MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
(UGC - AUTONOMOUS)

COURSE STRUCTURE
AND
DETAILED SYLLABI

MASTER OF TECHNOLOGY

MICRO & NANO ELECTRONICS (MNE)

M.Tech Regular Two Year P. G. Degree Course
(Applicable for the batches admitted from 2014-15)
MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE

(An Autonomous Instititution, affiliated to JNTUA, Anantapur)

Course Structure and syllabi for
M.Tech.MICRO AND NANO ELECTRONICS (MNE)

I Year I sem

S. No	Course code	Subject	Theory	Lab.	Credits	I.M	E.M	M.M
1.	14MNE11T01	Advanced Computing Methods	4	0	4	40	60	100
2.	14MNE11T02	Microelectronic Technology & IC fabrication	4	0	4	40	60	100
3.	14MNE11T03	Materials for Nanotechnology	4	0	4	40	60	100
4.	14MNE11T04	Micro sensors & Actuators	4	0	4	40	60	100
5	14MNE11T05	Nano CMOS Circuits & Physical Design	4	0	4	40	60	100
6.	14MNE11E1a 14MNE11E1b 14MNE11E1c	Elective – I Quantum Electronics Digital System Design Measurements and Characterization Nano Materials	4	0	4	40	60	100
7.	14MNE11P01	Simulation and Synthesis Lab		3	2	40	60	100
		Contact periods/week	24	3				
		Total	27		26	280	420	700

I YEAR II Semester

S. No	Course code	Subject	Theory	Lab.	Credits	I.M	E.M	M.M
1.	14MNE12T06	MEMS/NEMS Design	4	0	4	40	60	100
2.	14MNE12T07	Carbon Nanotubes and Applications	4	0	4	40	60	100
3.	14MNE12T08	Nano BioTechnology	4	0	4	40	60	100
4.	14MNE12T09	Nanosensors	4	0	4	40	60	100
5.	14MNE12T10	Nano Fabrication Techniques	4	0	4	40	60	100
6.	14MNE12E2a 14MNE12E2b 14MNE12E2c	Elective – II Nano Medicine Packing Technology Industrial Nanotechnology	4	0	4	40	60	100
7.	14MNE12P02	MEMS Lab		3	2	40	60	100
		Contact periods/week	24	3				
		Total	27		26	280	420	700

II YEAR (III & IV Semesters)

S. No	Course code	Subject	Credits	I.M	E.M	M.M
1	14MNE22S01	Seminar	2	50		
2	14MNE22D01	Project work	16	40		

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M. Tech I Year - I Sem(M & NE)

ADVANCED COMPUTING METHODS
(14MNE11T01)

Course Objectives:

- To learn about advanced computing methods.
- To learn how to solve complex variables and to understand use of numerical analysis
- The student will be able to understand formulation of optimization models and applications to a wide range of engineering problems
- Demonstrate an understanding of the basic concepts of probability and random variables

Course Outcomes:

After Completion of this course students will be able to

- Understand the advanced computing methods that are used
- Represent and Realize how to solve complex variable and to understand use of numerical analysis
- Understand concept of probability and random variables

UNIT I

Complex Variables: Elements of set theory, Set notations, Applications of set theory, Open & Closed Sets. Review of Complex variables, conformal mapping and transformations. Functions of complex variables, Integration with respect to complex argument, Residues and basic theorems on residues.

UNIT II

Numerical Analysis: Introduction, Interpolation formulae, Difference equations, Roots of equations, Solutions of simultaneous linear and non-linear equations, Solution techniques for ODE and PDE, Introduction to stability, Matrix Eigen value and Eigen vector problems.

UNIT III

Optimization Technique - I: Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient conditions for optimization.Elements of calculus of variation, Constrained Optimization, Lagrange multipliers, Gradient method, Dynamic programming.

UNIT IV

Probability and Statistics - I: Definition and postulates of probability, Field of probability, Mutually exclusive events, Bayes' Theorem, Independence, Bernoulli trial.

UNIT V

Probability and Statistics - II: Discrete Distributions, Continuous distributions, Probable errors, linear regression, Introduction to non-linear regression, Correlation, Analysis of variance.

TEXT BOOK:

1. Sen, M. K. and Malik, D. Fundamentals of Abstract Algebra- , Mc. Graw Hill
2. Khanna, V. K. and Ghamdri, S. K.- Course of Abstract Algebra, Vikash Pub.
3. Halmos, T. R.-Naive Set Theory, Van Nostrand
4. Scarborough, J. B.-Numerical Mathematical Analysis, Oxford University Press
5. Cone, S. D.-Elementary Numerical Analysis, Mc. Graw Hill.
6. Mukhopadhyay, P.-Mathematical Statistics ,New Central Book Agency
7. Kapoor, V. K and Gupta, S.C.-Fundamental of Mathematical Statistics, Sultan Chand and Sons.
8. Uspensky, J. V.-Introduction to Mathematical Probability, Tata Mc. Graw Hill
9. Dreyfus, S. E.-The Art and Theory of Dynamic Programming –Theory and Applications, Academic Press.
10. Rao, S. S.-Optimisation Theory and Application, Wiley Eastern Ltd., New Delhi

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MICRO ELECTRONIC TECHNOLOGY & IC FABRICATION (14MNE11T02)

Course Objectives:

- To learn and to understand about miniaturization technology.
- To learn and to realize fundamentals of MEMS fabrication technology
- To understand the applications of micro electronic technology

Course Outcomes:

- Possess knowledge and understanding of miniaturization technology
- Familiarity with MEMS fabrication technology
- Knowledge of uses of micro electronic technology

UNIT I (INTODUCTIONTO MEMS & LITHOGRAPHY

Introduction, Why Use Miniaturization Technology? From Perception to Realization, Overall MEMS Market Size, MEMS Market Character, MEMS Based on Si, Non-Silicon MEMS,MEMS versus

Traditional Precision Engineering The Times are a „Changing Introduction to Lithography , Historical Note: Lithography's Origins, Photolithography Overview Critical Dimension, Overall Resolution, Line-Width , Lithographic Sensitivity and Intrinsic Resist Sensitivity (Photochemical Quantum Efficiency), Resist Profiles, Contrast and Experimental Determination of Lithographic Sensitivity Resolution in Photolithography Photolithography Resolution Enhancement Technology Beyond Moore's Law Next Generation Lithographies Emerging Lithography Technologies

UNIT II (INTRODUCTION TO DRY TECHNOLOGY & ADDITIVE TECHNOLOGY)

Itroduction pattern transfer with dry etching techniques, Dry Etching: Definitions and Jargon, Plasmas or Discharges Physical Etching: Ion Etching or Sputtering and Ion-Beam Milling,

Plasma Etching (Radical Etching) Physical/Chemical Etching Introduction pattern transfer with Additive techniques, Silicon Growth, Doping of Si , Oxidation of Silicon, Physical Vapor Deposition , Chemical Vapor Deposition, Silk-Screening or Screen-Printing, Sol-Gel Deposition Technique , Doctors' Blade or Tape Casting, Plasma Spraying, Deposition and Arraying Methods of Organic Layers in BIOMEMS, Thin versus Thick Film Deposition , Selection Criteria for Deposition Method

UNIT III (SUBTRACTIVE AND PROCESS TECHNOLOGY)

WET BULK MICROMACHINING

Introduction to wet bulk micro aching, Historical Note, Silicon Crystallography , Silicon As Substrate Silicon As A Mechanical Element In MEMS , Wet Isotropic And Anisotropic Etching Alignment Patterns , Chemical Etching Models, Etching With Bias And/Or Illumination Of The Semiconductor, Etch-Stop Techniques, Problems With Wet Bulk Micromachining. I

UNIT IV (**SURFACE MICROMACHINING**)

Introduction to surface micromachining, Historical Note, Mechanical Properties of Thin Films, Surface Micromachining Processes , Poly-Si Surface Micromachining Modifications, Non-Poly-Si Surface Micromachining Modifications , Materials Case Studies. Introduction LIGA and micromolding, LIGA-Background, LIGA and LIGA-Like Process Steps

UNIT V (MINIATURIZATION TECHNIQUESMODELING AND APPLICATIONS)

Introduction, Absolute and Relative Tolerance in Manufacturing, Historical Note: Human Manufacturing,

Section I: Top-Down Manufacturing Methods,Section II: Bottom-Up Approaches Modeling, Brains In Miniaturization, Packaging, Substrate Choice Scaling, Actuators, Fluidics, Scaling In Analytical Separation Equipment, Other Actuators, Integrated Power Introduction, to Miniaturization Applications: Definitions and Classification Method, Decision Three

Text book:

1. Fundamentals of Microfabrication: The Science of Miniaturization, Second Edition: The Science of
   Miniturization, Marc J. Madou, 2nd Edition

Reference Books:

1. Process engineering analysis in semiconductor device fabrication by Stanley Middleman and Arthur
k.kochberg,McGraw Hill 1993.
2.Itching in Microsystem technology by Michael Kohler, 1999.

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M. Tech I Year - I Sem(M & NE)

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MATERIALS FOR NANOTECHNOLOGY
(14MNE11T03)

Course Objectives:

- Introduces basic concepts and methods about nano materials
- To create and understand micro and nano materials

Course Outcomes:

- A grasp over the basics of nano material technology
- Ability to create and understand micro and nano material

UNIT I

Introduction to nanomaterials, Properties of materials &nanomaterials, role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state. Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and coprecipitation;

UNIT II

Metal nanocrystals by reduction, Sol-gel synthesis; Microemulsions or reverse micellesmyle formation; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Electrochemical synthesis; , Photochemical synthesis, Synthesis in supercritical fluids

UNIT III

Self-Assembly and catalysis: Process of self-assembly, semiconductors islands, monolayers, nature of catalysis, porous materials, pillared clays, colloids, biometrics. Fabrication of Nanomaterials by Physical Methods: -Inert gas condensation, Arc discharge, Plasma arc technique, RF plasma, MW plasma, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method and Electro deposition.

UNIT IV

M based nanolithography and nanomanipulation, E beam lithography and SEM basednanolithography and nanomanipulation, Ion beam lithography, oxidation and metallization. Mask and its application. Deep UV lithography, X-ray based lithography.

UNIT V

Nanocomposites: An Introduction: Types of Nanocomposite (i.e. metal oxide, ceramic,glass and polymer based); Core-Shell structured nanocomposites.applications and milestones.

Reference Books:

1. Nanochemistry: A chemical approach to nanomaterials by G. A. Ozin, A. C. Aresnault, L. Cadematriri, RSC Publishing
2. Microfabrication and Nanomanufacturing. Mark James Jackson
3. Chemistry of nanomaterials : Synthesis, properties and applications by CNR Rao et.al.
4. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
5. Fabrication of fine pitch gratings by holography, electron beam lithography and nano imprint lithography (Proceedings Paper) Author(s): Darren Goodchild; Alexei Bogdanov; Simon Wingar; Bill Benyon; Nak Kim;

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MICRO SENSORS & ACTUATORS
(14MNE11T04)

Course Objective:

The obtained knowledge should enable the students to be able to develop sensor systems for a given measurement task and to develop necessary components for sensor systems including sensor interfaces.

Course Outcome:

Enables students to have an overview of different principles and realizations of sensors systems for different applications

UNIT I

Introduction - Sensing and Actuation: Case Studies of Real Devices.

UNIT II

Sensing mechanism: piezoresistive, piezoelectric, capacitive and others (tunneling, optical), Actuation mechanism: piezoelectric, Electrostatic, Magnetic, and Thermal. Physical Sensors - Pressure sensors and microphones, Accelerometers, Gyroscopes, Force sensors

UNIT III

Optofluidics - Optical forces, Electro-kinetics, Biosensors, MEMS devices for DNA analysis and medical applications.

UNIT IV

Sensors and actuators for turbulent flows: Introduction, MEMS fabrication, turbulent flows, Sensors for turbulence measurement and control, micro-actuators for flow control.

UNIT V

RF MEMS Elements and modeling: Capacitors, Varactors, Inductors, Resonators, and Switches. RF MEMS applications: RF MEMS filters, oscillators, phase shifters.

Text Books:

1. Kovacs, G.T.A., Micromachined Transducers Sourcebook, McGraw-Hill, 1998

2. Maluf, N. An Introduction to Microelectromechanical Systems Engineering, Artech House Mems Library, 2000
3. Beeby, S., Ensell, G., Kraft, W. and White, N., MEMS Mechancial Sensors, Artech House 2004
4. Senturia, S.D Microsystem Design, Kluwer, 2001.

Reference Books:

1. IEEE/ASME Journal of Microelectromechanical Systems, Sensors and Actuators: A, IOP Journal of

Micromechanics and Microengineering

2. Héctor J. De Los Santos, RF MEMS Circuit Design for Wireless Communications, Artech House,

London, 2002.

3. Mohamed Gad-el-Hak, The MEMS Handbook, CRC Press, New York, 2002.

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NANO – CMOS CIRCUIT AND PHYSICAL DESIGN
(14MNE11T05)

Course objective:

- Understanding of basic and trends in integrated circuit technology, knowledge of process steps and modules knowledge of physical models for semiconductors processes methodology and tools for process and equipment simulation . Gains Knowledge and techniques on ESD

Course Outcome:

- The concept of desingning the Nano-CMOS and their challenges can be understood
- We will learn the optical lithography and resolution enhancement techniques

UNIT I

NANO-CMOS SCALING PROBLEMS AND IMPLICATIONS

Design Methodology in the Nano-CMOS Era, Scaling, Overview of Sub-100-nm Scaling Challenges and

Subwavelength Optical Lithography, Back-End-of-Line Challenges (Metallization), Front-End-of-Line

Challenges (Transistors), Process Control and Reliability Lithographic Issues and Mask Data Explosion, New Breed of Circuit and Physical Design, Modeling Challenges, Need for Design Methodology Changes.

UNIT II

THEORY AND PRACTICALITIES OFSUB WAVELENGTH OPTICAL LITHOGRAPHY AND RESOLUTION ENHANCEMENT TECHNIQUES

Introduction, Simple Imaging Theory, Challenges for the 100-nm Node, ê-Factor for the 100-nm Node, Significant Process Variations, Impact of Low-ê Imaging on Process-Sensitivities, Low-ê Imaging and Impact on Depth of Focus, Low-ê Imaging and Exposure Tolerance, Low-ê Imaging and Impact on Mask Error, Enhancement Factor, Low-ê Imaging and Sensitivity to Aberrations ,Low-ê Imaging and CD Variation as a Function of Pitch, Low-ê Imaging and Corner Rounding Radius. Physics, Specialized Illumination Patterns, Optical Proximity Corrections, Subresolution Assist Features, Alternating Phase-Shift Masks, Physical Design

Style Impact on RET and OPC Complexity, Specialized Illumination Conditions- Two-Dimensional Layouts, Alternating Phase-Shift Masks, Mask Costs.

UNIT III

PROCESS SCALING IMPACT ON DESIGN AND MIXED-SIGNAL CIRCUIT DESIGN

Introduction - Design Considerations, Device Modeling, Passive Components, Design Methodology – Benchmark Circuits. Design Using Thin Oxide Devices - Design Using Thick Oxide Devices, Low-Voltage Techniques, Current Mirrors, Input Stages, Output Stages, Band gap References, Design Procedures, Electrostatic Discharge Protection, Multiple-Supply Concerns, Noise Isolation, Guard Ring Structures, Isolated NMOS Devices, Epitaxial Material versus Bulk Silicon, Decoupling, Power Busing, Integration Problems, Corner Regions, Neighboring Circuitry.

UNIT IV

ELECTROSTATIC DISCHARGE PROTECTION

Introduction - ESD Standards and Models, ESD Protection Design, ESD Protection Scheme, Turn-on

Uniformity of ESD Protection Devices, ESD Implantation and Silicide Blocking, ESD Protection

Guidelines, Low-C ESD Protection Design for High-Speed I/O, ESD Protection for High-Speed I/O or

Analog Pins, Low-C ESD Protection Design, Input Capacitance Calculations, ESD Robustness, Turn-on

Verification, ESD Protection Design for Mixed-Voltage I/O, Mixed-Voltage I/O Interfaces, ESD

Concerns for Mixed-Voltage I/O Interfaces, ESD Protection Device for a Mixed-Voltage I/O Interface.

UNIT V

ESD PROTECTION DESIGN & SIGNAL INTEGRITY PROBLEMS IN ON-CHIP INTERCONNECTS

Introduction ESD Protection Circuit Design for a Mixed-Voltage/O Interface, ESD Robustness, Turn-on Verification, SCR Devices for ESD Protection, Turn-on Mechanism of SCR Devices, SCR-Based Devices for CMOS On-Chip ESD Protection. Interconnect Figures of Merit, Interconnect Parasitics Extraction, Circuit Representation of Interconnects, RC Extraction, Inductance Extraction, Signal Integrity Analysis, Interconnect Driver Models, RC Interconnect

Analysis, RLC Interconnect Analysis, Noise-Aware Timing Analysis, Design Solutions for Signal Integrity, Physical Design Techniques, Circuit Techniques.

TEXT BOOKS:

1. Ban P. Wong, Anurag Mittal, Yu CaoGreg Starr, "NANO-CMOS CIRCUITAND PHYSICAL DESIGN", John Wiley & Sons, Inc., Hoboken, New Jersey. 2000.
2. Charles chiang, Jamil Kawa, "Design for manufacturability and yield for Nano - Scale CMOS", Springer, 2007.

Oleg Semenov, HosseinSarbishael, ManojSachdev, "ESD Protection Device and Circuit Design for Advanced CMOS Technologies", Springer, 2008.

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M. Tech I Year - I Sem(M & NE)

(14DECS11T02)

ELECTIVE-I

QUATUM ELECTRONICS
(14MNE11E1a)

Course Objective:

- Introduce the quantum mechanical concepts needed to understand the operation of not only current nanoelectronic and nanophotonic devices and materials, but to understand the operating principles behind devices and materials still in their infancy. To this end, we will apply the principles of quantum mechanics to understand cutting edge next generation nanoelectronic devices and materials

Course outcome:

- To understand, the principles of nanophotonic and nanoelectronic devices and details of materials.
- Knowledge will be obtained about the nanoelectronic devices and materials

UNIT I

CRYSTAL STRUCTURE: Crystalline and amorphous solids- Crystal lattice and crystal structureTranslational symmetry-space lattice-unit cell and primitive cell-symmetry elements in crystal-the seven crystal systems.

UNIT II

IMPERFECTIONS AND RECIPROCAL LATTICEE IN CRYSTALS: Wigner-seitz cells-Miller indices-Miller-bravais indices-Indices of a lattice direction-The spacing of a set of crystal planes, Importance of lattice imperfections- types of imperfection-Point defects-dislocations. Bragg law- Reciprocal lattice – Properties of Reciprocal lattice- Reciprocal lattice of simple cube- Reciprocal lattice of bcc- Reciprocal lattice of fcc- diffraction conditions- Brillouion zones.

UNIT III

QUANTUM MECHANICS OF ELECTRONICS:

Introduction-Why quantum mechanics - matter waves-length scales - De-Broglie hypothesis – wave particle duality. Heisenberg‟ s uncertainty principle-Schrodinger wave equation – General

postulates of Quantum mechanics- particle in one dimensional box. Electron as particle and electron as wave-

UNIT IV

Analogies between quantum mechanics and classical electromagnetic-Probabilistic current densitymultiple particle systems.

UNIT V

FREE AND CONFINED ELECTRONS: Free electrons-the free electron gas theory of metals-electrons confined to abounded region of space and quantum numbers-electrons confined to atom-the hydrogen atom and the periodic table-quantum dots-wires-wells.

Text books:

1. An introduction to solid states electronic devices by Ajay kumarsaxena Macmillan India Ltd {Unit-I,II}
2. Solid state Physics by Kittle {Unit-I,II}
3. P.M.Mathews and K.Venkatesan, "A textbook of Quantum Mechanics", Tata McGraw Hill Publishing Company Ltd {Unit-III}
4. Quantum Mechanics – Schiff {Unit-III}
5. Quantum Mechanics by B.k.Agarwal and Hariprakash, PHI {Unit-III}
6. Fundamentals of nanoelectronics by George W.Hanson Pearson education {Unit-IV,V}

Reference Books:

1. Introduction to Nanotechnology by Charles P.PooleJr& Frank J. Owens;Wiley India Pvt. Ltd The Feynman lectures on Physics; Vol I to III
2. Quantum mechanics by Brandsen&Joachem
3. J.J.Sakurari, "Modern Quantum Mechanics Mc.Graw Hill, Addison Wesley Longman Inc., USA, 1999
4. Nano Terchnology and Nano Electronics – Materials, devices and measurement Techniques by WR Fahrner – Springer
5. Nano Technology – science, innovation and opportunity by Lynn E Foster;Prentice Hall - Pearson education.
6. Hand book of Nano structured materials; Vol I to V Bio Ethics Readings and cases by Branch A.Brody&H.TristramEngelhardt.Jr; Pearson Education
7. Quantum mechanics: - Pawling & Wilson

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8. Quantum physics by A.Ghatak

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4	0	4

M. Tech I Year - I Sem(M & NE)

ELECTIVE-I

DIGITAL SYSTEM DESIGN
(14MNE11E1b)

Course Objectives:

- This course introduces the student to the design of digital logic circuits, both combinational and Sequential,
- And the design of digital systems in a hierarchical, top-down manner and Able to design and prototype withProgrammable logic.

Course Outcomes:

After Completion of this course students will be able to

- Understand structural functionality of different digital blocks
- Represent and Realize their designs in ASM charts
- Represent their designs in different modelling styles by using VHDL
- Understand concept of Micro program and issues related to micro programming

UNIT I

DESIGN OF DIGITAL SYSTEMS AND SEQUENTAIL CIRCUITS: ASM charts, Hardware description language and control sequence method, Reduction of state tables, state assignments. design of Iterative circuits, design of sequential circuits using ROMs and PLAs, sequential circuit design using CPLD, FPGAs.

UNIT II

FAULT MODELING AND TESTING: Fault classes and models – Stuck at faults, bridging faults, transition and intermittent faults. **TEST GENERATION:** Fault diagnosis of Combinational circuits by conventional methods – Path Sensitization technique, Boolean difference method, Kohavi algorithm. **TEST PATTERN GENERATION:** D – algorithm, PODEM, Random testing, transition count testing,

Signature Analysis and testing for bridging faults.

UNIT III

FAULT DIAGNOSIS IN SEQUENTIAL CIRCUITS: State identification and fault detection experiment. Machine identification, Design of fault detection experiment.

UNIT IV

PROGRAMMING LOGIC ARRAYS AND TESTING: Design using PLA‟ s, PLA minimization and PLA folding. Fault models, Test generation and Testable PLA design.

UNIT V

ASYNCHRONOUS SEQUENTIAL MACHINE: fundamental mode model, flow table, state reduction, minimal closed covers, races, cycles and hazards.

Text books:

1. Z. Kohavi – "Switching & finite Automata Theory" (TMH)
2. N. N. Biswas – "Logic Design Theory" (PHI)
3. NolmanBalabanian, Bradley Calson – "Digital Logic Design Principles" – Wily Student Edition 2004.

Reference Books:

1. M. Abramovici, M. A. Breues, A. D. Friedman – "Digital System Testing and Testable Design", Jaico Publications
2. Charles H. Roth Jr. – "Fundamentals of Logic Design".
3. Frederick. J. Hill & Peterson – "Computer Aided Logic Design" – Wiley 4th Edition.
4. R Goswami and K Chattopadhyay, Acta Mater. 52, 5503 (2004)
5. V. Germain et al., J. Phys. Chem. B, Vol. 107, No. 34, 2003

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4	0	4

M. Tech I Year - I Sem(M & NE)

ELECTIVE-I

MEASUREMENTS & CHARACTERIZATION OF NANOMATERIALS (14MNE11E1c)

Course Objective & Outcomes:

- Get introduction of different and complicate techniques.
- To characterize properties of Nanomaterials and know the basic types structural and different types of spectroscopic.

UNIT I

STRUCTURAL CHARACTERIZATION

X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM) Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

UNIT II

SPECTROSCOPIC AND SURFACE CHARACTERIZATIONS:

Basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurement, Raman spectroscopy

UNIT III

SURFACE CHARACTERIZATION:

X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS).

UNIT IV

RESONANCE METHODS AND THERMAL CHARACTERIZATION OF MATERIALS:

Electron Spin Resonance (ESR), Ferromagnetic Resonance (FMR), Nuclear Magnetic Resonance (NMR), Mossbauer SpectroscopyDTA, TGA, DSC (Principle and Applications), Determination of thermo physical parameters.

UNIT V

MULTI-WALLED CARBON NANOTUBES AND NANOMATERIALS FOR ORGANIC PHOTOVOLTAICS:

Synthesis, Characterization, MWNT Purity Assessment Material Characterization, Semiconducting Quantum dots, Fullerene Derivatives, Polymers, Composites

Text Books:

1. Elements of X –ray Diffraction, B. D. Cullity
2. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM
   - Ray F. Egerton
3. Thermal Analysis of Materials, Robert F Speyer, New York.

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M. Tech I Year - I Sem(M & NE)

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Course Objectives:

- To study about Hardware Modelling, Switch level models with the verilog HDL.
- To study in detail about Behavioral Description, Data types and Operators in VHDL
- To study in detail about Synthesis of Combinational Logic Circuits.
- To study different methods of processing using MATLAB

Course Outcomes:

- Students will be aware of different Modeling Systems using VHDL.
- Students will be able to get complete knowledge regarding Behavioral Descriptions, Data Types and Operators inVHDL.
- Students will be able to obtain the knowledge about Synthesis in VHDL.

SIMULATION AND SYNTHESIS LAB
(14MNE11P01)

1. Introduction to MATLAB Programming
2. Program assembly, Execution, Data processing and graphic analysis
3. Application of FFT for signal processing
4. Signal processing – Signal generation, filter design and analysis
5. MATLAB program to plot the one-dimensional rectangular potential well with infinite potential barrier
6. Numerical solution of the Schrodinger wave equation for rectangular potential well with infinite potential barrier using MATLAB program.
7. Design and simulation of (i) Combinational logic circuits, (ii) Sequential logic circuits, (iii) Analog circuits and (iv) A/D mixed circuits
8. Synthesis of Digital Circuit.
9. Place and Router Techniques for FPGAs.
10. Implementation of Design using FPGA and CPLD Devices.

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M. Tech I Year - IISem(M & NE)

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MEMS /NEMS DESIGN AND APPLICATIONS
(14MNE12T06)

Objective & Outcomes:

- Understanding of technology steps and technology process flows for MEMS and NEMS components and systems, technologies for advanced MEMS and NEMS, Technologies for system integration and different scaling issues.

UNIT I

Introduction to MEMS and NEMS: MEMS and NEMS – multidisciplinary nature of MEMS/NEMS – working principles: as micro sensors - acoustic wave sensor, biomedical and biosensor, chemical sensor, optical sensor, capacitive sensor, pressure sensor and thermal sensor. Micro devices: micro actuation - thermal actuation, piezoelectric actuation and electrostatic actuation, micro gripers – micro motors – micro valves – micro pumps – accelerometers – micro fluidics and capillary electrophoresis, active and passive micro fluidic devices.

UNIT II

Materials and material properties for MEMS/NEMS: Silicon – Compatible material systems, Silicon, Silicon oxide and nitride, Thin metal films, Polymers, Other materials and substrates, Glass and fused quartz substrates, Silicon carbide and diamond, Gallium Arsenide and other group III-V compound semi conductors, Shape - memory alloys transduction. Material properties: Important material properties and physical effects, Pizoresistivity, Pizoelectricity and thermoelectricity, Inter atomic bonds, Material structures.

UNIT III

MEMS/NEMS design, processing and Technologies: Basic process tools, Epitaxy, Oxidation, Sputter deposition, Evaporation, Chemical vapor deposition, spin on methods, Lithography, Lift off process, Bulk Micro machining, Etching processes – Wet etching, Plasma etching, Ion milling. Wafer bonding – Silicon fusion bonding, Anodic bonding, Silicon direct bonding, sol gel deposition methods, Self assembled mono layers, EFAB. LIGA electromagnetic micro drive, DRIE.

UNIT IV

MEMS/NEMS Scaling issues and Packaging: Introduction – Scaling of physical systems – Geometric scaling, Mechanical system scaling, Thermal system scaling, Fluidic system scaling, Electrical system scaling, Packaging-package design considerations, Process steps, Wafer thickness and dicing issues, Thermal management, Hermetic packaging, Electrical//Micro fluidic/and optical interconnects, Quality control-reliability and failure modes and analysis, Signal mapping transduction.

UNIT V

MEMS/NEMS applications: Applications in automotive industry – health care – aerospace – industrial product consumer products – lab on chip – molecular machines – data storage devices – micro reactor – telecommunications, Servo systems.

Text Books:

1. NadimMalut and Kirt Williams, "An introduction to Micro electro mechanical systems Engineering,"

Artech House, Inc, Boston, Second Edition.

2. James J Allen, "Micro electro mechanical systems Design," CRC Press – Taylor and Francis Group.
3. NicolaeLobontiu&Ephrahim Garcia, "Mechanics of micro electro mechanical systems," Kluwer.

Academic Publishers – Boston.

References Books:

1. BharathBhushan, "Springer Hand Book of Nano Technology "Springer publications.
2. Sergey Edward Lysherski, "Nano and Micro electro Mechanical systems," CRC Press.

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CARBON NANO TUBES AND APPLICATIONS
(14MNE12T07)

Course Objective:

- The course will give a historic and fundamental overview of carbonnano tubes and diamond, diamond like carbon films. The course will then cover growth, characterization and applications of various fields like nanowires, Computer applications (Nano chip), optical and telecommunication

Course Outcome:

- The student gains knowledge about the carbon nano tubes and their behavior .
- Different applications areas are being identified of optical and telecommunication

UNIT I

Diamond, nanodiamond particles, nanodiamond particles synthesis: high pressure high temperature technique, chemical methods using energetic particles and beam, Applications of nanodiamond particles.Diamond-like Carbon films (DLC), classification of DLC, properties and applications of DLCs: internal stress and adhesion, coating morphology, porosity and diffusional property, DLC/graphite transformation.

UNIT II

DLC properties continued: Optical properties, electrical properties, mechanical properties, chemical resistance, tribological properties; deposition techniques of DLC films.

UNIT III

Nanocrystalline diamond (NCD) films, pretreatment processes to enhance the nucleation of NCD films, propertiesand applications of NCD films: tribology, electron emission, electrochemical electrodes, conformal coatings, deposition of NCD films.

UNIT IV

Carbon nanotube (CNT), structure of CNT, synthesis of CNT, electronic, vibrational, mechanical and optical properties of CNT; applications of CNT. fabrication of Fullerene (C60). Functionalization of Carbon Nanotubes: covalent functionalization of CNTs, non covalent functionalization of CNTs, modification of CNTs via mechnochemical reactions, electrochemical deposition, electroless deposition; plasma activation of CNTs.

UNIT V

Lithium & Hydrogen adsorption & storages, Fuel cell applications and energy storage, Chemical Sensors applications of CNTs. Computer applications (Nano chip), optical and telecommunication applications. Nano composites, silicon Nanowires.

Text books:

1. Charles P. Poole Jr and Frank J.Owens, "Introduction to Nanotechnology," Wiley India Pvt Ltd.
2. W. R Fahrner, "Nanotechnology and Nano Electronics – Materials, devices and measurement

techniques," Springer publications.

3. Michael J. O'Connell, "Carbon Nanotubes: Properties and Applications."

Reference books:

1. J. Robertson, "Diamond-like Amorphous Carbon, Materials Science and Engineering," R 37 (2002)

129-281.

2. Olga A. Shenderova, Dieter M. Gruen William, " Ultrananocrystalline Diamond: Synthesis, Properties,

and Applications," Andrew Publishing Norwich, New York, U.S.A.

3. R Satio, "Physical properties of Carbon Nanotube."
4. C. N. R. Rao & A. Govindaraj, " Nanotubes and Nanowires," RCS Publishing.
5. M.Balakrishnarao and K.Krishna Reddy, "Encyclopaedia of Nanotechnology," Vol I to X Campus

books.

6. Lynn E. Foster, "Nanotechnology – science, innovation and opportunity," Prentice Hall Pearson

education.

7. T. Pradeep, "Nano: The Essentials – Understanding Nano Science and Nanotechnology," Tata

Mc.Graw Hill.

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NANO BIO-TECHNOLOGY
(14MNE12T08)

Course Objective & Outcome:

- The aim of this course is to convey a well-founded, wide-ranging basis of knowledge for developing, implementing and evaluating nanobiotechnological applications**.**This new course of study combines the three fields of chemical nanotechnology, nanomaterials and biotechnologyIt uses nanotechnology to analyse and create biological nanosystems.

UNIT I

Functional Principles of Nanobiotechnology: From Biotechnology to Nanobiotechnology, InformationDriven Nano assembly, Energetics, Topdown and bottom up approach for building nanomaterials, Chemical Transformation Biomaterials, Machine-Phase Nanobiotechnology.

UNIT II

Structural Principles of Nano-biotechnology Construction of Nano-machines, The Raw Materials: Biomolecular Structure and Stability, Protein Folding, Self-Assembly, Self-Organization, Molecular Recognition, Atomicity limits the tolerance of combining sites, Flexibility, Flexibility poses great challenges for the design of , nano bio machines.

UNIT - III

Nano biometrics – Introduction – lipids as nanobricks and mortar: self-assemblednanolayersthe bits that do think – proteins- three dimensional structures using a 20 aminoacid-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. Nanobio machines: The Unfamiliar World of Nanobiomachines, Modern nanobiomachine using different molecular motors, Biomaterials created by nano particle, Biomaterial supplementing important human body part, Guided Tour of Natural Nanobiomachinery.

UNIT IV

Biosensors as Precursors of Bioelectronics, Functionalization of Sensing Substrates, Biochip, Nanosensors-Miniaturization of Biosensors, Nanomaterial Based Biosensors. Electron Transfer of Biomolecules, Nanoparticle Biomaterial Hybrid Systems for Sensing and Electronic Devices, Effect of Biosensor in biological and physicochemical techniques. DNATemplated Electronics, Sequence –specific molecular lithography, Single Biomolecule Manipulation for Bioelectronics, DNA as a semiconductor.

UNIT V

Applications of nanobiotechnology in early medical diagnostics, drug targeting, drug delivery, nanosurgery and other biomedical field.The Future of Nanobiotechnology: A Timetable for Nanobiotechnology, Lessons for Molecular Nanotechnology, Case Studies: Nanotube synthesis;

A general nanoscale assembler, Nanosurveillance. Ethical Considerations. Respect for life, Potential dangers.

Text Books:

M. Niemeyer and Chad. A. Mirkin (eds.), "Nano biotechnology: concepts, applications & perspectives," Wiley VCH Weinheim (2004).

Jain, K. K, "Nanobiotechnology in molecular diagnostics: current techniques and applications,"

Reference Books

1. David.S.Goodsell, "Bionanotechnology: concepts, Lessons from Nature," Wiley-Liss 2004
2. Sandra J Rosethal, David W Wright, "Nanobiotechnology Protocols," Series Methods in Molecular Biology, 2005.
3. R.S. Greco, F.B.Prinz and R.L.Smith, "Nanoscale Technology in Biological Systems," CRC press, 2005.

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NANOSENSORS
(14MNE12T09)

Course Objective & Outcome:

- Enables students to have an overview of different principles, physical effects and realizations of transducers (sensors) and understands the characteristics of sensors. The course give knowledge on nano based organic and inorganic sensors and its Signal conditioning and data acquisition

UNIT I

Transducers: Conductometric and capacitive transducers, optical waveguide based transducers, optical fiber based transducers, Interferometric optical transducers, surface Plasmon resonance transducers, electrochemical transducers, solid state transducers, PN diodes or bipolar junction based transducers, schottky diode based transducers.MOS capacitor based transducers, FET based transducers, Acoustic wave transducers, Quartz crystal Microbalance, Film Bulk acoustic wave resonator (BAW transducer), Interdigitally launched surface acoustic wave transducer (SAW transducer), Cantilever based transducers.

UNIT II

Sensor Characteristics: Active and Passive sensors – Static characteristics, Accuracy, offset and linearity, Dynamiccharacteristics, First and second order sensors. **Physical effects:** Physical effects involved in signalTransduction, Photoelectric effect, photodielectric effect, Photoluminescence effect, electroluminescence effect, chemiluminescence effect, Doppler effect, Barkhausen effect, Hall effect, nernst / Ettinshausen effect, Thermoelectric effect, Peizoresistive effect, piezoelectric effect, pyroelectric effect, magneto-mechanical effect (magnetostriction),Magnetoresistive effect, Faraday-Henry Law, magneto optice Kerr effect, KerrandPockels effect.

UNIT III

Nano based Inorganic and organic sensors: Density of states (DOS) – DOS of 3D, 2D, 1D and 0D materials, one dimensional gassensors, gas sensing with nanostructured thin films, absorption on surfaces, metal oxidemodifications by additives, surface modifications, Nano optical sensors, nano mechanicalsensors, plasmon resonance sensors with nano particles, AMR, Giant and colossalmagnetoresistors, magnetic tunnelling junctions.Structure of Protein, role of protein in nanotechnology, using protein in nanodevices antibodies in sensing, antibody in nano particle

conjugates, enzymes in sensing, enzymenanoparticle hybrid sensors, Motor proteins in sensing, transmembrane sensors.

UNIT IV

Nanosensors based on Nucleotides and DNA, Structure of DNA – DNA decoders andmicroarrays, DNA protein conjugate based sensors, Bioelectronic sensors, DNAsequencing with nanopores, sensors based on molecules with dendritic architectures, biomagnetic sensors.

UNIT V

Signal conditioning and data acquisition: Earthing and grounding – series and common mode noise, errors due to common modeinterference, specification of common mode rejection ratio, instrumentation amplifiers, isolation amplifiers, charge amplifiers, filters, integrators and differentiators, phasesensitive detectors (PSD), Linear switching PSD, Multiplying PSD, Digital PSD, Edgetriggered PSD, Phase locked loop.

Text Books:

1. KouroushKalantar – Zadeh, Benjamin Fry, "Nanotechnology enabled sensors," Springer Verlog New York, 2007.
2. H. Rosemary Taylor Chapman and Hall, "Data acquisition for sensor systems," Sensor physics and technology 5, London, 1997.

Reference Books:

1. Ramon Pallas-Areny, John G. Webster, "Sensors and signal conditioning," John Wiley & Sons 2nd edition, 2001.
2. Jerome Schultz, MilarMrksich, Sangeeta N. Bhatia, David J. Brady, Antionio J. Ricco, David R. Walt, Charles L. Wilkins, " Biosensing: International Research and Development," Springer 2006.

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NANO FABRICATION TECHNIQUES
(14MNE12T10)

Course Objective & Outcome:

- This course will familiarize students with the principles of various micro/Nanofabrication techniques

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UNIT I
Introduction: Introduction to microelectronics fabrication and Moore`s empirical law - Limitations – Si processing methods: Cleaning/etching, oxidation, Gettering, doping, epitaxy-semiconductor device road map –gate dielectrics, poly Si, high k dielectrics.

UNIT II
Top-down Lithography techniques Necessity of clean a room, different types of clean rooms, maintenance, Importance of Lithography techniques. Photolithography, Electron Beam lithography, Extreme UV lithography, X-ray Lithography, Focused ion beam Lithography (FIB). Etching Techniques Types of etching - Reactive ion etching (RIE), Wet chemical etching, Isotropic etching, Anisotropic etching, electrochemical etching.

UNIT III
Bottom - up approach - I Self-assembly and Lithography: self-assembly, self-assembled mono layers, directed assembly, layer-by layer assembly, patterned growth, control of position and diameter.

UNIT IV
Combinations of top-down and bottom-up techniques: current state of the art - DNA self-assembly Chemical vapour deposition of Nanostructures: Nanocrystals - Nanowires by catalytic (Au, Ni and Ag) and non-catalytic VLS approach. Bottom - up approach II: Patterned growth Nanoimprint lithography (NIL), soft polymer photoresistive, moulding /replica, printing with stamp pads, RIE etching, patterned growth, control of position, size and density. Dip-pen lithography, setup, working principle.

UNIT V

M based nanolithography and nanomanipulation, E beam lithography and SEM based nanolithography and nanomanipulation. Ion beam lithography, oxidation and metallization, Mask and its application, Deep UV lithography, X-ray based lithography.

Text Books:

1. M. Madou, "Fundamentals of microfabrication," CRC press, 1997.
2. G. Timp, "Nanotechnology," AIP press, Springer Verlag, New York , 1999.
3. M.J.Jackson, "Micro fabrication and Nanomanufacturing," CRC press, 2005.
4. G.Cao, "Naostructures and Nanomaterials: Synthesis, properties and applications," Imperical College Press, 2004.

Reference Books:

1. R.D. Piner, "Dip-pen lithography Science," 1999.
2. W.T.S Huck, "Nanoscale assembly: Chemical Techniques (Nanostructure Science and Technology),"

Springer, 2005.

3. H. Schift et al, "Fabrication of polymer photonic crystals using nano imprint lithography,

Nanotechnology," 2005.

4. E. L Principe, P. Gnauck and P. Hoffrogge, "Microscopy and Microanalysis," Cambridge University

Press, 2005.

5. Leon L. Shaw (editor), "Processing & properties of structural naonmaterials."
6. Mark James Jackson, "Microfabrication and Nanomanufacturing,"

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ELECTIVES – II

NANO MEDICINE
(14MNE12E2a)

Course Objective & Outcome:

- This course will familiarize students with the principles of various nano molecular diagnostics systems and drug delivery system and Includes a general introduction to biological systems; emphasizes the structural and functional relationship between various biological compartments.

UNIT I

NANOMOLECULARDIAGNOSTICS-ARRAYANDCHIPS:
Introduction -Nanodiagnostics -Rationale of Nanotechnology for Molecular Diagnostics -Nanoarrays for
Molecular Diagnostics .NanoProTM System -Nanofluidic/Nanoarray Devices to Detect a Single Molecule of DNA-Self-Assembling ProteinNanoarrays -Fullerene Photodetectors for ChemiluminescenceDetectiononMicrofluidicChips -Protein Microarray for Detection of Molecules with Nanoparticles Protein Nanobiochip.

UNIT II

Nanoparticles for Molecular Diagnostics -Gold Nanoparticles -Quantum Dots for Molecular Diagnostics
Magnetic Nanoparticles -Use of Nanocrystals in Immunohistochemistry -Imaging Applications of Nanoparticles Study ofChromosomesbyAtomicForceMicroscopy-Applications of Nanopore Technology for Molecular Diagnostics DNA–Protein and DNA–Nanoparticle Conjugates.

UNIT III

NANOMACHINES AND NANOBARCODES, NANOBIOSENSORS:
DNA Nanomachines for Molecular Diagnostics -Nanobarcodes Technology -Nanobarcode Particle
Technology for SNP Genotyping -QdotNanobarcode for Multiplexed Gene Expression Profiling BiobarcodeAssay for ProteinsSingle-Molecule Barcoding System for DNA Analysis Nanoparticle-Based Colorimetric DNA Detection Method.Cantilevers as Biosensors for Molecular Diagnostics –CarbonNanotube Biosensors -FRETBasedDNANanosensors. Ion Channel Switch Biosensor Technology -Electronic Nanobiosensors Electrochemical Nanobiosensors -Quartz NanobalanceBiosensors -Viral Nanosensors - PEBBLENanosensors -

Microneedle-Mounted Biosensors OpticalBiosensors- Nanowire (NW) Biosensors - NanoscaleErasableBiodetectors.

UNIT IV

NANOPHARMACEUTICALS AND DRUG DELIVERY:
Introduction -Nanobiotechnology for Drug Discovery -Gold Nanoparticles for Drug Discovery -Use of Quantum Dots for Drug Discovery -Nanolasers for Drug Discovery -Cells Targeting by Nanoparticles with Attached Small Molecules -Role of AFM for Study of Biomolecular Interactions for Drug Discovery Nanoscale Devices for Drug Discovery -Nanotechnology Enables Drug Design at Cellular Level Nanobiotechnology-Based Drug Development - DendrimersasDrugs- Fullerenes as Drug Candidates – Nanobodies. Nanobiotechnology in Drug Delivery -NanoscaleDelivery of Therapeutics -Nanosuspension Formulations Viruses as Nanomaterials for Drug Delivery -Nanoparticle-Based Drug Delivery -Trojan Nanoparticles - Self-Assembling Nanoparticles for Intracellular Drug Delivery -Nanoparticle Combinations for Drug Delivery Liposomes -Liposome–Nanoparticle Hybrids-Nanospheres-Nanotubes – Nanocochleates.Nanomolecular Valves for Controlled Drug Release –Nanomotors forDrugDelivery.

UNIT V

ROLE OF NANOTECHNOLOGY IN BIOLOGICAL THERAPIES CANCER THERAPY & NANOMEDICINE:
Introduction - Development of nano medicines – Nano Shells – Nano pores – Tectodendrimers – Nanoparticle drug system for oral administration – Drug system for nasal administration – Drug system for ocular administration – Nanotechnology in diagnostic application. Preformulation Studies: on various dosage forms such as tablets, capsules, suspension, creams, emulsion, injectables, ophthalmic and aerosols etc. Biomedical nanoparticles – Liposome‟ s – Dentrimers – Different types of drug loading – Drug release – Biodegradable polymers – Applications Nanobiotechnologies for Single-Molecule Detection -Protease-Activated QuantumDot Probes - Nanotechnology for Point-of-Care Diagnostics Nanodiagnostics for the Battle Field - Nanodiagnostics for Integrating Diagnostics with Therapeutics.Introduction and Rationale for Nanotechnologyin Cancer Therapy -- Passive Targeting of Solid Tumors:Pathophysiological Principles and Physicochemical Aspects of Delivery Systems -Active Targeting Strategies in Cancer with a Focus on\Potential Nanotechnology Applications -Pharmacokinetics of Nanocarrier-Mediated Drug and Gene Delivery - Multifunctional Nanoparticles for Cancer Therapy- Neutron Capture Therapy of Cancer: Nanoparticlesand High Molecular Weight Boron Delivery Agents. Nano-Oncology- Nanoneurology- Nanocardiology- Nano-Orthopedics- Nano-Ophthalmology.

Text Books: „

1. Zhang, Nanomedicine: A Systems Engineering Approach,”1st Ed., Pan Stanford Publishing, 2005.
2. Robert A. Freitas Jr., “Nanomedicine Volume IIA: Biocompatibility,” Landes Bioscience Publishers, 2003.

Reference Book:

1.Kewal K. Jain, “The Handbook of Nanomedicine,”Humana Press, 2008.

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ELECTIVES – II

PACKING TECHNOLOGY
(14MNE12E2b)

Course Objectives:

- To provide knowledge on packaging and packaging materials. To understand the working various packaging methods and packing manufacturing process
- To enable the students to understand the various packaging sectors like electronics, manufacturing, automotive, textiles, pharmaceuticals, and agro etc.

Course Outcomes:

- Possessing knowledge of basics, methods and manufacturing of packaging materials
- An understanding of packaging methods used in various sectors

UNIT I

Packaging and its importance in retail industry, Types of Packaging.Evolution of Packaging, Purpose of packaging like Physical protection, Barrier protection, Containment, Information transmission, Marketing, Security, Convenience, Portion control.

UNIT II

Packaging requirements, regulations and standards.Understanding the Packaging Design Process: Packaging dynamics, Packaging for various sectors electronics, manufacturing, automotive, textiles, pharmaceuticals, and agro.

UNIT III

Package development considerations. Structural Design for Packaging, Measuring packaging design success.

UNIT IV

Elements of Packaging design: color, symbols, icons, illustration, surface graphics, typography, photography, material.

UNIT V

Understand the packaging manufacturing process, Packaging machining process like printing, stamping, cartons, case and tray forming. Packing, sealing, labeling, wrapping, vacuum packaging.

Text Books:

Akabane. N, "Package Form and Design: Encyclopedia of Paper-Folding Design," *PIE* Books, 2011.

Burke W, Baer L and Pietruszynski. J, "The Big Book of Packaging," Harper Design, 2011.

Denison E. and Cawthra .R, "The Big Book of Packaging Prototypes,"Rotovision, 2011.

Reference Books:

DuPuis S. and Silva. J, "Package Design Workbook: The Art and Science of Successful Packaging,"Rockport Publishers, 2008.

Coles R, McDowell D and Kirwan M. J, "Food Packaging Technology," Blackwell, 2003.

Capsule, "*Packaging 01:* An Essential Primer for Today's Competitive Market," Rockport Publishers, 2008.

Ambrose .*G*, "This End Up: Original Approaches to Packaging Design," Rotovision, 2002.

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ELECTIVES – II

INDUSTRIAL NANO TECHNOLOGY
(14MNE12E2c)

Course Objectives:

- To provide knowledge of various industrial applications of nano-technology.
- To elucidate on advantages of nanotechnology based applications in each industry
- To provide an overview of future technological advancements and increasing role of nanotechnology in each industry

Course Outcomes:

- Posses knowledge of various industrial applications of nano-technology.
- Having a know-how of the advantages of nanotechnology based applications in each industry
- Having an overview of future technological advancements and increasing role of nanotechnology in each industry

UNIT I

NANOTECHNOLOGY IN ELECTRICAL AND ELECTRONICS INDUSTRY:
Advantages of nano electrical and electronic devices –Electronic circuit chips – Lasers - Micro and NanoElectromechanical systems – Sensors, Actuators, Optical switches, Bio-MEMS – Diodes and Nano-wire Transistors - Data memory –Lighting and Displays – Filters (IR blocking) – Quantum optical devices – Batteries - Fuel cells and Photo-voltaic cells – Electric double layer capacitors – Lead-free solder – Nanoparticle coatings for electrical products.

UNIT II

NANOTECHNOLOGY IN BIOMEDICAL AND PHARMACEUTICAL INDUSTRY:
Nanoparticles in bone substitutes and dentistry – Implants and Prosthesis - Reconstructive Intervention and Surgery – Nanorobotics in Surgery – Photodynamic Therapy - Nanosensors in Diagnosis– Neuroelectronic Interfaces – Protein Engineering – Drug delivery – Therapeutic applications. Nanocatalyts – Smart materials – Heterogenous nanostructures and composites – Nanostructures for Molecular recognition (Quantum dots, Nanorods, Nanotubes) – Molecular Encapsulation and its applications – Nanoporous zeolites – Self-assembled Nanoreactors - Organic electroluminescent displays.

UNIT III

NANOTECHNOLOGY IN AGRICULTURE FOOD TECHNOLOGY TEXTILES AND COSMETICS

Nanofibre production - Electrospinning – Controlling: Nanotechnology in Agriculture - Precision farming, Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers - Nanotechnology in Food industry - Packaging, Food processing - Food safety and bio-security – Contaminant detection – Smart packaging. morphologies of nanofibers – Tissue engineering application – **Polymer nanofibers**- Nylon-6 nanocomposites from polymerization - Nano-filled polypropylene fibers.

UNIT IV

Bionics: Swim-suits with shark-skin-effect,Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, antibacterial, hydrophilic, self-cleaning, flame retardant finishes). Modern textiles: Lightweight bulletproof vests and shirts, Colour changing property, Waterproof and Germ proof, Cleaner kids clothes, Wired and Ready to Wear.

UNIT V

Cosmetics: Formulation of Gels, Shampoos, Hair-conditioners (Micellar self-assembly and its manipulation) – Sun-screen dispersions for UV protection using Titanium oxide – Color cosmetics.

Text Books:

1. Mark A. Ratner and Daniel Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea, Pearson, 2003.
2. Bharat Bhushan, "Springer Handbook of Nanotechnology,"Barnes & Noble, 2004.
3. Neelina H. Malsch (Ed.), "Biomedical Nanotechnology,"CRC Press, 2005. **Reference Books:**
4. Udo H. Brinker, Jean-Luc Mieusset (Eds.), "Molecular Encapsulation: Organic Reactions in Constrained Systems,"Wiley Publishers 2010.
5. Jennifer Kuzma and Peter VerHage, "Nanotechnology in agriculture and food production,"Woodrow Wilson International Center, 2006.
6. Lynn J. Frewer, WillehmNorde, R. H. Fischer and W. H. Kampers, "Nanotechnology in the Agri-food sector,"Wiley-VCH Verlag, 2011.
7. P. J. Brown and K. Stevens, "Nanofibers and Nanotechnology in Textiles,"Woodhead Publishing Limited, Cambridge, 2007.
8. Y-W. Mai, "Polymer Nano composites,"Woodhead publishing, 2006.
9. W.N. Chang, "Nanofibres fabrication, performance and applications," Nova Science Publishers Inc, 2009.

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M. Tech I Year - IISem(M & NE)

Course Objectives:

- To study about MEMS.
- To study in detail about Behavioral Description, Data types and Operators in Comsol
- To study different methods of processing using Comsol Software

Course Outcomes:

- Students will be aware of different Modeling Systems in MEMS
- Students will be able to get complete knowledge regarding Behavioral Descriptions, Data Types and Operators in COMSOL.
- Students will be able to obtain the knowledge about MEMS using Comsol software.

MEMS LABORATORY
(14MNE12P02)

1) Introduction and Familiarization to Comsol software
2) Introduction to Basic components menus in Comsol software and parameter settings
   a) Electric currents, b) Magnetic fields, c) Plasma and d) Heat flow
3) Basic Geometry operations in Comsol:
   a) Unifying, b) Intersecting and c) Subtraction
4) Advanced Geometry operations in Comsol:
   a) Scalling, b) Moving, c) Copying and d) Making Array.
5) Defining material and Meshing in Comsol.
6) Study and performance evolution of Accelerometer sensor
7) Study and performance evolution of gyro sensor
8) Study of Hall Effect
9) Study of Thermo electric cooling
10) Study and performance evolution of force sensor
11) Study and performance evolution of solar cell