BHARATHIAR UNIVERSITY : COIMBATORE – 641 046
M.Phil. / Ph.D. – NANOSCIENCE AND TECHNOLOGY

PAPER – I : Teaching Techniques / Pedagogical Methods in Nanoscience and Technology
(With effect from 2008-2009)

Unit I Methods and Techniques of Teaching

Objectives and role of higher education - Lecture – seminar – symposium – panel discussion – team teaching – project approach and workshop; Web based learning.

Unit II Feynman Lectures

The relation of Physics to other Sciences - Introduction – Chemistry – Biology – Astronomy – Geology – Psychology – How did it get the way?.

Unit III Basic properties and measuring methods of nanoparticles

Size effect and properties of Nanoparticles - Particle size - Particle shape - Particle density - Melting point, surface tension, wettability - Specific surface area and pore - Composite structure - Crystal structure - Surface characteristics - Mechanical property - Electrical properties - Magnetic properties - Optical property of nanoparticle

Unit IV Evaluation methods for properties of nanostructured materials

Functionality of nanostructures and their characteristic evaluation - Mechanical properties - Thermophysical properties - Electric properties - Electrochemical properties - Magnetic properties - Optical properties - Catalytic property - Properties of gas permeation and separation membranes .

Unit V Environmental and safety issues with nanoparticles

Nanoparticles and environment - Nanoparticles in atmospheric environment - Ground water environments and Nanoparticles - Nanoparticles in exhaust gases - Nanoparticles in wastewater - Indoor environments and nanoparticles - Industrial processes and nanoparticles ; Safety of nanoparticles- Problems caused by nanoparticles - Health effects on nanoparticles - Safety assessment for the nanoparticles ; Removal of nanoparticles - Principle of particle removal - Removal of nanoparticles suspended in gas - Removal of nanoparticles in liquid

References

1. Vedanayagam E.G. (1989) Teaching Technology for College Teachers, New Delhi, Sterling Publishers (P) Ltd.
2. Rajasekar, S. (2005) Computer Education and Educational Computing, Hyderabad, Neel Kamal Publications.
3. Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama (2007) Nanoparticle Technology Handbook, Elsevier Publishers.

PAPER – II : Research Methodology and Trends in Nanoscience and Technology

(With effect from 2008-2009)

Unit I Structural Studies

X-ray diffraction – Introduction – basic principles – characterization by XRD – examples of XRD characterization – Debye Scherer formula – FTIR – Introduction – basic principles – methodologies and accessories – interferences and artifacts.

Unit II Microscopic Techniques

Scanning electron microscopy – Introduction – basics and primary modes of operation – instrumentation – sample requirements – applications – Transmission electron microscopy – Introduction - basic principles – TEM operation – specimen preparation – Sacanning tunneling microscopy – Introduction – basic principles and instrumentation – common modes of analysis and examples – sample requirements – artifacts – Atomic force microscopy – Introduction – basic principle – modes of operation – applications.

Unit III Spectroscopic Techniques

Photoluminescence - Introduction – basic principles – common modes of analysis and examples - sample requirements - quantitative abilities – instrumentation - Spectroscopic Ellipsometry – Basic principles – Applications – Raman Spectroscopy – introduction – basic principles – instrumentation – sample requirements – bulk and microfocus Raman spectroscopic analysis – thin and thick films – Nuclear Magnetic Resonance – introduction – basic principles – structural and chemical information from solid state NMR line shapes – instrumentation - practical aspects and limitations – quantitative analysis.

Unit IV Elemental Analysis

X-ray photoelectron spectroscopy – introduction – basic principles – analysis capabilities – more complex effects – surface sensitivity – instrumentation – applications – comparison with other techniques – X-ray Fluorescence – introduction – basic principles – instrumentation – analytical capabilities – applications – related techniques – Inductively coupled plasma mass spectrometry – introduction – basic principles and Instrumentation – sampling – quantification – interferences – novel sampling techniques.

Unit V MATLAB

Introduction – basic commends and syntax – saving work – arrays and matrices – array operation – scripts and functions – more on functions – graphics – optimizing performance – advanced data structures – graphical user interfaces – object oriented programming – linking to FORTRAN or C.

References:

1. C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson (1992) Encyclopedia of Materials Characterization, Butterworth-Heinemann Publishers..
2. Tobin A. Driscoll (2003) Crash Course in MATLAB.
3. B. D. Cullity (1977) Elements of X-ray diffraction, Addison- Wesley Publishers.
4. Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama (2007) Nanoparticle Technology Handbook, Elsevier Publishers.

PAPER III – 1 : Structural control of Nanoparticles and Applications

(With effect from 2008-2009)

Unit I : Structural control of nanoparticles

Structure construction and function adaptation of nanoparticles - Particle size - Particle shape - Composite structure - Pore structure - Nanoparticle design for DDS - Nanotubes (CNT).

Unit II : Nanophysics

Development of bright phosphors using glasses incorporating semiconductor nanoparticles - Development of fuel cells - Development of a high-performance secondary battery by controlling the surface structure - Expression of optical function by nanostructure using femtosecond laser processing - Evaluation and applications of dispersing carbon nanotube in the polymers - Development of photonic crystals based on nanoparticle assembly - Electrical conductive CNT dispersed Si3N4 ceramics - Enhancement of the performance of insulating materials - Development of novel ferroelectric materials - A dye-sensitized solar cell utilizing metal nanoparticle - Sensing based on localized surface plasmon resonance in metallic nanoparticles - Generation of metal nanoparticles using reactive plasma arc evaporation - Formation of thick electronic ceramic films with bonding technique of crystalline fine particles and their applications - Closely packed colloidal crystal assembled with nanoparticles and its application for smart materials with tunable structural color.

Unit III : Nanochemistry

Surface modification of inorganic nanoparticles by organic functional groups - Instantaneous nanofoaming method for fabrication of closed-porosity silica particle- Development of photocatalyst inserted into surface of porous aluminosilicate - Fabrication technique of organic nanocrystals and their optical properties and materialization - Dispersion control of Al2O3 nanoparticles in ethanol - Development of new cosmetics based on nanoparticles - Liquid-crystalline inorganic nano and fine particles - Development of functional skincare cosmetics using biodegradable PLGA nanospheres - Development of high-performance electrochemical reactors - Barium titanate nanoparticles synthesized under sub and supercritical water conditions - Zeolite membrane - Development of new phosphors - Development of polymer-clay nanocomposites by dispersion of particles into polymer materials

Unit IV : Nanobiology

Application of quantum dots for bio-medical engineering - Bio-imaging with quantum dots - Pinpoint drug and gene delivery - Delivery to the brain - Development of the thermoresponsive magnetic nanoparticle and its deployment in the biotechnology field - Addressing of nanoparticles by using DNA molecules - Nanoparticle formation of DNA (globule transformation) - Development and multi-functionalization of high-functional separation membranes - Design of nanoparticles for oral delivery of peptide drugs

Unit V : Nanoengineering

AC overhead transmission line audible-noise reduction measures using surface improvement - Development of optical memory using semiconductor nanoparticles - Nozzle-free inkjet technology - Dendrimers and their application to organic electronics devices - Ceramic filter for trapping diesel particles - Microelectronics packaging by metal nanoparticle pastes - Dispersion of fine silica particles using alkoxysilane and industrialization

Reference

1. Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama (2007) Nanoparticle Technology Handbook, Elsevier Publishers.

PAPER III – 2 : Nanotechnology for Electrochemical Energy Systems

(effective from the academic year 2010 – 11 and onwards)

Unit I Nanomaterials for batteries and fuel cells

Nanomaterials utilization in primary batteries- Dry Lechlanch cells- Alkaline batteries- Zn/Air, Lithium batteries. Nanomaterial utilization in secondary batteries - Lead Acid, Nickel Cadmium, Lithium ion Batteries and Fuel cells. Battery characteristics.

Unit II Nanotechnology for solar Cells

Basic principles of solar cells and nanomaterials applications, Amorphous Silicon Solar cells, Photo electrochemical cells (PEC) for conversion of light energy to electrical energy, PEC cells based on nano CdSe and GaAs - Dye sensitiseded solar cells (DSSC) .

Unit III Fundamentals of electrochemical principles and electrochemical techniques

Polaraizations- anodic and cathodic polaraizations - Butler –Volmer equations, Tafel equations-Tafel slope-three electrodes cell, reference electrodes, Galvanostatic polaraizations – Cyclic Voltammetry-Chronopotentiometric-Chronoamprometric techniques.

Unit IV Electrodeposition of nanomaterilas and corrosion

Electrodeposition principles – electroplating of nanocrystalline metals and alloys – electroless plating of Nickel-Anodization and formation of self assembled alumina films, pulsed electrochemical deposition and synthesis of nanostructured materials by template process- corrosion potential, corrosion current density, corrosion rate, exchange current density, corrosion control – design, selection of corrosion resistant materials – nano coating for corrosion prevention, corrosion inhibitors, electrochemical techniques – polarization curves, Tafel extrapolation, linear polarization, AC impedance methods – electrochemical impedance spectroscopy .

Unit V Hydrogen storage

Hydrogen storage for automotive applications – methods of storage – storing hydrogen as a gas, high pressure gas cylinders, liquid hydrogen storage, storage via chemical reactions, hydrogen in metals, metal hydrides, complex hydrides, hydrogen uptake in carbon nanotubes.