casting, Powder metallurgy, welding, Thermal processing of metals, Heat treatment, cold and hot working of metals, recovery, recrystallization and grain growth, Precipitation hardening
Unit II - Types and applications of ceramics – glasses, clay products, refractories, abrasives and advanced ceramics, Fabrication and processing of ceramics –glass forming, particulate forming and cementation, powder pressing and tape casting.
Unit III - Polymer molecules, Molecular weight, Molecular structure, Mechanical behavior of polymers, Mechanisms of deformation and strengthening of polymers, Crystallization, melting and glass transition, Polymer types, Polymer synthesis and processing.
Unit IV - Particle reinforced composites - Large-Particle Composites, Dispersion-Strengthened composites, Fiber reinforced composites- Polymer-Matrix Composites, Metal-Matrix Composites, Ceramic-Matrix Composites Carbon–Carbon Composites, Hybrid Composites , Structural composites - Laminar Composites, Sandwich Panels.
Unit V - Electrical conduction in ionic ceramics and in polymers, Ferroelectricity, Piezoelectricity, Heat capacity, Thermal expansion, Thermal conductivity, Thermal stresses, Basic concepts- Optical properties of metals- Optical properties of nonmetals.

Reference Books:

1. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, 2007.
2. C. Kittel, "Introduction to Solid State Physics" Wiley Eastern Ltd, Eigth edition, 2005.
3. V. Raghavan, "Materials Science and Engineering: A First Course", Prentice Hall, 2006

4. A.J. Dekker, "Solid State Physics", Macmillan & Co, 2000.
5. Charles P Poole Jr., and Frank J. Ownes, Introduction to Nanotechnology, John Wiley Sons, Inc., 2003

17NT2006 NANOTECHNOLOGY IN HEALTHCARE

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- The Pharmaceutical applications of nanotechnology
- The antibody based diagnosis.
- Prosthetic and medical implants

Course Outcome:

Ability to

- Demonstrate the pharmaceutical application of nanotechnology
- Categorize the different types antibody based diagnosis
- Analyze the immunoassay Techniques
- Interpret the invivo imaging
- Apply medical implants for fast curation
- Apply nanotechnology in targeted drug delivery

Unit I - Human anatomy – Form function and physiology – Developmental prolog - principle of development – Neurophysiology – sensory physiology and muscle physiology - Trends in nanobiotechnology - Protein and peptide based compounds for cancer, diabetes, infectious diseases and organ transplanttherapeutic classes- focused pharmaceutical delivery systems.

Unit II - IMMUNOASSAY TECHNIQUES: Understanding of antibody based diagnostic techniques (immunoassay) - micro and nano immunosensors - Bio-Barcode Assay - use of magnets, gold, DNA and antibodies - therapies and diagnostics for cancer and central nervous system disorders.

Unit III - IMPROVED MEDICAL DIAGNOSTICS: Improved diagnostic products and techniques - in vivo imaging capabilities by enabling the detection of tumors, plaque, genetic defects and other disease states - ability to control or manipulate on the atomic scaleNanobot medical devices - logic and intelligence embedded into medical devices- standalone sensing and computing devices.

Unit IV - PROSTHETIC AND MEDICAL IMPLANTS: New generations of prosthetic and medical implants - artificial organs and implantsartificial scaffolds or biosynthetic coatings - biocompatibility and reduced rejection ratio - retinal, cochlear and neural implants - repair of damaged nerve cells and replacements of damaged skin, tissue, or bone.

Unit V - METHODS FOR DIAGNOSIS: Animation of the PCR - DNA Profiling - Cantilever Sensors - Targeted Drug Delivery - Magnetic Nanoparticles - Cancer cell targeting - Stem Cell Scaffolds - Electrochemical Impedance Spectroscopy (EIS) - Tethered Lipid Membranes. (8) Total 42

References:

1. Brian R.Eggins, "Chemical Sensors and Biosensors", John Wiley & Sons, 2002.
2. Ed. L Gorton "Biosensors and Modern Biospecific Analytical Techniques", & Ed. D.Barcelo," Comprehensive Analytical Chemistry", Wilson & Wilson's, 2005.
3. Ed. David Wild, "The Immunoassay Handbook", Elsevier, 2005.
4. Allen J Bard and Larry R Faulkner, "Electrochemical Methods, Student Solutions Manual: Fundamentals and Applications", Wiley, 2002.
5. Ed. Vladimir M.Mirsky, "Ultrathin Electrochemical Chemo and Biosensors: Technology and Performance" Springer, 2004.

17NT2007 NANOTECHNOLOGY IN TEXTILES

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- The fabrication and processing of nanofibres

- The carbon based fibres and textiles.
- Nanocoatings on fibres for medical fabrices

Course Outcome:

Ability to

- Demonstrate the fabrication and processing of nanofibres
- Categorize the different types of nanofibers based on carbon materials
- Interpret the functionalization of nanofibers with composites and dyes
- Demonstrate the surface modification of nano fibres with nano materials
- Demonstrate the drug loaded medical fabric preparation
- Apply the nano coatings and fibres in textiles and self-cleaning fabrics

Unit I - NANO FIBRE PRODUCTION: Electrospinning of Nano fibers - Continuous yarns from electrospun nanofibers- Controlling the morphologies of electrospun nanofibers- Producing nanofiber structures by electrospinning for tissue engineering.

Unit II - CARBON NANOTUBES AND NANO COMPOSITES: Structure and properties of carbon nanotube - polymer nanofibers - Multifunctional polymer nanocomposites for industrial applications -. Multiwall carbon nanotube – nylon-6 nanocomposites from polymerization - Nano-filled polypropylene fibers.

Unit III - IMPROVING POLYMER FUNCTIONALITY: Nanostructuring polymers with cyclodextrins- Properties of polymer-cyclodextrin inclusive compounds- Dyeable polypropylene via nanotechnology-modification of polypropylene using co-polymerisation. Polyolefin/clay nanocomposites- the range of polyolefin nano composites.

Unit IV - NANOCOATINGS AND SURFACE MODIFICATION TECHNIQUES: Nanotechnologies for coating and structuring of textiles - Electrostatic self-assembled nanolayer films for cotton fibers - Nanofabrication of thin polymer films - Hybrid polymer nanolayers for surface modification of fibers - Structure–property relationships of polypropylene nanocomposite fibers.

Uint V - NANO FINISHING IN TEXTILES: Introduction to Nano-finishes- Application of Nano-finishes in textiles - UV resistant, antibacterial, hydrophilic, odour resistant, self-cleaning, flame- retardant finishes. Future scope of nano-finishing treatments.

Reference Books:

1. P. J. Brown and K, Stevens, “Nanofibers and Nanotechnology in Textiles”, CRC Press, 2007.
2. Y-W. Mai, “Polymer Nano composites”, Woodhead publishing, 2006.
3. W.N. Chang, “Nanofibres fabrication, performance and applications”, Nova Science Publishers Inc, 2009.
4. Seeram Ramakrishna, “An introduction to electro spinning and Nano fibers”, World Scientific Publishing Co, 2005.
5. Joseph H. Koo, “Polymer Nanocomposites, Processing, characterization and Applications”, McGraw-Hill, 2006.

17NT3001 NANOMATERIALS CHARACTERIZATION METHODS

Credits: 3:0:0

Course objectives:

To impart knowledge on

- The Different diffraction techniques
- The techniques to study the morphology
- The measurement of hardness of nanomaterials

Course outcome:

Ability to

- Relate the structure of nanomaterials
- Demonstrate the nanoscale properties through x-ray and electron beam diffractions
- Extend the microscopic techniques for nano identification
- Analyze the composition of nanomaterials by EDAX and XPS
- Assess the specimen preparation methods for various analyses

Unit I - General microscopy concepts- resolution-magnification-optical microscopy -limitations-electron microscopy Electron sources- thermionic emission-field emission-wavelength of electron beam- electron- electron lens system requirement of ultrahigh vacuum-electron diffraction - electron scattering

Unit II - Diffraction techniques: Powder X–ray diffraction, small angle x ray diffraction Neutron diffraction: principles and applications. Low energy electron diffraction (LEED)

Unit III - Reflection high energy electron diffraction (RHEED), electron energy loss spectroscopy (EELS), Dynamic light scattering (DLS), Nano indentation physical principles and applications. Transmission Electron Microscopy, Scanning Transmission Electron Microscopy

Unit IV - Atomic Force Microscope, Scanning Tunneling Microscope: working and applications. Resolution and Abbe's equation, interaction of electrons with samples, image formation, specimen preparation methods

Unit V - Scanning Near–Field optical Microscopy: optical resolution, applications in solid state chemistry, technological applications-EDAX -XPS

References

1. W. Zhou, Z. L. Wang, Scanning Microscopy for Nanotechnology, Springer Publishers, 2006.
2. A. I. Kirkland, J. L. Hutchison, Nanocharacterisation, RSC Publishing, 2007.
3. G. Kaupp, Atomic Force Microscopy, Scanning Nearfield Optical Microscopy, and Nanoscratching, Springer Publishing, 2006.
4. T.Pradeep, "Nano: The Essentials", Tata McGraw Hill, New Delhi, 2007.
5. Charles P Poole Jr and Frank J Ownes, "Introduction to Nanotechnology", John Wiley Sons, 2003.
6. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkar Raguse, "Nanotechnology: Basic sciences and emerging technologies", Overseas Press, 2005.
7. Willard, Merritt, Dean, Settle "Instrumental Methods of Analysis", CBS PUBS & DISTS New Delhi 2007.
8. Ewing. Etal, "Instrumental Methods for Chemical Analysis", Tata McGraw Hill Pub, New Delhi 2010.

17NT3002 NANOELECTRONICS

Credit 3:0:0

Course objectives:

To impart knowledge on

- The transistor scaling and its limits
- Various Short channel transistors
- The CMOS technology

Course outcome:

Ability to

- Relate the transistor scaling and its limits
- Infer about the short channel transistors and its limits
- Analyze the various split gate transistor structures
- Model the CMOS transistors for the various circuits
- Utilize the Tunneling devices for high frequency applications
- Design of computing model of Nanostructured Devices

Unit I - Introduction to MOSFET, Enhancement and depletion MOSFET, output and transfer current-voltage characteristics, limits in scaling, vertical and horizontal system integration, short channel MOS transistor

Unit II - Drain Induced Barrier Lowering, I-V characteristics analysis of short channel field effect transistor, various split gate transistor- Planar, Double gate, tri gate and Gate all around transistor, Advanced Nanoscale transistor.

Unit III - Principles of CMOS technology, inverter CMOS, I-V characteristics and Nano CMOS design, Tunneling element technology, Quantum cellular automate – wire, inverter, logic gate and Majority gate design of QCA.

Unit IV - Tunneling Diode, I-V characteristics, Resonant Tunneling Diode, I-V analysis, circuit design of RTD, Principles of Single Electron Transistor (SET), Architecture, circuit design of SET, comparison between FET and SET circuit design.

Unit V - Vertical MOSFETs, Principles of High Electron Mobility Transistor- design and applications, Molecular electron devices, Nanotubes based sensors and Field Effect Transistor, Ferroelectric random access memory and its circuit design, Softcomputing.

References Books:

1. Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "Introduction to Nanoelectronics:Science, Nanotechnology, Engineering, and Applications", Cambridge University Press 2011
2. SupriyoDatta,"Lessons from Nanoelectronics: A New Perspective on Transport", World Scientific2012
3. Karl Goser, Peter Glösekötter, Jan Dienstuhl,"Nanoelectronics and Nanosystems: FromTransistors to Molecular and Quantum Devices", Springer 2004
4. George W. Hanson,"Fundamentals of Nanoelectronics", Pearson 2009
5. Korkin, Anatoli; Rosei, Federico (Eds.), "Nanoelectronics and Photonics",Springer 2008
6. W. R. Fahrner, Nanotechnology and Nan electronics: Materials, Devices, Measurement Techniques(SpringerVerlag Berlin Heidelberg 2005)
7. J.P. Colinge, "FinFETs and other Multi-Gate Transistor", Integrated Circuits and Systems, Springer 2008.
8. Jaap Hoekstra, "Introduction to Nanoelectronic Single-Electron Circuit Design", Pan Stanford Publishing 2010

17NT3003 NANOLOTHOGRAPHY

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Photolithography process
- The CMOS lithographic techniques.
- The e-beam lithography

Course Outcome:

Ability to

- Demonstrate Photolithography process.
- Experiment the mask preparation
- Apply lithographic technique to construct a device
- Appraice the different lithographic techniques.
- Illustrate the fabrication of nanoelectronic devices and sensors.
- Design nanscale devices

Unit I - Introduction to lithography – Lithography process steps; Mask making, wafer pre-heat, resist spinning, pre-bake, exposure, development & rinsing, post-bake, oxide etching and resist stripping - Alignment marks in mask plate – Optical lithography – Light sources – Contact, proximity and projection printing

Unit II - Application of lithography – Semiconductor IC fabrication – Fabrication of n-type/p-type MOSFETs using metal gate and self-aligned poly-gate with lithographic masks – Fabrication of CMOS FET using p-well and n-well process with lithographic masks – Fabrication of NPN and PNP BJT with lithographic masks – MEMS design flow

Unit III - Next generation lithographic techniques – Extreme ultraviolet lithography - X-ray lithography – X-ray resists - Synchrotron radiation – Merits and demerits of X-ray lithography – Geometrical effects in X-ray lithography – Mask making for X-ray lithography – E-beam lithography – E-beam resists - Merits and demerits – Inter- and intra-proximity effects - SCALPEL - Ion beam lithography

Unit IV - Nanolithography, Nano-sphere lithography – Molecular self-assembly – Nano-imprint lithography, Dip-pen nanolithography, soft lithography - Nano-scale 3D shapes
and 3-D lithographic methods – Stereo-lithography and Holographic lithography.

Unit V - Tools for nanolithography, molecular manipulation by STM and AFM – Very thin resist layers; LB film resists – Nano-pattern synthesis – Nano scratching

References:

1. M J. Madou, Fundamentals of Microfabrication, CRC Press, 2nd edition, (2002).
2. B. Bhushan, Handbook of Nanotechnology, Springer – Verlag, 2nd edition, (2006).
3. S. A. Campbell, The Science and Engineering of Microelectronic Fabrication, 2nd Edition, Oxford University Press, (2001).
4. J.R. Sheats, and B. W. Smith, Microlithography Science and Technology – CRC Press, New York, (2007).
5. Nanolithography: A Borderland between STM, EB, IB, and X-Ray Lithographies – M. Gentili (ed.) Carlo

Giovannella Stefano Selci,, Springer; 1st edition, (1994).
6. Franssila S, Introduction to Microfabrication, 2nd Ed., Wiley 2010.
7. Cui Z, Nanofabrication: Principles, Capabilities and Limits, Springer 2008

17NT3004 MAGENTIC NANOMATERIALS AND NANOFLUIDS

Credits: 3:0:0

Course objectives:

- To impart knowledge on magnetism in nanomaterials.
- To relate the properties of nanofluids with molecular interactions
- To train the students in relating types of magnetic materials with devices and medicine.

Course outcome:

Ability to

- Demonstrate nanomagnetism in materials
- Explain the origin of microscopic interactions in nanomaterials
- Interpret nanomagnetism in spintronic devices
- Choose the righ magnetic nanomaterials for different applications.
- Apply nanofluids for heat transfer applications
- Apply magnetic nanoparticles and their synthesis method to prepare new materials.

Unit I - Origin of magnetism and magnetic phenomena: Origin of atomic moments – magnetic moment and magnetic dipole – magnetic induction – magnetic susceptibility and permeability – classification of magnetic materials – paramagnetism of free ions – ferromagnetism – antiferromagnetism – ferrimagnetism – diamagnetism

Unit II - Magnetic anisotropy and magnetic domains: Magneto crystalline anisotropy – influence of the stoichiometry of alloys – shape anisotropy - induced magnetic anisotropy - Stress anisotropy (magnetostriction) - surface and interface anisotropy. Magnetic domains - magnetization of an ideal crystal, magnetization of a real crystal – domain walls – domain wall width

Unit III - Magnetism in reduced dimensions: Magnetism in clusters – influence of geometric arrangement and surface symmetry – magnetic domains of nanoparticles – size dependence of magnetic domain formation – magnetic vortices – single domain particles – superparamagnetism of nanoparticles – magnetism of free nanoparticles – magnetism of nanoparticles on surfaces

Unit IV - Magnetic materials: Measurement techniques – Vibrating Sample Magnetometer – SQUID magnetometer – permanent magnets – domains – coercivity – magnetic nanomaterials – iron oxide – ferrites – applications in medicine and in data storage

Unit V – Nanoferrofluids: Synthesis of nano ferrofluids, Synthesis of colloidal nanoparticles, Turkevich method, Brust method, Microwave Assisted Synthesis, Solvothermal Synthesis. Magnetic Nanofluids and applications in heat transfer and mechanical dampers, Hyperthermia treatment using magnetic nanoparticles, Lab on chip for point of health care

References

1. K. H. J. Buschow, F. R. de Boer, Physics of Magnetism and Magnetic Materials, Kluwer Academic Publishers, New York, 2003.
2. Nanofluids: Science and Technology, Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, John Wiley & Sons, 2007.
3. M. Getzlaff, Fundamentla of magnetism, Springer Publishers, Berlin, 2008.

17N3005 FUNCTIONALIZATION OF NANOMATERIALS

Credits: 3:0:0

Course objectives:

- To impart knowledge on surface modification of carbon derivatives
- To convey the methods of functionalization of different nanomaterials.
- To train the students solve problems on functionalization of nanomaterials

Course outcome:

Ability to

- Demonstrate the mechanism of functionalization
- Infer the metal oxide, organic functionalization in carbon nanomaterials
- To solve problems on functionalization methods.
- To choose reagents for deriving functional group on nanomaterials.
- To envisage the tailoring of properties of nanomaterials based on functionalization.
- To understand recent newer developments in functionalized nanomaterials for plausible new devices.

Unit I - Functionalization of fullerenes and carbon nanotubes: Functionalization of fullerenes: cyclopropanation using Bingel reaction, pericyclic reaction and 4+2 cycloaddition, preparation of nitrile imines of fullerenes. Functionalization of CNTs: attachment of oxidic groups, reactions of carboxylic groups.
Unit II - Gold and silica nanoparticles: Gold nanoparticles: gold clusters with ligand stabilizers, gold nanoparticle–Fullerene hybrids, Silica nanomaterials: Surface coverage of OH and OR, dehydroxylation. Core shell method of functionalization and its classification,
Unit III - Functionalization of graphene and graphene oxide: Surface modification and molecular interaction of functional groups of GO – Diels–Alder cycloaddition – Bingel type cycloaddition – diazonium salt reaction – nucleophilic addition - electrophilic addition on graphene – the role of hydroxyl groups of GO – analysis using spectroscopic techniques. Photoluminescence, IR spectroscopy and NMR.
Unit IV - Surface modification of magnetic nanoparticles: Surface functional groups – surface acidity and acidity constants – point of zero charge – stability of iron oxide colloids – stability of iron oxide suspensions – adsorption of organic ligand on iron oxide nanoparticles – cation adsorption
Unit V - Quantum dot surface modification strategies: Coating of quantum dots with amphiphilic molecules – water-solubilization of QDs using thiol- or amine-containing ligands. Covalent and non-covalent binding of biomolecules to the surface of functionalized quantum dots – quantum dot bioconjugates for diagnosis and imaging – conjugates of QDs with RNA and DNA

References

1. Hirsch, M. Brettreich, Fullerenes, Chemistry and Reactions, Wiley – VCH, 2005.
2. F. Langa, J. –F. Nierengarten, Fullerenes: Principles and Applicaions, RSC Publishing, Royal Society of Chemistry, Cambridge, CB4 0WF, UK, 2009.
3. J. Brinker, G. W. Scherrer, Sol–Gel Science, Academic Press, 1990.
4. V. Georgakilas, Functionalization of grapheme, Wiley-VCH,
5. R. M. Cornell, H. C. U. Schwertmann, The Iron Oxides: Properties, Reactions, Occurrences and Uses, Edition II, Wiley–VCH, 2003, Weinheim.
6. R. Bilan, F. Fleury, I. Nabiev, A. Sukhanova, Quantum dot surface chemistry and functionalization for cell targeting and imaging (Review), Bioconjugate Chemistry, 2015, 26, 609.

17NT3006 NANOSAFETY AND ENVIRONMENTAL ISSUES

Credits: 3:0:0

Course objectives:

- To impart knowledge on Safety precautions for using nanomaterials..
- To impart knowledge on environmental issues of nanoscience and technology.
- To orient the students in finding out newer nanomaterials for safe materials.

Course outcome:

Ability to

- Relate the toxic effects of nanotechnology on human health.
- Analyze the various issues on environmental effects.
- Identify suitable remedial measures.
- Suggest start-of-the pipe solution for environmental issues based on nanomaterials
- Work out problems on nanomaterials related to toxicity.
- To frame a model policy on preventing health hazards.

Unit I - Risks with nanomaterials: Identification of Nano, Specific Risks, Responding to the Challenge, Human health hazard, Risk reduction, Standards, Safety, transportation of NP, Emergency responders

Unit II - Risk assessment: Risk assessment –Environmental Impact – Predicting hazard – Materials Characterization. Risk Assessment related to nanotechnology – Environmental and policy making

Unit III - Ecotoxicity of nanomaterials: Ecotoxicity - Inhalation deposition and Pulmonary clearance of Insoluble Solids – Bio –persistence of Inhaled solid material. Systemic Trenslocation of inhaled Particles. Pulmonary effects of SWCNT

Unit IV - Ecotoxicological tests: Terms and parameters frequently used in ecotoxicological tests – endpoint classifications - ecotoxicological approaches in the evaluation of soil quality – ecotoxicity measurement for polychlorinated biphenyls – measurement of genotoxicity by Ames test

Unit V - Legal aspects and regulations on toxicity of nanomaterials: The approaches to assessment of exposure to the nanotechnology. Bioethics and legal aspects of potential health and environmental risks in nanotechnology, FDA regulation, cytotoxicity of nanoparticles

References

1. P.P. Simeonova, N. Opopol and M.I. Luster, "Nanotechnology - Toxicological Issues and Environmental Safety", Springer 2006.
2. Vinod Labhasetwar and Diandra L. Leslie, "Biomedical Applications of nanotechnology", A John Willy & son Inc,NJ, USA, 2007 .
3. Miyawaki, J.; et.al Toxicity of Single-Walled Carbon Nanohorns. ACS Nano 2 (213–226) 2008.
4. Hutchison, J. E. Green Nanoscience: A Proactive Approach to Advancing Applications and Reducing Implications of Nanotechnology. ACS Nano 2, (395–402) 2008.
5. Mo-Tao Zhu et.al Comparative study of pulmonary responses to nano- and submicron-sized ferric oxide in rats Toxicology, 21 (102-111) 2008.
6. Dracy J. Gentleman, Nano and Environment: Boon or Bane? Environmental Science and technology, 43 (5), P1239, 2009.

17NT3007 BIOMEDICAL NANOSTRUCTURES AND NANOMEDICINE

Credits: 3:0:0

Course objectives:

- To impart knowledge on Nanomaterials for biomedical applications.
- To impart knowledge on Nanotechnology in biomedical instruments
- To understand the applications of nanofiber in medical fabrics

Course outcome:

Ability to

- Explain the properties of biomedical nanostructures
- Explain the applications of biomedical nanomaterials in nanomedicine
- Utilize nanomaterials in biomedical field
- Justify the suitability of various nanostructures
- Demonstrate the nanofiber synthesis for medical fabrics
- Predict any possible downsides of each nanomaterial.

Unit I - Micro/nanomachining: Micro/nanomachining of soft and hard polymeric biomaterials, orthopedic applications, dental implants, biocompatible photoresists, three dimensional lithography, blood contacting materials.

Unit II - Soft nanomaterials: Bioconjugation of soft nanomaterials. Hydrogels: definition and classification, stimuli-sensitive polymers. Microgels and nanogels. Core-shell structured materials. Bioconjugated hydrogel particles in nanotechnology, applications.

Unit III - Nanodrug delivery: Nanotechnology and drug delivery. electrospun polymeric nanofibers for drug delivery. Advantages of nanostructured delivery systems. Ability to cross biological membranes. Activation and targeting through physicochemical stimuli. Drug targeting through targeting molecules. Nanoparticles for gene delivery.

Unit IV - Viral vectors; gene delivery: Viral vectors and virus like particles. Recombinant virus vectors – types and applications. Drug nanocrystals. Bioconjugated nanoparticles for ultrasensitive detection of molecular biomarkers and infectious agents. DNA / RNA transfection – barriers.

Unit V - Bio-nano interfaces: Cell-extra-cellular matrix interactions. Cell behavior toward nanotopographic surfaces created by lithography, aligned nanofibers, self-assembly, chemical etching, incorporating carbon nanotubes / nanofibers. Nanostructures for tissue engineering / regenerative medicine.

References

1. K. E. Gonsalves, C. R. Halberstradt, C. T. Laurencin, L. S. Nair, Biomedical Nanostrcutures, Wiley – Interscience, 2007.
2. M. Ferrari, A. P. Lee, L. J. Lee, BioMEMS and Biomedical Nanotechnology, Volume I, Springer Publishing, 2006.
3. Vinod Labhasetwar and Diandra L. Leslie, "Biomedical Applications of nanotechnology", A John Willy & son Inc,NJ, USA, 2007 .
4. H. S. Nalwa (Ed.), "Encyclopedia of Nanoscience & Nanotechnology", American Scientific Publishers, California, 2004.
5. B. Bhushan, Handbook of Nanotechnology, Springer – Verlag, 2nd edition, (2006).

17NT3008 MEMS & NEMS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- Microsystems and Microelectronics
- Fabrication techniques of MEMS & NEMS
- Silicon and non-silicon substrates materials of MEMS/NEMS

Course Outcome:

Ability to

- classify the microelectronics and microsystems
- Relate the fabrication techniques of MEMS & NEMS
- Analyze the various substrates materials of MEMS and NEMS
- Demonstrate various tools used for design and analysis of MEMS/NEMS.
- Make use of clean room protocols
- Design various applications of MEMS/NEMS.

Unit I - Microsystems and Microelectronics, Introduction to Micro Electro Mechanical Systems (MEMS) Miniaturization techniques and fabrication techniques of MEMS - LIGA process, 3D Technologies.
Unit II - Design and Modeling of MEMS & NEMS and its packing, Challengers in packing design of MEMS, MEMS based Products for various applications, Introduction to CMOS MEMS, Fabrication methods of CMOS MEMS.
Unit III - Advanced Non-Silicon MEMS, Fabrication methods of MEMS over the non-silicon substrate- comparison of Non-Silicon MEMS over the Silicon MEMS technology, various non silicon based MEMS/NEMS.
Unit IV - MEMS based digital gates – OR, AND, NOT, MEMS based volatile and non-volatile memory devices, Energy harvesting applications of MEMS/NEMS, various Sensors and actuators of MEMS/NEMS.
Unit V - Various software tools for analysis of MEMS/NEMS, various property analysis of (Electrical, Mechanical) of MEMS/NEMS devices, challengers in design, fabrication and testing of MEMS. Clean room protocols.

Reference Books:

1. Tai,Ran Hsu, "MEMS & Microsystems Design & Manufacture", Tata Mc Graw Hill,2008.
2. Richard Booker, Earl Boysen,"Nanotechnology", Wiley Dreamtech(p) Ltd, 2006.
3. J.M. Martinez-Duart, R.J. Martin Palma, F. Agullo Reuda, Nanotechnology for microelectronics and optoelectronics, Elsevier,2006.
4. Charles P.Poole. "Introduction to Nanotechnology", Wiley publications, 2007.
5. Henne van Heeren "MEMS Recent Developments, Future Direction" , Published in 2007 by Electronics Enabled Products Knowledge Transfer Network Wolfson School of Mechanical and Manufacturing Engineering Loughborough University, Loughborough

17NT3009 NANOTECHNOLOGY FOR CANCER DIAGONSIS AND TREATMENT

Credits: 3:0:0

Course objectives:

- To impart knowledge on different types of cancer cells and mutation.
- To provide knowledge on diagnosis and treatment of cancer using functionalized nanomaterials.
- To enable compare cancer treatment methods of various ages with cancer nanotechnology

Course outcome:

Ability to

- Demonstrate the mechanism of mutation and cancer causing cells
- Identify the different cancer diagnosis techniques.
- To explain the pros and cons of cancer nanotechnology methods
- To justify the best method in the students perspective
- To choose methods of improvising cancer diagnosis and treatment using nanomaterials
- Demonstrate the applications of nanomaterials in cancer diagnosis and treatment

Unit I - Cancer molecular biology: Introduction to cancer molecular biology. Mutations and repair of DNA, growth factor signaling and oncogenes, tumor suppressor genes, apoptosis, metastasis

Unit II - Cancer chemotherapy Stages in cancer - methods in chemotherapy – timing of chemotherapy - biomarkers and their uses - clinical assessment of biomarkers – pharmacogenetics of cancer chemotherapy – chemotherapeutic drug nanoparticles for cancer treatment

Unit III - Techniques in diagnosis of cancer: Computer tomography (CT) scanning, magnetic resonance (MR), positron emission tomography (PET), single photon emission CT (SPECT), ultrasonography. MRI and PET. Principles and applications of the techniques.

Unit IV - Nanomaterials for cancer diagnosis: Nanomaterials for cancer diagnosis, nanotechnology and patient diagnostics, fluorescent quantum dots, surface plasmon resonance (SPR), nanoparticles and Nanoshells, fiber optic biosensors, nanomaterials for enhanced electron transfer, electrochemical biosensors, magnetic, mechanical, and imaging diagnostics using nanomaterials

Unit V - Nanomaterials for treatment of cancer: Quantum dots, gold nanoparticles, dye–doped silica nanoparticles, and magnetic nanoparticles in cancer imaging. Magnetic drug targeting, Animal models, clinical trials

References

1. C. S. S. R. Kumar, Nanomaterials for Cancer Therapy, Wiley – VCH, 2006.
2. C. S. S. R. Kumar, Nanomaterials for Cancer Diagnosis, Wiley – VCH, 2007.
3. L. Pecorino, Molecular Biology of Cancer, Ed. 3., Oxford University Press, UK, 2012.
4. T. Vo-Dingh, Nanotechnolgy in Biology and Medicine, CRC Press, 2006.
5. H. S. Nalwa (Ed.), "Encyclopedia of Nanoscience & Nanotechnology", American Scientific Publishers, California, 2004.

17NT3010 NANOBIOTECHNOLOGY

Credit 3:0:0

Course objectives:

- To impart knowledge on the differences between nanobiotechnology and bio-nanotechnology.
- To elaborate the methods of designing bio nanomaterials.
- To assist the students extend the knowledge gained on nanomaterials to integration of molecules to memory chips.

Course outcome:

Ability to

- Explain the concepts of nanobiotechnology
- Identify new materials based on nanobiotechnology.
- Apply nanomaterials to interface with the biological systems.
- Prepare newer nanomaterials with a focus on nanobiotechnology
- Articulate the trend of the present scenario on nanobiotechnology research
- Explain the foreseen ideas on nanobiotechnology for electronics and medicine

Unit I - Biological networks and biometrics: Biological networks – biological neurons – the function of neuronal cell – biological neuronal cells on silicon modelling of neuronal cells by NLSI circuits

Unit II - Bioelectronics: Bioelectronics- molecular processor – DNA analyzer as biochip, PCR, molecular electronics. Nano biometrics – Introduction – lipids as nanobricks and mortar: self-assembled nanolayers the bits that do things

Unit III - Nanoscale motors: Nanoscale motors – ATP molecule – proteins: three dimensional structures using a 20 amino acid – biological computing – a protein based 3D optical memory using DNA to build nano cubes and hinges – DNA as smart glue – DNA as wire template – DNA computers, Bio markers

Unit IV - Functional principles of Bionanotechnology: Information-Driven Nano-assembly - nucleic acids and ribosomes - information storage - chemical energy transfer by carrier molecules - light capture with specialized small molecules - electrical conduction and charge transfer in DNA - electrochemical gradients across membranes - entropy reduction of a chemical reaction and stabilization of transition states by enzymes - chemical tools by enzymes to perform a reaction

Unit V - Artificial design of functional biomachines: Molecular design using biological selection - antibodies may be turned into enzymes - peptides screening with bacteriophage display libraries – selection of nucleic acids with novel functions – common functional bionanomachines - artificial life - artificial protocells reproduce by budding - self-replicating molecules: an elusive goal - poliovirus creation with only a genetic blueprint - hybrid materials

References:

1. C.M. Niemeyer and C.A. Mirkin, "Nanobiotechnology, Concepts, Applications and perspectives", WILEY-VCH, 2004.
2. David.S.Goodsell, "Bionanotechnology: concepts, Lessons from Nature", Wiley-Liss, 2004
3. Sandra J Rosenthal, David W Wright, "Nanobiotechnology Protocols", Humana Press Inc, 2005
4. R.S. Greco, F.B.Prinz and R.L.Smith, "Nanoscale Technology in Biological Systems", CRC press, 2005.
5. Tuan Vo-Dinh, "Protein Nanotechnology -Protocols, Instrumentation and Applications", Humana Press Inc, 2005.
6. M. Wilson, K. K. G. Smith, M. Simmons, B. Raguse, Nanaotechnology: Basic Science and Emerging Technologies, Chapman and Hall, CRC Press, Florida.

17NT3011 PHOTOVOLTAICS : ADVANCED MATERIALS AND DEVICES

Credits: 3:0:0

Course Objective:

To impart knowledge on

- The fundamental parameters in solar cells
- The selection of different substrate materials
- The advanced materials for energy generation in solar cells

Course Outcome:

Ability to

- Demonstrate the fundamental concepts of solar cells
- Choose the substrate materials for solar cells
- Explain the various materials for enhancing the efficiency of solar cell.
- Categorize the different generations of solar cells
- Design a solar cell
- Estimate the factors affecting the solar cell parameters

Unit I - Electromagnetic spectrum-Photovoltaic effect-Solar cell fundamentals-Basic diode solar cells- material selection,- classification of solar cells, solar cell parameters,

Unit II - transport properties in soar cells, Dark IV characteristics-Illuminated IV characteristics-Solar cell fabrication methods-Role of transparent window layers- Conditions for achieving high efficiency -silicon based solar cells,

Unit III - Thin film based solar cells- Materials for solar cells-CdSe, CdTe, CIGS, CZTS, dye sensitized solar cells, Maulti band solar cells- Multi layer solar cells- Cascade solar cells.

Unit IV - Organic solar cells, Polymer based solar cells quantum dot solar cells, flexible solar cells and space age solar cells,

Unit V - Fabrication of PV cells, Different techniques for solar cell fabrication- casting method thin film coatings, crystal growth. Factors affecting the PV properties, Industrial applications and grid connectivity,

Reference Books:

1. K.L. Chopra,S.R Das, Thin film solar cells, Springer 2014
2. Jenny Nelson., "The Physics of Solar Cell-", Imperial College Press
3. S. M. Sze and Kwok K. Ng., "Physics of Semiconductor Devices"– 3rd Edition Copyright - John Wiley & Sons, Inc.
4. H.P. Garg, J. Prakash Solar Energy: Fundamental and Applications, Tata McGraw Hill Education 2000.
5. "Organic Photovoltaics Mechanisms", Materials and Devices- Niyazi Serdar Sariciftci. CRC Press, Mar 29, 2005.

17NT3012 LUMINESCENT NANOMATERIALS

Credits: 3:0:0

Course objectives:

- To impart knowledge on the luminescence phenomena of different materials.
- To explain the classification of luminescence and their applications.
- To convey information on the photophysical processes involved in luminescent materials

Course outcome:

Ability to

- Explain the phenomenon of luminescence
- Compare the mechanism of luminescence in different nanomaterials.
- Describe the applications of luminescent nanomaterials in various fields
- Compare and contrast rare earth phosphors from other phosphors
- Compare and contrast fluorescence and phosphorescence phenomena
- Demonstrate the applications of rare earth materials in luminescence

Unit I - Luminescence phenomena: Luminescence mechanisms – center luminescence – charge transfer luminescence – donor–acceptor pair luminescence – electroluminescence – luminescence quantum yield and quenching

Unit II - Lanthanide luminescence: Basics of lanthanide photophysics – lanthanide luminescence in solids – upconverting nanoparticles – lanthanide nanoparticules as photoluminescent reporters – imaging of lanthanide luminescence – electrochemiluminescence of lanthanides

Unit III - Scintillator materials: Scintillator materials – alkali halides – tungstates – $Bi_4Ge_3O_{12}$ (BGO) – $Gd_2SiOs:Ce^{3+}$ and $Lu_2SiO_5:Ce^{3+}$ – CeF_3 – other Ce^{3+} scintillators and related materials – (Cross luminescence; particle discrimination) – other materials with cross luminescence

Unit II - Quantum dots and nanophosphors: Optical properties of quantum dots – density of states in low–dimensional structures – electrons, holes, and excitons – photoluminescence of quantum dots prepared by wet chemical methods – photoluminescence from doped quantum dots – luminescence of nanoparticles of rare earth phosphors

Unit III - Applications of luminescent phosphors: Phosphors for plasma display panels – performance of applied phosphors in PDPs – phosphor efficiency – quantum splitting phosphors – Europium and Gadolinium ions – quantum efficiency – limitations – brief account of positron emission tomography using lanthanides

References

1. C. Ronda, Luminescence: From Theory to Applications, Wiley – VCH, 2008.
2. Hardev Singh Virk, Luminescence: Basic Concepts, Applications and Instrumentation, Trans Tech Publications Ltd, Switzerland.
3. A. H. Kitai: Solid State Luminescence: Theory, Materials, and Devices, Chapman & Hall, 1993
4. H. S. Nalwa (Ed.), "Encyclopedia of Nanoscience & Nanotechnology", American Scientific Publishers, California, 2004.
5. G. Blasse, B. C. Grabmaier, Luminescent Materials, Springer Verlag, Heidelberg, 1994.

17NT3013 NANOSCALE TRANSISTORS

Credits: 3:0:0

Course objectives:
To impart knowledge on
- Basic concepts of MOSFET devices
- Short channel effects
- Multi structural Gate transistor

Course outcome:
Ability to
- Define the concepts of MOSFET devices
- Infer about the short channel effects
- Illustrate the Multi structural Gate transistor
- Analysis of fabrication of advanced FET
- Determine the various materials used in GAA
- Evaluate the property analysis of Nanoscale transistor**.**

Unit I - Modeling of MOSFET IV characteristics – ON current, Off current, Threshold voltage, Voltage swing, trans-conductance, ON Resistance, Analysis of various short channel effects of MOSFET and DIBL effects, Scaling and Moore's law, Technology Node.
Unit II - Introduction to 1D, 2Dand 3D channel transistors, important and principles of Single Gate, double gate and Multi gate transistor, fabrication techniques of Multi-gate MOSFET technology, Electrical analysis.
Unit III - Tri-gate MOSFET, 4T-MuGFET principle and its fabrication design, Design of Fully Silicided Metal Gate, Introduction to Fin FET design of MOSFET, Mobility and Strain Engineering of Fin FET.
Unit IV - Tilted implantation of Source & Drain for the Fin FET, Fin FET contacts analysis, Techniques of Raised Source and Drain Structure of Fin FET, Silicon On Insulator MOSFET, Design and befits over the silicon substrate devices.
Unit V - Gate All Around Transistor (GAA), various materials used in Gate of GAA, Channel and Dielectric Materials of GAA and Electrical and mechanical property analysis of GAA .

Reference Books:
1. J.P. Colinge, "FinFETs and other Multi-Gate Transistor", Integrated Circuits and Systems, Springer 2008.
2. Lundstrom, Mark, Guo, jing, "Nanoscale Transistors: Device Physics, Modeling, and Simulation" 2006, VII – Springer.
3. Mick Wilson, Kamali Kannangara, Geoff smith, "Nanotechnology: Basic Science and Emerging Technologies", Overseas press, 2005.
4. Karl Goser, Peter Glösekötter, Jan Dienstuhl,"Nanoelectronics and Nanosystems: FromTransistors to Molecular and Quantum Devices", Springer 2004
5. Charles P.Poole Jr and. Frank J.Owens, "Introduction to Nanotechnology", Wiley Interscience, 2003. 4. Mark A.Ratner, Daniel Ratner,"Nanotechnology: A gentle introduction to the next Big idea", Pearson Education, 2003. 5. W.Goddard, "Handbook of Nanoscience, engineering and technology", CRC Press, 2007.

17NT3014 MOLECULAR MECHINES AND SENSORS

Credits: 3:0:0
Course objectives:
- To impart knowledge on molecular logical operations for nanosensors
- To provide knowledge on molecular imaging techniques
- To enable the students to distinguish the functional methods of different molecular machines

Course outcome:
Ability to
- Define the fundamentals of molecular switches.
- Describe the various types of molecular machines
- Demonstrate the interface of molecular switches with neurons
- Differentiate functional molecules based on their working pattern
- Distinguish between natural and artificial molecular machines of different types

- To envisage newer methods of synthesizing molecular machines and devices

Unit I - Concept of molecular machines: Basic principles – energy supply: chemical energy, light energy, electrochemical energy. Types of motion: control and monitoring, reset, time scale, functions. Light harvesting antennae. Photo-induced charge separation and solar energy conversion.
Unit II - Molecular switches: Molecular switches: chiroptical, photochemical, and redox switches. Overcrowded alkenes. Molecular rotor guests. Light + pH inputs. Molecular logic gates, signal communication between molecular switches.
Unit III - Molecular machines: Molecular machines: Brownian ratchet model, molecular machines and motors. Artificial allosteric systems. Tweezers and harpoons, molecular pump. Molecular knots based on cyclodextrins. Molecular actuators. Artificial ion channels. Rotary movement: ring switching processes, rotary motors on surfaces.
Unit IV - Molecular threading and interlocked compounds: Molecular motion driven by STM – molecular shuttles operated by photoswitching – molecular information ratchet – light induced memory effect - threaded and interlocked compounds on surfaces – molecular threading and dethreading with directional control.
Unit V - Molecular sensing: Molecular sensing: cyclodextrin based molecular sensors. Metal ion sensing: ion recognition by photoinduced electron transfer, charge transfer, limit of detection and sensitivity, selectivity, binding constants. Intracellular fluorescent chemosensors: biological requirements. Intracellular Ca^{2+} concentration.

References

1. V. Balzani, A. Credi, M. Vemuri, Molecular Devices and Machines, Wiley – VCH, 2nd Ed., 2008.
2. Jonathan Steed, David Turner, Carl Wallace, Core Concepts in Supramolecular and Nanochemistry, John Wiley & Sons, 2007.
3. I. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Second Edition, Wiley-VCH Publishers, 2007.
4. W.Goddard, "Handbook of Nanoscience, engineering and technology", CRC Press, 2007.

17NT3015 INDUSTRIAL NANOTECHNOLOGY

Credit 3:0:0

Objectives:
To impart knowledge on

- Nano magnetic memories
- Data storage using Lasers
- Energy storage devices

Outcome:
The student will be able to

- Appraise the the magnetic storage devices
- Demonstrate the optical storage devices
- Apply nano in energy storage devices
- Design nano encapsulated drug for targeted delivery
- Develop nano chip for biomedical applications

Unit I - Overview of Information Storage and Nanotechnology Different types of information storage materials and devices: solid state memory, optical memory, magnetic recording, emerging technologies, role of nanotechnology in data storage.
Unit II - Optical Data Storage Write and read techniques (signal modulation, disk format, data reproduction), read and write principles (read-only, write-once, phase-change, magnetooptic disks), optical pickup heads (key components, diffraction-limited laser spot, focusing and tracking error signals, servoloop design, actuator), optical media, near field optical recording, holographic data storage.
Unit III – Energy Devices Solar cells - Thin film Si solar cells - Chemical semiconductor solar cells - Dye sensitized solar cells - Polymer solar cells - Nano quantum dot solar cells - Hybrid nano-polymer solar cells Fuel Cells – principle of working – basic thermodynamics and electrochemical principle – Fuel cell classification – Fuel cell Electrodes and Carbon nano tubes – application of power and transportation.
Unit IV – Nano pharmaceuticals Generation and significance of Nano pharmaceuticals like nanosuspensions, nanogels, nanocarrier systems - Nano formulation – Nano incapsulation – Enhancement of drug therapy epitaxy 176

Unit V - Industrial applications of nanomaterials Nanoparticles and Micro–organism, Nano-materials in bone substitutes & Dentistry, Food and Cosmetic applications, Textiles, Paints, Catalysis, Drug delivery and its applications, Biochips- analytical devices, Biosensors.

Reference Books

1. Black Hole Computers, Scientific American Magazine, November 2004, by Seth Lloyd and Y. Jack Ng.
2. Information in the Holographic Universe, Scientific American Magazine, August 2003, Jacob D. Bekenstein.
3. Wu YH, "Nano Spintronics for Data Storage", Encyclopedia for Nanoscience and Nanotechnology, vol.7, American Scientific Publishers, 2003
4. . 4. Optical Data Storage, Erwin R. Meinders , Matthias Wuttig, Liesbeth Van Pieterson, Andrei V.Mijiritskii, 2006, Springer.
5. A. A. Balandin, K. L. Wang "Handbook of Semiconductor Nanostructures and Nanodevices" Vol 1-5
6. F. Kreith and J.F. Kreider, "Principles of Solar Engineering, McGra-Hill (1978)
7. S.P. Sukhtame, "Solar Energy: Principles of Thermal Collection and Storage", TataMcGraw-Hill (1984)

17NT3016 NANOTECHNOLOGY IN FUEL CELLS AND ENERGY STORAGE

Credits: 3:0:0

Objective:

- The application of nanotechnology in energy storage will be discussed
- The question of possibility of alternative energy will be met with on theoretical basis
- The materials in use for such energy storage will be introduced to the students

Outcome:

The students will be able to

- Apraise the working of fuel cells
- Demonstrate the working of solar cells
- Appraise the oxides of semiconductor materials
- Demonstrate the hydrogen evaluation and storage
- Apply kinetic properties in hydride systems
- Apply fuel cell and solar energy for long term energy strorage

Unit I - Nanostructured catalysts for low temperature fuel cells Working principle of a fuel cell – electrode reactions at low temperature fuel cells – supported catalysts – catalyst preparation – impregnation method, colloidal method, microemulsion method – catalyst supports – nanostructured carbon – nanoporous carbon – mesoporous carbon – hierarchical pore structures

Unit II - Nanocrystalline solar cells Dye-sensitized solar cells – cell operation, materials – semiconductor-sensitized solar cells (SSSC) – liquid junction SSSCs – recombination rates in semiconductors – back-transport of electrons from oxide to absorbing semiconductor – electron injection from oxide / substrate into electrolyte

Unit III - Oxides and solid-state SSSCs Losses in semiconductor aggregates on oxides – multilayer semiconductors – other porous oxides – solid state semiconductor-sensitized solar cells (sSSSCs) – the ETA cell – twocomponent ETA cells - three-component ETA cells – built-in fields in SSSCs

Unit IV - Nano-scale materials for hydrogen and energy storage Introduction – methods for energy storage – energy storage in super-capacitors and batteries – hydrogen storage in mobile applications – challenges in material development – physisorption materials – nanoporous inorganic materials for hydrogen storage – zeolitebased and transition metal-based structures

Unit V - Nano-porous organic materials for hydrogen storage Nanoporous organic and carbon materials – activated carbon, carbon nanotubes, carbidederived carbons – metal-organic framework – chemisorption materials – magnesium hydride, complex hydrides – reaction systems – experimental aspects – materials handling – synthesis methods – characterization of hydrogen storage materials – thermodynamic and kinetic properties of hydride systems

References Books

1. Gerard Wilde, Nanostructured materials, Elsevier, 2009
2. A.B. Hart and G. J. Womack, “Fuel Cells: Theory & Applications”, Prentice Hall, NY, 1997
3. Narayan R and B Viswanathan, “Chemical and Electrochemical Energy Systems”, University press (India) Ltd., 1998 1.,

17NT3016 NANOTECHNOLOGY IN FUEL CELLS AND ENERGY STORAGE

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- The application of nanotechnology in energy storage will be discussed
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6. Narayan R and B Viswanathan, “Chemical and Electrochemical Energy Systems”, University press (India) Ltd., 1998 1.,

UNIT IV - NANOSTRUCTURES

Classifications of nanomaterials - Zero dimensional, one-dimensional and two dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites.

UNIT V - NANOSYSTEMS

Nanoparticles through homogeneous and heterogeneous nucleation-Growth controlled by surface and diffusion process- Oswald ripening process - influence of reducing agents-solid state phase segregation- Mechanisms of phase transformation- grain growth and sintering- precipitation in solid solution- hume rothery rule.

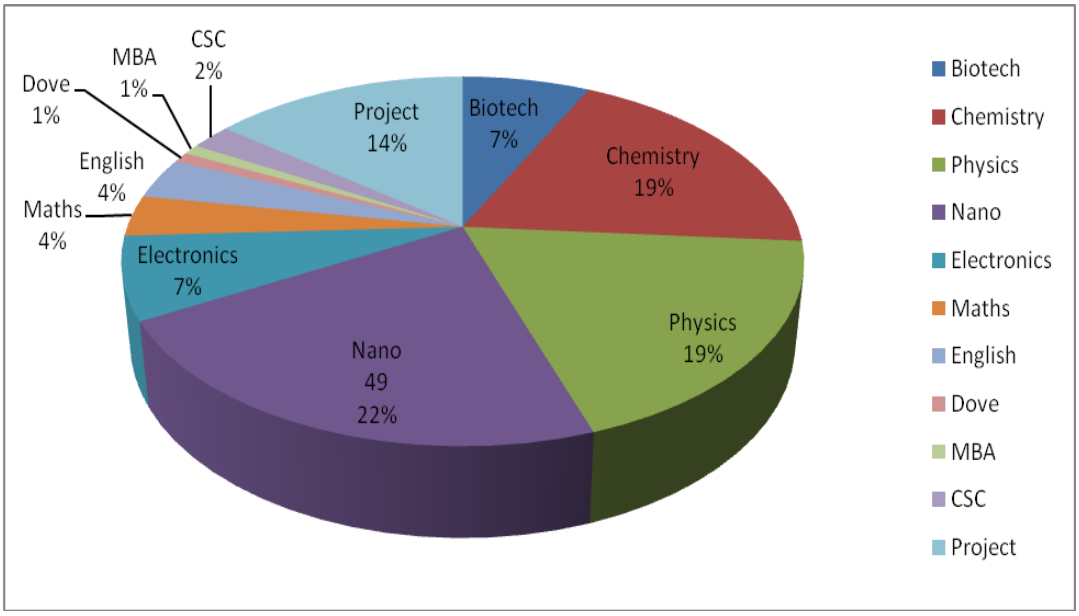
References

1. K.W. Kolasinski, -Surface Science: Foundations of Catalysis and Nanoscience‖, Wiley, 2002.
2. G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties & Applications ,Imperial College Press, 2004.
3. Joel I. Gersten, -The Physics and Chemistry of Materials‖, Wiley, 2001.
4. S. Edelstein and R. C. Cammarata, -Nanomaterials: Synthesis, Properties and Applications‖, Institute of Physics Pub., 1998.
5. S.Yang and P.Shen: -Physics and Chemistry of Nanostructured Materials‖,Taylor & Francis, 2000.
6. G.A. Ozin and A.C. Arsenault, -Nanochemistry : A chemical approach to
7. nanomaterials‖, Royal Society of Chemistry, 2005.
8. Physical Chemistry – Atkins Peter, Paula Julio.

Annexure III

S.No	Course Code	Name of the Course	Credit	Employable	Skill development	Entrepreneurship
1	17NT2002	Synthesis of Nanomaterials	3:0:0	•	•	•
2	17NT2003	Properties of Nanomaterials	3:0:0	•	•	
3	17NT3001	Nanomaterials characterization methods	3:0:0	•	•	•
4	17NT3006	Nanosafety and Environmental Issue	3:0:0		•	
5	17NT3002	Nanoelectronics	3:0:0	•	•	
6	17NT3003	Nano-lithography	3:0:0	•	•	•
7	17NT3004	Magnetic nanoparticles and nanofluids	3:0:0		•	
8	17NT3005	Functionalization of Nanostructures	3:0:0	•	•	•
9	17NT3007	Biomedical Nanostructures and Nanomedicine	3:0:0	•	•	•
10	17NT3043	Material characterization Lab	0:0:2	•	•	•
11	17NT3044	Advanced Material characterization Lab	0:0:2	•	•	•
12	17NT3045	Nano simulation lab	0:0:2		•	
13	17NT3046	Nano-Bio Lab	0:0:2	•	•	
14	17NT2007	Nanotechnology in textiles	3:0:0		•	•
15	17NT3008	MEMS and NEMS	3:0:0	•	•	
16	17NT3010	Nano-biotechnology	3:0:0	•	•	
17	17NT3009	Nanotechnology for cancer diagnosis and treatment	3:0:0		•	
18	17NT3015	Industrial Nanotechnology	3:0:0	•	•	
19	17NT3011	Photovoltaics: Advanced	3:0:0	•	•	

		materials and devices				
20	17NT3013	Nanoscale transistors	3:0:0	•	•	
21	17NT3016	Nanotechnology in fuel cells and energy storage	3:0:0	•	•	
22	17NT2004	Materials Science I	3:0:0	•	•	
23	17NT2005	Materials Science II	3:0:0	•	•	
24	17NT2006	Nanomaterials for Health Care	3:0:0	•		



Revamped Curriculum of M.Sc. Nanoscience and Technology (in percentage distribution)