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COURSE OBJECTIVES:
This course will help the students to

- Acquire the knowledge of solving system of linear equations using an appropriate numerical methods.
- Approximate the functions using polynomial interpolation numerical differentiation and integration using interpolating polynomials.
- Acquire the knowledge of numerical solution of ordinary differential equation by single and multi step methods.
- Obtain the solution of boundary value problems in partial differential equations using finite differences.
- Study simulation and monte-carlo methods and their applications.

UNIT I MATRICES AND LINEAR SYSTEMS OF EQUATIONS

UNIT II INTERPOLATION, DIFFERENTIATION AND INTEGRATION
Lagrange’s interpolation - Newton’s divided differences - Hermite’s interpolation – Newton’s forward and backward differences – Numerical differentiation – Numerical integration: Trapezoidal and Simpson's $\frac{1}{3}$ rules - Gaussian quadrature : 2 and 3 point rules.

UNIT III DIFFERENTIAL EQUATIONS

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS
Classification of second order PDE's - Finite difference approximations to partial derivatives - Elliptic equations : Solution of Laplace and Poisson equations - One dimensional parabolic equation - Bender Schmidt method - Hyperbolic equation : One dimensional wave equation.

UNIT V SIMULATION AND MONTE CARLO METHODS

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to

- Solve an algebraic or transcendental equation and linear system of equations using an appropriate numerical method.
- Approximation of functions using polynomial interpolation, numerical differentiation and integration using interpolating polynomials.
- Numerical solution of differential equations by single and multistep methods.
- Solution of boundary value problems and initial boundary value problems in partial differential equations using finite differences.
- Simulation and Monte-Carlo methods and their applications.
REFERENCES:

NT4101 QUANTUM MECHANICS

UNIT 1 BASICS OF QUANTUM MECHANICS
Wave-particle duality, group velocity, Phase velocity, De-Broglie wavelength, Uncertainty principle and Schrödinger equation.

UNIT II TIME DEPENDENT SCHRODINGER EQUATION
Solutions of the one-dimensional Schrödinger equation for free particle, particle in a box, particle in an infinitely deep well, potential, linear harmonic oscillator. Reflection and transmission by a potential step.

UNIT III TIME INDEPENDENT SCHRODINGER EQUATION

UNIT IV APPROXIMATE METHODS
Time independent and time dependent perturbation theory for non-degenerate and degenerate energy levels, the variational method, WK B approximation, adiabatic approximation, sudden approximation.

UNIT V QUANTUM COMPUTATION
Concept of quantum computation, Quantum Q-bits, Introduction to nuclear spin, quantum confinement, quantum devices, single electron devices.

TOTAL: 45 PERIODS

REFERENCES:
### UNIT 1 PHYSICS ASPECTS

Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials – surface area and aspect ratio- band gapenergy- quantum confinement size effect.

### UNIT II CHEMISTRY ASPECTS


### UNIT III DIFFUSION AND SURFACE DEFECTS

Fick's Law-mechanisms of diffusion-influence of pressure and temperature-Kirkendall effect- surface defects in nanomaterials- effect of microstructure on surface defects-interfacial energy.

### UNIT IV NANOSTRUCTURES

Classifications of nanomaterials-Zero dimensional, one-dimensional and two dimensional nanostructures-Kinetics in nanostructured materials-multi layer thin films and super lattice-clusters of metals, semiconductors and nanocomposites.

### UNIT V NANOSYSTEMS


**TOTAL: 45PERIODS**

**REFERENCES:**

7. Atkins Peter, Paula Julio Physical Chemistry.

### UNIT I CELLULAR NANOSTRUCTURES

Cellular elements in developing functional nanostructures and nanomaterials– Nanopatterning – Cytoskeletal nanomechanics – Bacterial and viral nanostructured materials – Plant-derived nanostructures: types, evolution and applications – Phytochemicals in the genesis of nanoparticles.

### UNIT II DNA NANOARCHITECTURE

UNIT III PROTEIN AND ENZYME NANOPARTICLES
Proteins: Structure, classification and functions – Protein nanoparticles: Designing, synthesis strategy, ligands used and their applications – Enzymes and Enzyme nanoparticles: properties, structure: Preparation, immobilization, kinetic properties and applications of enzyme nanoparticles in day-day to life– Synzymes, ribozymes.

UNIT IV CARBOHYDRATES AND GLYCO NANOPARTICLES

UNIT V LIPIDS AND LIPID BASED NANOPARTICLES
Structure, function and significance of lipids and membrane transport– Membranous nanostructures and their role in cellular traffic – Different types of lipid nanostructures: Preparation, applications – Lipid-based nanomaterials-Lipid-polymer nanoparticles and solid lipid nanoparticles–

TOTAL: 60 PERIODS

REFERENCES:
UNIT I  RESEARCH DESIGN  6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II  DATA COLLECTION AND SOURCES  6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III  DATA ANALYSIS AND REPORTING  6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV  INTELLECTUAL PROPERTY RIGHTS  6

UNIT V  PATENTS  6

REFERENCES:

TOTAL : 30 PERIODS

NT4111  COMPUTATION AND SIMULATION LABORATORY  0 0 4 2

1. Numerical programme to plot the first four Eigen functions of a one-dimensional rectangular potential well with infinite potential barrier.
2. Numerical solution of the Schrodinger wave equation for a rectangular potential well with infinite potential barrier using numerical programme.
3. Toy model in molecular electronics: IV characteristics of a single level molecule
4. To determine the lattice constant and lattice angles for atomically resolved STM image of HOPG (Highly Oriented Pyrolytic Graphite using offline Scanning Probe Imaging Processor (SPIP) Software.
5. To determine the surface roughness of raw and processed AFM images of glass, silicon and films made by different methods using offline SPIP software.
7. Study of Single Electron Transistor using MOSES1.2 Simulator.
NT4112 NANOMATERIALSYNTHESIS LABORATORY L T P C
0 0 4 2

LIST OF EXPERIMENTS
1. Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloid solution; Mie formalism; Estimation of size by curve fitting
2. Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap
3. Estimation from the band edge
4. Aqueous to organic phase transfer of Ag and CdS nanoparticles; Confirmation by UV-Visible absorption
5. Microwave assisted polymerization synthesis of ZnO nanowires
6. Sol-gel synthesis of metal oxide(ZnO, TiO₂, CdO) nanoparticles:
7. Sol-gel spin coating route to SnO₂ nano thin films: surface roughness measurement by AFM
8. Electro spraying route to carbon nanofibers; surface morphology by SEM
9. Hydrothermal synthesis of ZnS Nano rods; Nano rods formation by SEM analysis
10. Mechanical ball milling technique to oxide ceramics preparation: crystallite size measurement by XRD

TOTAL: 60 PERIODS

SEMESTER II

NT4201 IMAGING TECHNIQUES FOR NANOTECHNOLOGY L T P C
3 0 0 3

UNIT I OPTICAL MICROSCOPY
Concept of resolution and depth of field/focus in imaging, types of aberrations (spherical, chromatic, diffraction and astigmatism), Optical microscopy (OM) – reflected/transmitted light microscopy, theoretical and practical resolution of an optical microscope, numerical aperture, principles of image formation, dark field, polarized light and phase contrast microscopy and applications of each in metallurgical and materials engineering, sample preparation for optical microscopy and limitations.

UNIT II SCANNING ELECTRON MICROSCOPY
Advantages/disadvantages as compared to OM and other imaging techniques, mechanics of SEM, types of electron gun and comparison between them (in terms of resolution, brightness, efficiency and applications), SEM, its working and construction, concept of magnification as applied to SEM, electron-matter interaction, imaging modes (secondary and backscattered), effect of spot size, apertures, accelerating voltage on SEM imaging, signal detection (by using Everhart-Thornley, Robinson and solid state detectors), atomic number and topological contrast, critical probe current, chemical analysis of phases using SEM (EDS).

UNIT III TRANSMISSION ELECTRON MICROSCOPY

UNIT IV ATOMIC FORCE MICROSCOPY
Basic concepts-Interaction force-AFM and the optical lever- AFM tip on nanometer scale structures- force curves, measurements and manipulations-feedback control-different modes of operation –contact, non contact and tapping mode-Imaging and manipulation of samples in air or liquid environments- Imaging soft samples. Scanning Force Microscopy-types -Magnetic Force
microscopy.

UNIT V SCANNING TUNNELING MICROSCOPY
Principle- Instrumentation- importance of STM for surface and molecular manipulation, 3D map of electronic structure.

REFERENCES

NT4202 PHYSICOCHEMICAL CHARACTERIZATION OF NANOMATERIALS

UNIT I SPECTROSCOPIC TECHNIQUES

UNIT II DIFFRACTION METHODS
X-ray powder diffraction – single crystal diffraction techniques - Determination of accurate lattice parameters - structure analysis -profile analysis - particle size analysis using Scherer formula - electron and neutron diffractions

UNIT III THERMAL ANALYSIS METHODS
Principle and Instrumentation of Thermogravimetry; Differential Thermal Analysis and Differential scanning calorimetry-Importance of thermal analysis for nanostructures.

UNIT IV QUALITATIVE AND QUANTITATIVE ANALYSIS

UNIT V NANOMECHANICAL ANALYSIS
Nanoindentation principles- elastic and plastic deformation -mechanical properties of materials in small dimensions- models for interpretation of nanoindentation load displacement curves- Nanoindentation data analysis methods-Hardness testing of thin films and coatings- BET analysis.

REFERENCES:
NT4203  SYNTHESIS OF NANOMATERIALS  L T P C
            3 0 0 3
UNIT I  MECHANICAL ALLOYING AND MILLING  9
Introduction to synthesis of nanostructure materials, bottom-up approach and top-down approach–
equipment for mechanical alloying, process variables in milling, Mechanism of alloying,
Mechanochemical processing - Thermodynamic Aspects, Powder Contamination , Safety Hazards
Related to Mechanical Alloying Processes.

UNIT II  CHEMICAL APPROACHES  9
Sol gel method, Solvothermal and hydrothermal routes, precipitation, Spray pyrolysis, Electro
spraying and spin coating routes. Self-assembled monolayers (SAMs), Langmuir-Blodgett (LB)
films, micro emulsion polymerization - Template based synthesis of nanomaterials - Electrochemical
deposition, Electrophoretic deposition.

UNIT III  PHYSICAL APPROACHES  9
Inert gas condensation technique – arc plasma and laser ablation, Vapor deposition and different
types of epitaxial growth techniques (CVD,MOCVD, MBE,ALD)- pulsed laser deposition,
Sputtering- Magnetron sputtering - Lithography :Photo/UV/EB/FIB techniques, Dip pen
nanolithography, Etching process :Dry and Wet etching, micro contact printing.

UNIT IV  NANOPOROUS MATERIALS  9
Zeolites and Mesoporous materials - Synthesis, properties and applications, Role of nanomaterials
and nanomembranes in water purification - Carbon nanotubes and graphene - Core shell
nanostructures and hybrid nanocomposites.

UNIT V  APPLICATION OF NANOMATERIALS  9
Overview of nanomaterials properties and their applications, nanopaints, nano coating,
nanomaterials for renewable energy, Nanoelectronics - Nanobots - Biological Applications.
TOTAL :45 PERIODS

REFERENCES:
1. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and
2. T. Pradeep, Nano: The Essentials Understanding nanoscience and nanotechnology, Tata
3. A S Edelstein and R C Cammarata, Nanomaterials Synthesis, Properties and Applications,
   IOP Publishing Ltd 1996.
4. Frank J. Owens and Charles P.Poole, The Physics and Chemistry of Nano Solids, Wiley-
   Interscience, 2008.

NT4211  MATERIALS STRUCTURAL CHARACTERIZATION LABORATORY  L T P C
            0 0 4 2
1. Determination of size and lateral dimensions of various samples (pollen grains, strands of
   hair) using a high magnification optical microscope.
2. SEM analysis of powder, thin films, porous materials
3. SEM interpretation of powder, thin films, porous materials
4. Surface topography analysis using AFM : powder, thin films, porous materials
5. Surface topography interpretation of powder, thin films
6. XRD analysis of powder sample.
7. XRD interpretation of powder samples: Determination of lattice parameters and crystallite
   size.

TOTAL: 60 PERIODS
1. FTIR analysis of Nanostructures
2. FTIR interpretation of results
3. RAMAN Analysis of Nanostructures
4. RAMAN interpretation of results
5. TGA analysis of nanomaterials
6. TGA interpretation of results
7. DSC analysis of nanomaterials
8. DSC interpretation of results
9. UV-vis analysis of nanomaterials
10. UV-vis interpretation of nanomaterials
12. Preparation of GO and rGO, fabrication of an EDLC based electrode materials and electrochemical performance analysis of the electrode.

TOTAL: 60 PERIODS

NT4311  
PROJECT WORK I  
L T P C  
0 0 12 6

OBJECTIVES
The course aims to enable the students to
• identify the problem/process relevant to their field of interest that can be carried out
• search databases and journals to collect and analyze relevant data
• plan, learn and perform experiments to find the solution
• prepare project report

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

TOTAL: 180 PERIODS

OUTCOMES:
At the end of the course the students will be able to
CO1 Identify the research/industrial problems
CO2 Collect and analyze the relevant literature
CO3 Design, conduct experiment and analyse the data
CO4 Prepare project report

NT4312  
INTERNSHIP  
L T P C  
0 0 0 1

OBJECTIVE:
To train the students in the field work so as to have a firsthand knowledge of practical problems
SYLLABUS: The students individually undertake training in reputed organizations/research institutes during the summer vacation for a specified duration of two weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME:
On completion of the course, the student would be able to
CO1: practically handle the machines in which he/she got trained
CO2: Generate and analyse
COE: Prepare technical report and present
OBJECTIVES
The course aims to
- train students to analyze the problem/think innovatively to develop new methods/product/process
- make them understand how to find solutions/create products economically and in an environmentally sustainable way
- enable them to acquire technical and experimental skills to conduct experiment, analyze the results and prepare project report
- enable them to effectively think about strategies to commercialize the product.

TOTAL: 360 PERIODS

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

COURSE OUTCOMES
At the end of the project the student will be able to
CO1 Formulate and analyze problems for developing new methods/solutions/processes.
CO2 Plan and conduct experiments to find solutions in a logical manner
CO3 Analyze the results, interpret and prepare project report/know the strategies for commercialization

ELECTIVES

NT4001 LITHOGRAPHY AND NANOFABRICATION  L T P C  3 0 0 3

UNIT I SEMICONDUCTOR PROCESSING AND MICROFABRICATION  9
Introduction to semiconductor device processing - Necessity and different types of clean rooms-construction and maintenance of a clean room - Microfabrication process flow diagram – Chip cleaning, coating of photoresists, patterning, etching, inspection – Process integration - Etching techniques- Reactive Ion etching- RIE reactive ion etching- Magnetically enhanced RIE- IBE Ion beam etching.

UNIT II PHOTOLITHOGRAPHY AND PATTERNING OF THIN FILMS  9
Lithography -Optical lithography - different modes - Optical projection lithography - Multistage scanners - resolution and limits of photolithography - Resolution enhancement techniques - Photomask- Binary mask- Phase shift mask - Attenuated phase shift masks - alternating phase shift masks - Off axis illumination- Optical proximity correction - Sub resolution assist feature enhancement-Optical immersion lithography

UNIT III DIRECT WRITING METHODS-MASKLESS OPTICAL LITHOGRAPHY  9
Maskless optical projection lithography – types, Advantages and Limitations – required components - Zone plate array lithography - Extreme ultraviolet lithography – Light sources - Optics and materials issues

UNIT IV ELECTRON BEAM LITHOGRAPHY (EBL), X-RAY AND ION BEAM LITHOGRAPHY  9
Scanning electron-beam lithography- Electron sources, and electron optics system mask less EBL- parallel direct-write e-beam systems-electron beam projection lithography - Scattering with
angular limitation projection e-beam lithography (SCALPEL) – Projection reduction exposure with variable axis immersion lenses. XRPP - Ion beam lithography- Focusing ion beam lithography - Ion projection lithography.

UNIT V  NANOIMPRINT LITHOGRAPHY AND SOFT LITHOGRAPHY

TOTAL : 45 PERIODS

REFERENCES:

NT4002  NANOCOMPOSITE MATERIALS  L T P C
UNIT I  BASICS OF NANOCOMPOSITES  9

UNIT II  METAL BASED NANOCOMPOSITES  9
Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III  POLYMER BASED NANOCOMPOSITES  9
Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV  NANOCOMPOSITE FROM BIOMATERIALS  9
Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V  NANOCOMPOSITE TECHNOLOGY  9

TOTAL : 45 PERIODS

REFERENCES:
1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization-
NT4003  NANOELECTRONICS AND SENSORS  L T P C
3 0 0 3

UNIT I  OVERVIEW OF NANO-ELECTRONICS  9
Nano-scale electronics; Foundation of nano-electronics – low dimension transport, quantum
confinement, Coulomb blockade and quantum dot; Ballistic transport and Quantum interferences;
Landauer formula, quantization of conductance, example of Quantum point contact.

UNIT II  TWO-TERMINAL JUNCTION TRANSISTORS  9
Basic CMOS process flow; MOS scaling theory; Issues in scaling MOS transistors; Requirements
for non-classical MOS transistor; PMOS versus NMOS; Design and construction of MOS
capacitor; Integration issues of high-k MOS – interface states, bulk charge, band offset, stability,
reliability; MOS transistor and capacitor characteristics.

UNIT III  GATE  9
Metal gate transistors – motivation, basics and requirements; quantum transport in nanoMOSFET;
Ultrathin body silicon on insulator (SOI) – double gate transistors; Vertical transistors – FinFET
and surround gate FET; compound semiconductor MOSFET – Hetero-structures MOSFET.

UNIT IV  SENSORS AND ACTUATOR CHARACTERISTICS  9
Basic types and working principles of sensors and actuators; Characteristic features: Range,
Resolution, Sensitivity, Error, Repeatability, Linearity and Accuracy, Impedance, Nonlinearities,
Static and Coulomb Friction, Eccentricity, Backlash, Saturation, Deadband, System Response,
First Order System Response, Under-damped Second Order System Response, Frequency
Response.

UNIT V  MEMORY DEVICES AND SENSORS  9
Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design –ferroelectric
thin film properties and integration – calorimetric -sensors – electrochemicalcells – surface and
bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas sensors – electronic
noses – identification of hazardous solvents and gases –semiconductor sensor array.

TOTAL :45 PERIODS

REFERENCES
4. Vladimir V. Mitin, Vievacheslov A. Kochelap, Micheal A. Strosicio, Introduction to
UNIT I  NANOTECHNOLOGY IN CROP PRODUCTION  
Fertilizer – types and mode of action; Nanofertilizer – nanourea and mixed fertilizers; Nanomaterials as soil conditioners – zeolites, nano clay, superabsorbent polymers, nanocomposites; Nanoemulsion based antitranspirants; Nanosensors for monitoring soil moisture; Effect of nanoparticles in seed – carbon based, TiO₂, aluminium, silver, copper, ZnO nanoparticles; Smart delivery systems for nanofertilizer release; 

UNIT II  NANOTECHNOLOGY IN PEST MANAGEMENT  
Introduction to pest management; nanomaterials for pest management; Nanoherbicide, nanopesticide and nanofungicide- its application, mode of action and evaluation; nanoparticles and mesoporous nano materials for smart delivery; Nanosensors for pest management; Assessment of efficacy and safety on nontarget organisms; 

UNIT III  NANOTECHNOLOGY IN FOOD PROCESSING  
Introduction and scope; Nanobased smart delivery system for nutraceuticals and its release mechanism; Nano cochleates – formulation methods and mechanism of release; Nanoclusters; Nanolaminates- properties, preparation and application; Nanoemulsions – preparation and application; Nanoencapsulation technology- materials used, principle, release mechanism and advantages; 

UNIT IV  NANOTECHNOLOGY IN FOOD PACKAGING  
Nanocomposites; Nanostructured layers; Nanomaterials for food preservation; Nanopackaging for enhanced shelf life; Nanotechnology in intelligent packaging; Nanosensors for food safety monitoring. 

UNIT V  IMPACTS OF NANOAPPLICATION  
Nanoparticles – mode of action, bioaccumulation and its interaction with biological systems; Fate of nanoparticles in the environment; Health hazards of nanomaterials in the workplace; Nanoethics, safe handling and precautionary protocol. 

TOTAL : 45 PERIODS 

REFERENCES: 
6. Monique A. V. Axelos (Editor), Marcel Van de Voorde (Editor), Nanotechnology in Agriculture and Food Science; ISBN: 978-3-527-69773-1; March 2017; 450p
UNIT I   INTRODUCTION
Sustainable energy - Materials for energy - Green house effect - CO₂ emission - Energy demand and challenges.

UNIT II   RENEWABLE ENERGY TECHNOLOGY

UNIT III   NANOMATERIALS IN FUEL CELL AND STORAGE TECHNOLOGY

UNIT IV   HYDROGEN STORAGE AND PHOTOCATALYSIS
Hydrogen storage methods - metal hydrides - size effects - hydrogen storage capacity - hydrogen reaction kinetics - carbon-free cycle- gravimetric and volumetric storage capacities - hydriding/dehydriding kinetics - multiple catalytic effects - degradation of the dye - nanomaterials based photocatalyst design - kinetics of degradation.

UNIT V   ENVIRONMENTAL APPLICATIONS & IMPACTS OF NANOMATERIAL
Nanomaterials as adsorbents - Nanocomposite membrane systems for water remediation: Membrane fabrication; Membrane reactors & Active Membrane systems -Ecotoxicological impacts of nanomaterials - Lifecycle assessment of nanomaterials.

REFERENCES:

TOTAL : 45 PERIODS
UNIT I BASIC OF LIGHT AND OPTICS
Interaction of light with cells, tissues, non-linear optical processes with intense laserbeams, photo-induced effects in biological systems.

UNIT II IMAGING TECHNIQUES

UNIT III SINGLE MOLECULE SPECTROSCOPY
UV-VIS spectroscopy of biological systems, single molecule spectra and characteristics – IR and Raman spectroscopy and Surface Enhanced Raman Spectroscopy for single molecule applications.

UNIT IV OPTICAL FORCE SPECTROSCOPY
Generation optical forces – Optical trapping and manipulation of single molecules and cells in optical confinement - Laser trapping and dissection for biological systems – single molecule biophysics, DNA protein interactions.

UNIT V SENSORS AND OPTICAL TECHNIQUES
Biosensors, fluorescence immunoassay, flow cytometry, Fluorescence correlation spectroscopy, Fluorophores as cellular and molecular tags.

REFERENCES:
UNIT V    DEVICES FOR DRUG DELIVERY 9
Fabrication and Applications of Microneedles, Micropumps, microvalves. Implantable microchips.

TOTAL : 45 PERIODS

REFERENCES:

NT4008  PROCESSING AND PROPERTIES OF NANOSTRUCTURED MATERIALS L T P C
3 0 0 3

UNIT I  DEFORMATION PROCESSING AND METAL FORMING 9

UNIT II  MICROSTRUCTURAL PROPERTIES 9
Defects in solids – classifications of defects – Microstructure – grain size, grain boundary, effects of processing and defects – Processing, microstructure, properties correlations – Mechanical Properties and processing - grain size evolution and grain size control; Hall Petch relation-strengthening mechanisms; work hardening - grain boundary strengthening – solid solution strengthening – precipitation hardening - effects of diffusion on strength and flow of materials.

UNIT III  PROCESSING OF POLYMERS 9
Engineering plastics – Pellets and sheets – Glass transition temperature of polymers –Melt flow index – Polymer processing tools and process conditions - injection moulding, thermoforming, vacuum and pressure assisted forming.

UNIT IV  PROCESSING OF POWDERS OF METALS AND CERAMICS 9

UNIT V  PROCESSING OF FUNCTIONAL NANOMATERIALS 9
Properties of nanocrystalline materials required for structural, energy, environmental, textile and catalytic applications; processing techniques; techniques for retaining the nanocrystalline structure in service. Pervoskite structures, catalytic applications.

TOTAL :45 PERIODS

REFERENCES
5. H Gleiter, “Nanocrystalline Materials”, Progress in Materials Science Vol. 33,
UNIT I MEMS MICROFABRICATION

UNIT II SCALING OF MEMS
Introduction to Scaling Issues, Scaling effects on a cantilever beam, Scaling of electrostatic actuators, Scaling of thermal actuator, Scaling of Thermal Sensors, mechanics and electrostatics. Influence of scaling on material properties.

UNIT III MICROSYSTEMS

UNIT IV MATERIALS FOR MEMS
Materials for mems and pro mems-silicon-metals and polymers-Substrate Materials for MEMS-Silicon-quartz-ceramics-Bulk metallic glasses-Sharp Memory alloys, Carbon based MEMS

UNIT V COMMERCIAL AND TECHNOLOGICAL TRENDS

REFERENCES:
2. MEMS and Microsystems design and manufacture, Tai-Ran Hsu,Tata Mc Graw Hill2011.

TOTAL : 45 PERIODS

NT4010 SEMICONDUCTOR NANOSTRUCTURES
UNIT I SEMICONDUCTOR FUNDAMENTALS

UNIT II SEMICONDUCTOR NANOPARTICLE SYNTHESIS
Cluster compounds, quantum-dots from MBE and CVD, wet chemical methods, reverse micelles, electro-deposition, pyrolytic synthesis, self-assembly strategies.

UNIT III PHYSICAL PROPERTIES
Melting point, solid-state phase transformations, excitons, band-gap variations-quantum confinement, effect of strain on band-gap in epitaxial quantum dots, single particle conductance.
UNIT IV SEMICONDUCTOR NANOPARTICLES – APPLICATIONS

Optical luminescence and fluorescence from direct band gap semiconductor nanoparticles, surface-trap passivation in core-shell nanoparticles, carrier injection, polymer-nanoparticle, LED and solar cells, electroluminescence, barriers to nanoparticle lasers, doping nanoparticles, Mn-Zn-Se phosphors, light emission from indirect semiconductors, light emission form Si nanodots.

UNIT V SEMICONDUCTOR NANOWIRES

Fabrication strategies, quantum conductance effects in semiconductor nanowires, porous Silicon, nanobelts, nanoribbons, nanosprings.

TOTAL : 45 PERIODS

REFERENCES:


NT4011 NANOTOXICOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION TO TOXICOLOGY


UNIT II NANOTOXICOLOGY


UNIT III PROTOCOLS IN TOXICOLOGY STUDIES


UNIT IV ANIMAL MODELS

Types, species and strains of animals used in toxicity studies. Dosing profile for animal models. Studies on toxicology, pathology and metabolism in mouse and rat. Laws and Regulations Governing Animal Care and Use in Research.

UNIT V RISK ASSESSMENT AND EXECUTION


TOTAL : 45 PERIODS

REFERENCES:


NT4012 NANO TECHNOLOGY IN HEALTH CARE L T P C 3 0 0 3

UNIT I TRENDS IN NANOBIO TECHNOLOGY 9
Nanotechnology in gene therapy. Stem Cell technology. PCR, ELISA, DNA Profiling and Blotting techniques-Nanoprobes.

UNIT II NANOIMMUNOTECHNOLOGY 9
Nanooimmuno assay and nano-immuno sensors- Bio-Barcode Assay- use of magnets, gold, DNA and antibodies. Immunodiagnostics for cancer and central nervous system disorders.

UNIT III NANO TECHNOLOGY BASED MEDICAL DIAGNOSTICS 9

UNIT IV PROSTHETIC AND MEDICAL IMPLANTS 9

UNIT V BIOMEDICAL APPLICATIONS OF NANOTECHNOLOGY 9

TOTAL : 45 PERIODS

REFERENCES:

NT4013 NANO BIOSENSORS L T P C 3 0 0 3

UNIT I ESSENTIALS OF BIOSENSORS 9
General principle, component, characteristics. Types- Calorimetric Biosensor, Potentiometric Biosensor, Amperometric Biosensor, Optical Biosensor, Piezo-electric Biosensor. Detection systems. Techniques used for microfabrication -microfabrication of electrodes-on chip analysis.
UNIT II PROTEIN BASED BIOSENSORS

UNIT III DNA BASED BIOSENSOR
Heavy metal complexing with DNA and its determination, sensing in water and food samples – DNA zymo Biosensors.

UNIT IV SENSING OF CELLS AND PATHOGENS
Nanoscale biosensors. Nanobiosensors for cellular biosensing and sensing of rare cells. Detection of pathogens in food and water samples.

UNIT V APPLICATIONS OF BIOSENSORS
Designed protein pores and protein cages -as components of biosensors. Biosensors for pharma and medicine, bioremediation, defense and food technology, wearable biosensor.

REFERENCES:

NT4014 NANOTECHNOLOGY IN TISSUE ENGINEERING

UNIT I NANOMEDICINE AND TISSUE ENGINEERING
Relationship of Nanomedicine and Tissue Engineering, Nano drug Delivery Systems for Tissue Regeneration,
Synthesis of polymeric nano materials for tissue engineering, Chitosan as Biomaterial for Tissue Engineering, Skeletal Tissue Engineering, Nanotechnology Approaches to Regenerative Engineering

UNIT II ELECTROSPINNING OF POLYMERS FOR TISSUE ENGINEERING
Introduction, History of Electrospinning, Experimental Setup and Basic Principle, Effects of Parameters on Electrospinning, Biomedical Applications of Electrospun Nanofibers ,Cancer Detection and Diagnosis, Pharmaceutical Nanotechnology

UNIT III REGENERATION OF SENSORY SYSTEM

UNIT IV BIOMIMETIC NANOFIBERS FOR MUSCULOSKELETAL TISSUE ENGINEERING
Structural and Functional Requirements for Musculoskeletal Tissues, Nanofibers as 3D Scaffolds for Tissue Regeneration, Extracellular Matrix Analogs for Cartilage Regeneration, Bioactive Nanofibers and Methods of Immobilizing Biomolecules, Gene Delivery Through Nanofibers, Techniques to Improve Porosity and Cell Infiltration on Nanofiber Scaffolds, Nanofiber Scaffolds for Interface Regeneration


**UNIT V  DERMAI TISSUE ENGINEERING: CURRENT TRENDS**

Introduction, Nanotopography-Guided Skin Tissue Engineering, Stem Cells for Skin Tissue Engineering, Scarless Fetal Skin Wound Healing, Preparation of Self-Assembled Hydrogels, Hydrogels Characteristics for Cells, Self-Assembled Hydrogels, Significance of Natural and Synthetic Polymer for Hydrogels, Recent Development of Self-Assembled Hydrogel, Future of Nanotechnology in Tissue Engineering

**REFERENCES:**


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**NT4015  ENTREPRENEURSHIP  L T P C  3 0 0 3**

**UNIT I  ENTREPRENEURSHIP**


**UNIT II  MOTIVATION**

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, self Rating, Business Game, Thematic Apperception Test – Stress management, Entrepreneurship Development Programs – Need, Objectives.

**UNIT III  BUSINESS**


**UNIT IV  FINANCING AND ACCOUNTING**


**UNIT V  SUPPORT TO ENTREPRENEURS**


**REFERENCES:**


**TOTAL: 45 PERIODS**
AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C

2000

COURSE OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:
COURSE OBJECTIVES:
- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I  INTRODUCTION
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II  REPERCUSSIONS OF DISASTERS AND HAZARDS

UNIT III  DISASTER PRONE AREAS IN INDIA
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV  DISASTER PREPAREDNESS AND MANAGEMENT
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V  RISK ASSESSMENT
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

COURSE OUTCOMES:
At the end of the course, students will be able to
- CO1 Ability to summarize basics of disaster
- CO2 Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- CO3 Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- CO4 Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- CO5 Ability to develop the strengths and weaknesses of disaster management approaches
REFERENCES:

AX4093 CONSTITUTION OF INDIA

COURSE OBJECTIVES:
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

UNIT IV ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

UNIT VI ELECTION COMMISSION
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS
COURSE OUTCOMES:
Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING
1. The Constitution of India, 1950 (Bare Act), Government Publication.

AX4094 职能性 データベース L T P C
UNIT I

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AX4094 職能性 データベース L T P C
UNIT I 職能性 データベース | 6 |
UNIT II 職能性 データベース | 6 |
UNIT III 職能性 データベース | 6 |
UNIT IV 職能性 データベース | 6 |
4. தமிழ்க்கல்வீன தொழில்விழா விளைவு
5. புத்தாண்டு
   - சிறியிருக்கும் விளைவு
6. அகநூறு (4) - பொருள்
   தொழில்விழா (11) - பொருள்
   வளிமத்தொகு (11) - பொருள்
   விளையாட்டுவிளை 50 (27) - பொருள்

அண்மை பார்வை நெவ்வை

UNIT V  தமிழ் தொழில்விழா
6

1. தமிழ் தொழில்விழா
   - குறிப்பிட்டு புத்தாண்டு
   - குறிப்பிட்டு நூறு விளைவு
   - குறிப்பிட்டு நூறு விளைவு
   - பொருள் தொழில்விழா
   - பொருள் தொழில்விழா

2. தமிழ் விளையாட்டு விளையாட்டு தொழில்விழா
3. தமிழ் விளையாட்டு தொழில்விழா
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5. தமிழ் விளையாட்டு
6. தமிழ் விளையாட்டு
7. தமிழ் விளையாட்டு தொழில்விழா

TOTAL: 30 PERIODS

தமிழ் தொழில்விழா விளையாட்டுகள் / பக்ககாள்கள்

1. தமிழ் தொழில்விழா தமிழ் விளையாட்டு (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விளையாட்டு (Tamil Wikipedia)
   - https://ta.wikipedia.org
3. தமிழ் விளையாட்டு (Tamil Wikipedia)
4. தமிழ் விளையாட்டு (Tamil Wikipedia)
   - தமிழ் விளையாட்டு விளையாட்டு
5. தமிழ் விளையாட்டு (Tamil Wikipedia)
   - தமிழ் விளையாட்டு விளையாட்டு
6. தமிழ் விளையாட்டு (Tamil Wikipedia)
   - தமிழ் விளையாட்டு விளையாட்டு