Scheme of Teaching and Examination and Syllabus
B. E. NANO TECHNOLOGY (NT)
III-VIII SEMESTER
(Effective from Academic year 2018-19)
### B. E. Common to all Programmes
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

**SEMESTER - III**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18MAT31</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(2:2:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>3</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To have an insight into Fourier series, Fourier transforms, Laplace transforms, Difference equations and Z-transforms.
- To develop the proficiency in variational calculus and solving ODE’s arising in engineering applications, using numerical methods.

**Module-1**

**Laplace Transform:** Definition and Laplace transforms of elementary functions (statements only). Laplace transforms of Periodic functions (statement only) and unit-step function – problems.

**Inverse Laplace Transform:** Definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) and problems. Solution of linear differential equations using Laplace transforms.

**Module-2**

**Fourier Series:** Periodic functions, Dirichlet’s condition. Fourier series of periodic functions period $\frac{\pi}{2}$ and arbitrary period. Half range Fourier series. Practical harmonic analysis.

**Module-3**

**Fourier Transforms:** Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Problems.

**Difference Equations and Z-Transforms:** Difference equations, basic definition, $z$-transform-definition, Standard $z$-transforms, Damping and shifting rules, initial value and final value theorems (without proof) and problems, Inverse $z$-transform and applications to solve difference equations.

**Module-4**

**Numerical Solutions of Ordinary Differential Equations (ODE’s):**
Numerical solution of ODE’s of first order and first degree- Taylor’s series method, Modified Euler’s method. Runge - Kutta method of fourth order, Milne’s and Adam-Bashforth predictor and corrector method (No derivations of formulae)-Problems.

**Module-5**

**Numerical Solution of Second Order ODE’s:** Runge -Kutta method and Milne’s predictor and corrector method. (No derivations of formulae).

**Calculus of Variations:** Variation of function and functional, variational problems, Euler’s equation, Geodesics, hanging chain, problems.

**Course Outcomes:** At the end of the course the student will be able to:
- CO1: Use Laplace transform and inverse Laplace transform in solving differential/ integral equation arising in network analysis, control systems and other fields of engineering.
- CO2: Demonstrate Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- CO3: Make use of Fourier transform and Z-transform to illustrate discrete/continuous function arising in wave and heat propagation, signals and systems.
- CO4: Solve first and second order ordinary differential equations arising in engineering problems using single step and multistep numerical methods.
- CO5: Determine the external of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Advanced Engineering Mathematics</td>
<td>Chandrika Prasad and Reena Garg</td>
<td>Khanna Publishing</td>
<td>2018</td>
</tr>
</tbody>
</table>

**Web links and Video Lectures:**
1. [http://nptel.ac.in/courses.php?disciplineID=111](http://nptel.ac.in/courses.php?disciplineID=111)
2. [http://www.class-central.com/subject/math(MOOCs)](http://www.class-central.com/subject/math(MOOCs))
4. VTU EDUSAT PROGRAMME - 20
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

FOUNDATIONS OF NANOSCALE SCIENCE AND TECHNOLOGY

<table>
<thead>
<tr>
<th>Course Code</th>
<th>CIE Marks</th>
<th>SEE Marks</th>
<th>Credits</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>18NT32</td>
<td>40</td>
<td>60</td>
<td>04</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
In this course students will learn about the basics of nanoscale science, types of materials, and their engineering applications and hazards.

Module-1
INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY
History, background and interdisciplinary nature of nanoscience and nanotechnology, challenges of Richard Feynman, scientific revolutions, nanosized effects surface to volume ratio, examples of surface to volume ratio, atomic structure, Bohr atomic model, molecules and phases, introduction to classical physics and quantum mechanics, importance of nanoscale materials and their devices.

Module-2
CLASSIFICATION OF NANOSTRUCTURES
Zero dimensional, one-dimensional and two dimensional nanostructure materials - classification of solids: conductor, semiconductors, insulator, types of semiconductor, doping, diodes, current flow in semiconductors, ceramics and nanocomposites, quantum size effect(QSE) in 1D, 2D, 3D nanomaterials, quantum dots, nanowires, nanotubes, nanosheets, top down and bottom up approach.

Module-3
BIOMIMETICS AND BIOMATERIALS
Biomaterials: Introduction, Classification of Biomaterials, Biomaterials as implant in human body, characterization of biomaterials.

Module-4
INTRODUCTION TO NANOMATERIALS AND DEVICES:
Types of nanomaterials: Metal nanoparticles eg Au, Ag, Cu, Pt and their application as FETs. Metal oxide nanoparticles TiO$_2$, ZnO, SnO$_2$ and their application in solar cells, MEMS based gas sensors, Semiconductor Cadmium and Selenide quantum dots bio imaging, Carbon based nanomaterials and their applications in FETs, MOSFETS, sensors and actuators, Silicon based nanostructures and their application in single electron electronics used as tips for AFM and Field emission microscopy, magnetic and ceramics nanomaterials and their application.

Module-5
INTRODUCTION TO NANOTOXICOLOGY:
Nanomaterials pollution – Nanomaterials in Environment - Toxicology of Airborne – Effect of Nanomaterials in the environment. Safety and pollution Control techniques-handling, storage, packaging, transportation and disposal.

Course Outcomes: At the end of the course the student will be able to:
- CO1: Describe fundamentals of nanoscience and nanotechnology;
- CO2: Classify nano-structures;
- CO3: Develop smart materials;
- CO4: Analyse biomaterials;
- CO5: Explain nanotoxicology.
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

### BASICS OF MATERIAL SCIENCE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT33</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(3:0:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
In this course, students will get basics of engineering materials and their properties. Also, this course will create awareness among the students about the importance of material science in the field of nanoscience and nanotechnology.

**Module-1**
**INTRODUCTION TO MATERIAL SCIENCE:** Fundamentals of materials science; Structure: Introduction to microstructure, and nanostructure; Introduction, importance and examples for nanomaterials, biomaterials, electronic, optical, and magnetic materials, ceramic and glass materials, composite materials, polymeric materials, metals and alloys; Introduction and applications of modern engineering materials: shape memory materials, chromic materials (thermo, photo, and electro chromic); rheological fluids, metallic glasses, advanced ceramics; Introduction and applications of Ferroelectricity and ferroelectric materials, Piezoelectricity and piezoelectric materials, pyro-electric materials.

**Module-2**
**ELECTRICAL PROPERTIES OF MATERIALS:** Introduction; Measurement of electrical resistivity; Electrical conductivity: conductors, semiconductors, and insulators; Electronic conduction: energy band structures in solids, band and atomic bonding models (for metals, semiconductors, and insulators), drift velocity and electron mobility, factors influencing electrical resistivity of metals, intrinsic semiconduction, extrinsic semiconductor (n-type and p-type), carrier mobility, Hall effect; Semiconductor devices: rectifier and p-n rectifying junction (forward, and reverse bias), transistor, junction transistor and MOSFET; Conduction in ionic materials; Dielectric behaviour: Introduction to electric dipole, capacitance, polarization (electronic, ionic, and orientation); Supper conductors and their applications.

**Module-3**
**OPTICAL PROPERTIES OF MATERIALS:** Absorbance and Transmittance: Introduction and measurement of absorbance by absorbance spectroscopy; Index of refraction and Abbe’s refractometer; Birefringence and birefringent materials; Photosensitivity, Photoconductivity, and Photoreisitivity; Reflectance and reflectivity, Scattering (Rayleigh, Mie, and geometric) and their applications; Luminescence: types and applications; Fluorescence and its applications; Photonic Materials: principle, and device construction; Liquid crystals and liquid crystal display: molecular orientations, sensitivity to electric field, LCD construction, operation; Photoconducting materials: photoconductive device, construction, materials used, and applications; Photodetectors: characteristics, charged coupled device; Photonic crystals: classification and applications.

**Module-4**
**THERMAL AND MAGNETIC PROPERTIES:** **Thermal Properties:** Introduction; Heat capacity: specific, molar, and volume heat capacity, factors affecting specific heat capacity; Thermal expansion: factors affecting thermal expansion, coefficient of thermal expansion, importance, and applications of thermal expansion property (bimetal, and mercury-in-glass thermometer); Thermal conductivity: Fourier’s law, thermal conductance, resistance, transmittance, and admittance, factors affecting thermal conductance.

**Magnetic Properties:** Magnetic materials, angular momentum; definitions of magnetic dipole, dipole moment, flux, flux density, field strength, magnetization, susceptibility, permeability, relative permeability, Bohr Magneton; Classification of magnetic materials: diamagnetic, paramagnetic, ferromagnetic, antiferromagnetic, and ferrimagnetic materials; Hard and soft magnetic materials: comparison, properties and applications; Introduction and applications of Garnets, Magnetoplumbites, Magnetic bubbles, and Magnetic thin films; Spintronics and devices: OMR, GMR, TMR, CMR, advantages, and applications.

**Module-5**
DEFECTS AND IMPERFECTIONS & MECHANICAL PROPERTIES OF MATERIALS: Defects and Imperfections: Point defects: vacancies, interstitialcy, Schottky defect, Frankel defect, and impurity defects; Line defects: edge dislocation, screw dislocation, Burger’s vector, cross slip of a screw dislocation, climb of an edge dislocation; Surface imperfections: grain boundary, tilt boundary, twin boundary. Mechanical Property of Materials: Mechanism of elastic action; UTM: Components; Tensile strength, and compression strength: Introduction, concept, testing procedure; Engineering stress and strain, true stress and strain, linear and non-linear elastic properties; Relationship between engineering strain and true strain, engineering stress and true stress; Hardness: Brinell, and Rockwell hardness tests; Fracture: ductile and brittle fracture; Fatigue: mechanism of fatigue; Creep: various stages of creep; Impact strength: Izod and Charpy impact strength tests.

Course Outcomes: At the end of the course the student will be able to:
- CO1: Demonstrate fundamentals of material science;
- CO2: Illustrate electrical and optical properties of materials;
- CO3: Explain thermal and magnetic properties of materials;
- CO4: Analyse mechanical properties of materials;
- CO5: Apply ceramic materials for nano-scale applications

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>SL No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
**B. E. NANO TECHNOLOGY (NT)**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - III  

## PHYSICAL AND CHEMICAL PRINCIPLES OF NANOTECHNOLOGY

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT34</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE Marks</td>
<td>40</td>
</tr>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(3:0:0)</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
</tr>
<tr>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

### Course Learning Objectives:
- To learn the physical and chemical principles involved in the materials and systems.

### Module-1

**QUANTUM MECHANICS:**

### Module-2

**BASICS OF THERMODYNAMICS**
Thermodynamics: Introduction, importance and limitations of thermodynamics; thermodynamic terms definition and examples for: system and surroundings, properties of a system, state variables, processes, thermodynamic equilibrium, internal energy, enthalpy, and heat capacity of a system; Zeroth law of thermodynamics.; First law of thermodynamics: definition, mathematical expressions, heat capacity (at constant volume, and constant pressure); Spontaneous process: criteria for spontaneity; Second law of thermodynamics: equivalent forms, entropy and its illustrations. Third law of thermodynamics: definition and

### Module-3

**LATTICE VIBRATIONS AND BAND THEORY OF SOLIDS**
Concept of lattice vibrations and thermal heat capacity, classical, Einstein and Debye theories of molar heat capacity and their limitations.  

### Module-4

**SEMICONDUCTORS AND TUNNELING**
Semiconductor: Intrinsic semiconductors, doping and extrinsic semiconductors, simple models for semiconductors, Donor and acceptor levels, p-n junction and rectification, tunnelling and resonant tunnelling.  
Tunnelling: Concept of tunnelling, tunnelling through potential barrier, classical vs quantum tunnelling, tunnelling junction, tunnelling diode.

### Module-5

**COLLOIDAL SYSTEMS**
Introduction, Crystalloids and colloids, Classifications of colloids with examples: based on state of aggregation, affinity, and natural dispersed phase. Characteristics of colloidal solutions: Dynamic properties (Brownian motion, diffusion, sedimentation, colligative properties, adsorption, and filterability), Optical properties (visibility, colour, and Tyndall effect), Electrical properties (electrophoresis, and electro-osmosis). Emulsion: introduction, classification, types of emulsions formed on mixing of two partly or completely insoluble liquids, inter-conversion of dispersed phase and medium, characteristics of emulsions, identification of type of emulsion.

### Course Outcomes:
At the end of the course the student will be able to:
- CO1: Basics of quantum mechanics
- CO2: Basics of thermodynamics
- CO3: Concepts of lattice vibrations and band theory of solids
- CO4: Semiconductors and tunnelling
- CO5: Principles and applications of colloidal systems
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Basic Principles of Nanotechnology</td>
<td>Wesley C. Sanders</td>
<td>CRC Press, Taylor and Francis group</td>
<td>First Edition, 2018</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

FUNDAMENTALS OF BIOSCIENCE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT35</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>3:0:0</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To understand the basic concepts of biochemistry and pathways involved in metabolism.
- To study characteristics of microbes and microbial synthesis of nano materials.

Module-1
CELL BIOLOGY
The Cell: the Basic Unit of Life - Molecular Components of Cells; Cell Metabolism; Cell division – Introduction to Mitosis and meiosis, Eukaryotic and prokaryotic cells, Plant and animal cells.

Module-2
BIOLOGICAL MEMBRANES
Biological membranes: Structure and conformational properties of cell membranes, Singer and Nicholson model, Membrane permeability, fluidity, micelle formation, reverse micelles, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of Na⁺/K⁺, Blood Brain Barrier.

Module-3
MOLECULAR BIOLOGY:
Gene; Genetic Code; Replication; Transcription; translation; Expression of Genetic Information; Genetic Engineering - Recombinant DNA Technology. Catalytic strategies: Protease, Carbonic Anhydrases-. Restriction Enzymes.

Module-4
IMMUNOLOGY:
Immune system: The Cellular Basis of Immunity; Innate immunity and adaptive immunity; The Fine Structure of Antibodies and types; The Functions of Antibodies; T Cell Receptors and Subclasses-MHC Molecules and Antigen Presentation to T Cells-Cytotoxic T Cells-Helper T Cells and T Cell Activation-Selection of the T Cell Repertoire, CD4 cells.

Module-5
BIOMACHINES:
Biomotors: Conversion of Chemical Energy into Mechanical Work by Protein Motors, Brief Description of ATP Synthase Structure – FI motor, a power stroke, pure power stoke, coupling and coordination of motor.
Biomachines: Heart as a pump, Kidney as a filtration Unit, Brain as a data storage device, Stomach as a digester. Biological Sensors in the human body.

Course Outcomes: At the end of the course the student will be able to:
- CO1: Basics of cell biology
- CO2: Concepts of biological membranes
- CO3: Fundamentals of molecular biology
- CO4: Basics of immunology
- CO5: Concepts and applications of biomachines
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
# SYNTHESIS AND PROCESSING OF NANOMATERIALS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT36</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(3:0:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
To provide students with the knowledge of techniques used for synthesis and surface modification of nanomaterials.

**Module-1**

**PHYSICAL METHODS:**
- Ball milling synthesis, Arc discharge, RF-plasma, Plasma arch technique, Inert gas condensation, electric explosion of wires, Ion sputtering method, Laser pyrolysis, Molecular beam epitaxy and electrodeposition.
- Electro spinning, Physical vapor Deposition (PVD) – Chemical vapour Deposition (CVD) - Atomic layer Deposition (ALD) – Self Assembly- LB (Langmuir-Blodgett) technique.

**Module-2**

**CHEMICAL METHODS 1:**
- Chemical precipitation methods- co-precipitation, arrested precipitation, sol-gel method, chemical reduction, photochemical synthesis, electrochemical synthesis, Microemulsions or reverse micelles, Sonochemical synthesis, Hydrothermal, solvothermal, supercritical fluid process, solution combustion process.

**Module-3**

**CHEMICAL METHODS 2:**
- Spray pyrolysis method, flame spray pyrolysis, gas phase synthesis, gas condensation process, chemical vapor condensation.
- Fundamental aspects of VLS (Vapor-Liquid-Solid) and SLS (Solution-Liquid-Solid) processes – VLS growth of Nanowires – Control of the size of the nanowires – Precursors and catalysts – SLS growth – Stress induced recrystallization.

**Module-4**

**BIOLOGICAL METHODS:**
- Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Natural and artificial synthesis of nanoparticles in microorganisms; Use of microorganisms for nanostructure formation, Role of plants in nanoparticle synthesis, synthesis of nanoparticles using proteins and DNA templates.

**Module-5**

**SURFACE MODIFICATION OF NANOPARTICLES:**
- Surface modification of inorganic nanoparticles by organic functional groups - Instantaneous nanofoaming method for fabrication of closed-porosity silica particle- Development of photocatalyst inserted into surface of porous aluminosilicate - Fabrication technique of organic nanocrystals and their optical properties and materialization - Development of new cosmetics based on nanoparticles - Development of functional skincare cosmetics using biodegradable PLGA nanospheres.

**Course Outcomes:** At the end of the course the student will be able to:
- CO1: Experiment physical techniques used for synthesis and processing of nanomaterials;
- CO2: Analyse chemical methods used for synthesis and processing of nanomaterials;
- CO3: Understand spray pyrolysis methods and fundamentals of VLS
- CO4: Select biological methods used for synthesis and processing of nanomaterials;
- CO5: Test surface modifications of nanoparticles.
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Reference Books</th>
</tr>
</thead>
</table>
# SIMULATION AND MODELLING LAB

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to MAT Lab</td>
</tr>
<tr>
<td>2</td>
<td>Use ‘if’, ‘elseif’, and ‘else’ for conditional assignment</td>
</tr>
<tr>
<td>3</td>
<td>Switch case and otherwise for executing one of several groups of statements</td>
</tr>
<tr>
<td>4</td>
<td>Use a while loop to calculate factorial</td>
</tr>
<tr>
<td>5</td>
<td>Matrix operations</td>
</tr>
<tr>
<td>6</td>
<td>Plotting of UV Vis spectra graph for the synthesis of Ag Nanoparticles</td>
</tr>
<tr>
<td>7</td>
<td>Sign wave generation</td>
</tr>
<tr>
<td>8</td>
<td>Evaluating mathematical expression using MAT lab code</td>
</tr>
<tr>
<td>9</td>
<td>Drawing contours</td>
</tr>
<tr>
<td>10</td>
<td>Three dimensional plots</td>
</tr>
<tr>
<td>11</td>
<td>Plotting bar charts using MAT lab</td>
</tr>
</tbody>
</table>
| 12      | Solve using MATLAB the following array operations:  
|         | (a) 1+ [2 3 1]. (b) 3 x [1 4 8]. (c) [1 2 3] x [0 1 1]. (d) Square each element of the vector [2 3 1]. |

**Course Outcomes:**  
At the end of the course the student will be able to:  
- Students can able to understand the materials behaviour at basic level.  
- Students can also learn effect of temperature, electric field and magnetic fields on the different types of materials.

**Conduct of Practical Examination:**  
1. All laboratory experiments are to be included for practical examination.  
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.  
3. Students can pick one experiment from the questions lot prepared by the examiners.  
4. Change of experiment is allowed only once, and 15% Marks allotted to the procedure part to be made zero.
# DIGITAL ELECTRONICS LAB

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NTL38</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(0:2:2)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

## Course Learning Objectives:
This laboratory course enables students to get practical experience in design, realisation and verification of Demorgan’s Theorem, Full/Parallel Adders and Subtractors, Multiplexer using logic gates, Demux and Decoder, Flip-Flops, Shift registers and Counters; and in interfacing microcontroller to Toggle Switch and LEDs, LCD, Stepper Motor, Light dependant resistor (LDR ), a relay and buzzer.

## Course Outcomes:
At the end of the course the student will be able to:
- Demonstrate the truth table of various logic gates.
- Design, Test and Evaluate various combinational circuits such as adders, subtractors, multipliers, comparators, parity generators, multiplexers and de-Multiplexers.
- Construct flips-flops, counters and shift registers.
- Develop and Test interfacing of 8051 Microcontroller to various devices.

## Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To verify (a) Demorgan’s Theorem for 2 variables (b) The sum-of product and product-of-sum expressions using universal gates.</td>
</tr>
<tr>
<td>2</td>
<td>To design and implement (a) Full Adder using basic logic gates. (b) Full subtractor using basic logic gates.</td>
</tr>
<tr>
<td>3</td>
<td>To design and implement 4-bit Parallel Adder/subtractor using IC 7483.</td>
</tr>
<tr>
<td>4</td>
<td>To realize (a) 4:1 Multiplexer using gates (b) 3-variable function using IC 74151(8:1 MUX) (c) 1:8 Demux and 3:8 Decoder using IC74138</td>
</tr>
<tr>
<td>5</td>
<td>To realize the following flip-flops using NAND Gates. (a) Clocked SR Flip-Flop (b) JK Flip-Flop</td>
</tr>
<tr>
<td>6</td>
<td>To realize the following shift registers using IC7474 (a) SISO (b) SIPO (c)PISO (d) PIPO</td>
</tr>
<tr>
<td>7</td>
<td>To realize the Ring Counter and Johnson Counter using IC7476</td>
</tr>
<tr>
<td>8</td>
<td>To realize the Mod-N Counter using IC7490</td>
</tr>
<tr>
<td>9</td>
<td>To Interface 8051 to a toggle Switch and 8 LEDs to light up LEDs alternatively when the Switch is ON (in Assembly language).</td>
</tr>
<tr>
<td>10</td>
<td>To Interface 8051 to LCD to display a message (in C Language).</td>
</tr>
<tr>
<td>11</td>
<td>To Interface 8051 to Stepper Motor to rotate the motor for a given number of steps (C language programming).</td>
</tr>
<tr>
<td>12</td>
<td>Interface a Light dependant resistor (LDR), a relay and buzzer to make a light operated switch (in Assembly language).</td>
</tr>
</tbody>
</table>

## NOTE:
Use discrete components to test and verify the logic gates. Multisim may be used for designing the gates along with the above.
B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II / III / IV
Aadalitha Kannada

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18KAK28/39/49</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(0:2:0)</td>
</tr>
<tr>
<td>CIE Marks</td>
<td>100</td>
</tr>
<tr>
<td>Credits</td>
<td>01</td>
</tr>
</tbody>
</table>

### अतिमी (अतिमी क्षेत्र विशेषता विषय) अनि

- 1. (Kannada for Administration) अनि
- 2. (Kannada for Administration) अनि
- 3. (Kannada for Administration) अनि
- 4. (Kannada for Administration) अनि
- 5. (Kannada for Administration) अनि
- 6. (Kannada for Administration) अनि
- 7. (Kannada for Administration) अनि
- 8. (Kannada for Administration) अनि
- 9. (Kannada for Administration) अनि
- 10. (Kannada for Administration) अनि

### अर्ह्न क्षेत्र सिद्धांत विशेषता विषय

- 1. (Kannada for Administration) अनि
- 2. (Kannada for Administration) अनि
- 3. (Kannada for Administration) अनि
- 4. (Kannada for Administration) अनि
- 5. (Kannada for Administration) अनि
- 6. (Kannada for Administration) अनि
- 7. (Kannada for Administration) अनि
- 8. (Kannada for Administration) अनि
- 9. (Kannada for Administration) अनि
- 10. (Kannada for Administration) अनि

### अर्ह्नीय (अर्ह्नीय क्षेत्र क्षेत्रांसूची)

- 1. (Kannada for Administration) अनि
- 2. (Kannada for Administration) अनि
- 3. (Kannada for Administration) अनि
- 4. (Kannada for Administration) अनि
- 5. (Kannada for Administration) अनि
- 6. (Kannada for Administration) अनि
- 7. (Kannada for Administration) अनि
- 8. (Kannada for Administration) अनि
- 9. (Kannada for Administration) अनि
- 10. (Kannada for Administration) अनि
B. E. (Common to all Programmes)

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II & III/IV

Vyavaharika Kannada

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18KVK28/39/49</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE Marks</td>
<td>100</td>
</tr>
<tr>
<td>Credits</td>
<td>01</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
The course will enable the students to understand Kannada and communicate in Kannada language.

Table of Contents:
Chapter - 1: Vyavaharika kannada – Parichaya (Introduction to Vyavaharika Kannada).
Chapter - 2: Kannada Aksharamale haagu uchcharane (Kannada Alphabets and Pronunciation).
Chapter - 3: Sambhashanegagi Kannada Padagalu (Kannada Vocabulary for Communication).
Chapter - 4: Kannada Grammar in Conversations (Sambhashaneyalli Kannada Vyakarana).
Chapter - 5: Activities in Kannada.

Course Outcomes:
At the end of the course, the student will be able to understand Kannada and communicate in Kannada language.
### Course Information

**Course Code:** 18CPC39/49  
**CIE Marks:** 40  
**Teaching Hours/Week (L:T:P):** (1:0:0)  
**SEE Marks:** 60  
**Credits:** 01  
**Exam Hours:** 02

### Course Learning Objectives:

- To know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens.
- To understand engineering ethics and their responsibilities, identify their individual roles and ethical responsibilities towards society.
- To know about the cybercrimes and cyber laws for cyber safety measures.

### Module-1: Introduction to Indian Constitution


### Module-2: Union Executive and State Executive

- Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism.
- State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles 370,371,371J) for some States.


### Module-4: Professional / Engineering Ethics


### Module-5: Internet Laws, Cyber Crimes and Cyber Laws

- Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.

### Course Outcomes:

- **CO 1:** Have constitutional knowledge and legal literacy.
CO 2: Understand Engineering and Professional ethics and responsibilities of Engineers.
CO 3: Understand the the cybercrimes and cyber laws for cyber safety measures.

**Question paper pattern for SEE and CIE:**
- The SEE question paper will be set for 100 marks and the marks scored by the students will proportionately be reduced to 60. The pattern of the question paper will be objective type (MCQ).
- For the award of 40 CIE marks, refer the University regulations 2018.

**Textbook:**

**Reference Books:**
B. E. Common to all Programmes
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMMESTER - III

ADDITIONAL MATHEMATICS – I
(Mandatory Learning Course: Common to All Programmes)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech. programmes)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18MATDIP31</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE Marks</td>
<td>40</td>
</tr>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(2:2:0)</td>
</tr>
<tr>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>0</td>
</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To provide basic concepts of complex trigonometry, vector algebra, differential and integral calculus.
- To provide an insight into vector differentiation and first order ODE’s.

Module-1
Complex Trigonometry: Complex Numbers: Definitions and properties. Modulus and amplitude of a complex number, Argand’s diagram, De-Moivre’s theorem (without proof).

Module-2

Module-3

Module-4
Integral Calculus: Review of elementary integral calculus. Reduction formulae for \( \sin^n x, \cos^n x \) (with proof) and \( \sin^m x \cos^n x \) (without proof) and evaluation of these with standard limits-Examples. Double and triple integrals-Simple examples.

Module-5

Course Outcomes: At the end of the course the student will be able to:
- CO1: Apply concepts of complex numbers and vector algebra to analyze the problems arising in related area.
- CO2: Use derivatives and partial derivatives to calculate rate of change of multivariate functions.
- CO3: Analyze position, velocity and acceleration in two and three dimensions of vector valued functions.
- CO4: Learn techniques of integration including the evaluation of double and triple integrals.
- CO5: Identify and solve first order ordinary differential equations.

Question paper pattern:
- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.
<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Textbook</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B. E. Common to all Programmes  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - IV  
COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS  
(Common to all Programmes)  
[As per Choice Based Credit System (CBCS) scheme]

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18MAT41</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(2:2:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:

- To provide an insight into applications of complex variables, conformal mapping and special functions arising in potential theory, quantum mechanics, heat conduction and field theory.
- To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.

Module-1

Module-2
Conformal transformations: Introduction. Discussion of transformations: \( w = z^2, w = e^z, \)
\[ w = z + \frac{1}{z}, \quad (z \neq 0). \]
Bilinear transformations- Problems.

Complex integration: Line integral of a complex function-Cauchy’s theorem and Cauchy’s integral formula and problems.

Module-3
Probability Distributions: Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions- problems (No derivation for mean and standard deviation)-Illustrative examples.

Module-4
Curve Fitting: Curve fitting by the method of least squares- fitting the curves of the form-
\[ y = ax + b, \quad y = ax^b \quad \& \quad y = ax^2 + bx + c. \]

Module-5
Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation and covariance.

Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student’s t-distribution, Chi-square distribution as a test of goodness of fit.

Course Outcomes: At the end of the course the student will be able to:

- CO1: Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.
- CO2: Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing.
- CO3: Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
- CO4: Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
- CO5: Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

Question paper pattern:
- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Textbooks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reference Books</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Advanced Engineering Mathematics</td>
<td>Chandrika Prasad and Reena Garg</td>
<td>Khanna Publishing,</td>
<td>2018</td>
</tr>
</tbody>
</table>

**Web links and Video Lectures:**
2. http://www.class-central.com/subject/math(MOOCs)
4. VTU EDUSAT PROGRAMME - 20
APPLICATIONS OF NANOTECHNOLOGY

<table>
<thead>
<tr>
<th>Course Code</th>
<th>CIE Marks</th>
<th>SEE Marks</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>18NT42</td>
<td>40</td>
<td>60</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
In this subject student will be introduced to applications of nanotechnology in fields of energy, defence, health, communication, transportation, and agriculture.

Module-1
NT IN PHOTOVOLTAICS, BATTERIES, AND FUEL CELLS APPLICATIONS:

Module-2
NT IN ENERGY TRANSMISSIONS, WATER PURIFICATION, AND DEFENSE APPLICATIONS:
Energy transmissions: Applications of nanotechnology to energy production, Nanoscale materials; General energy applications: lighting, heating, transportation, capacitors, power chips; Nanoparticles for energy transmission development: wires and cables; electrical transmission infrastructure: transformers, substations, and sensors. Water purification: Nanooligodynamic metallic particles: oligodynamic effect, mechanism and applications; Photocatalysis: types and applications of nanotechnology in photocatalysis; Desalination: nanofiltration, advantages and limitations, future directions of nanotechnology in membrane process. NT in Defense: Nanotechnology for soldiers: Smart helmets: significance, sensors, optical/IR, RF, and acoustic arrays, antiballistic protection. Smart suits: as armour, for ventilation, for camouflage. Smart equipments: B/C detection, health monitoring and wound healing.

Module-3
NT IN AGRICULTURE, AND FOOD PROCESSING APPLICATIONS:

Module-4
NT IN CIVIL ENGINEERING, AUTOMOBILE, AND AEROSPACE APPLICATIONS:
NT in civil engineering applications: Nanotechnology for green building: Introduction, Coatings: self-cleaning coatings, anti-stain coatings, De-polluting surfaces, Scratch-resistant coatings, Anti-fogging and anti-icing coatings, Antimicrobial coatings, UV protection, Anti-corrosion coatings, and Moisture resistance. NT in automobile applications: Functionalities of nanotechnologies (mechanical, geometric effect, electronic/magnetic, optical, and chemical); Applications of NT towards car body shell, car body, car interior, chasis and tyres, electrics and electronics, engine and drive train. NT in aerospace applications: Potential applications in space craft and space structures, Requirements for future space systems, Radiationshielding (Thermal protection), Space elevator, Space elevator (electromagnetic).

Module-5

NANOTECHNOLOGY IN ELECTRONICS, COMPUTER ENGINEERING & PHOTONICS

Course Outcomes: At the end of the course the student will be able to:
- CO1: Describe applications of nanotechnology in the photovoltaics, batteries, and fuel cells;
- CO2: Illustrate nanotechnology in the energy transmissions, water purification, and defense;
- CO3: Explain nano technology in the agriculture and food processing;
- CO4: Describe nano technology in the civil engineering, automobile, and aerospace sector;
- CO5: Research nano technological advances in the electronics, computer engineering, and photonics.

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - IV

MATERIAL SCIENCE AND ENGINEERING

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT43</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(3:0:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
In this course, students will understand various concepts related to the material science and engineering, crystal structure, various types of materials, and their uses in developing new technology.

Module-1
INTRODUCTION TO MATERIALS SCIENCE AND ENGINEERING
Functional Classification of Materials; Classification of Materials Based on Structure; Environmental and Other Effects; Materials Design and Selection; The Structure of Materials: Technological Relevance; The Structure of the Atom; The Electronic Structure of the Atom; The Periodic Table and Engineering materials; Atomic Bonding; Binding Energy and Inter-atomic Spacing; Amorphous Materials: Principles and Technological Applications; Lattice, unit cells, Basis, and crystal structure; Points, directions, and planes in the unit cell.

Module-2
CRYSTAL STRUCTURE
Introduction, Differences between Crystalline solids and amorphous solids; Unit cell: Introduction, Miller Indices, high density planes and influence on the behavior of the crystal, Close packing (hexagonal, and cubic), Bravias lattices (in two and three dimensional space), Lattice systems: possible variations, edge lengths, axial angle, and examples; Crystallographic point groups and symmetry operations; Wigner-Seitz cell: Introduction, and construction; Atomic packing: packing fraction, Co-ordination number; Examples of simple crystal structures: NaCl, ZnS and diamond; Symmetry operations, point groups and space groups, Single Crystals, Polycrystalline Materials, Anisotropy.

Module-3
DIFFUSION
Introduction, diffusion Vs bulk flow, diffusion vs osmosis, diffusion Vs drift; Diffusion in the context of different disciplines, Introduction to: atomic diffusion, Eddy diffusion & Eddy motion, Effusion & Graham’s law, Photon diffusion, and Passive transport (simple, facilitated, filtration, and osmosis); Mechanism of diffusion in solids (vacancy, and interstitial); Steady state diffusion (Fick’s first law); Unsteady state diffusion (Fick’s second law); Types of diffusion (self, inter, volume, grain boundary, and surface diffusions); Factors affecting diffusion (diffusion species, temperature, concentration, crystal structure, grain boundary, grain size); Introduction to diffusion in: ionic materials, polymeric materials; Diffusion and material processing (melting and casting, sintering, grain growth, and diffusion bonding); Applications of diffusion.

Module-4
POLYMERIC MATERIALS AND LIQUID CRYSTALS
Introduction, Thermotropic liquid crystals; Lyotropic liquid crystals: lamellar, hexagonal, cubic, and nematic phases; Chemical constitution and liquid crystalline behaviour; liquid crystalline behaviour in homologous series (para-azoxyanisole, para-alkyloxy benzene homologous series); molecular ordering in nematic, cholesteric, smetic, and columnar liquid crystals; Identification of liquid crystals; liquid crystalline polymers; Applications of liquid crystal in displays: introduction, twisted nematic cell transmissive, and reflective displays; types of liquid crystal displays and their applications, applications of chiral liquid crystals in thermography.

Module-5
CERAMIC, AND SMART MATERIALS

Ceramic Materials: Types of ceramics, synthesis and processing of ceramics, classification of ceramics, applications.

Smart materials: Historical background, definition, classification of smart materials, thermo responsive materials, piezoelectric materials, ferrofluids: synthesis and application, electro- rheological fluids (ER) and magneto-rheological fluids (MR) fluids modes of operation and application, smart gel, shape memory alloys.

Course Outcomes: At the end of the course the student will be able to:
- CO1: Describe the physics of materials;
- CO2: Explain the crystal structure of materials;
- CO3: Apply diffusion process for preparing materials;
- CO4: Demonstrate preparation of polymeric materials and liquid crystals;
- CO5: Analyze ceramic and smart materials for engineering and technology applications.

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

Reference Books

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
# B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

## SEMESTER - IV

### ELECTRONIC INSTRUMENTS AND MEASUREMENTS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT44</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE Marks</td>
<td>40</td>
</tr>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(3:0:0)</td>
</tr>
<tr>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

### Course Learning Objectives:
- The accuracy and precision, types of errors, statistical, and probability analysis.
- The basic functional concepts of various analog and digital measuring instruments.
- The basic concepts of microprocessor-based instruments.
- The functioning and types of oscilloscopes and signal generators, AC and DC bridges.
- The significance and function of different types of transducers.

### Module-1

#### MEASUREMENT AND ERRORS, AMMETERS, VOLTMETERS & MULTIMETERS, AND MEASURING PROBES:

- **Measurement and Error**: Definitions, Accuracy and Precision, Significant Figures, Types of Error, Statistical Analysis, Probability of Errors, Limiting Errors.
- **Ammeters**: DC Ammeter, Multirange Ammeter, The Ayrton Shunt or Universal Shunt, Requirements of Shunt, Extending of Ammeter Ranges, RF Ammeter (Thermocouple), Limitations of Thermocouple.

#### Module-2

#### DIGITAL INSTRUMENTS AND DATA ACQUISITION:

- **Digital Voltmeters**: Introduction, RAMP technique, Dual Slope Integrating Type DVM, Integrating Type DVM, Most Commonly used principles of ADC, Successive Approximations.
- **Data Acquisition**: ADC, DAC, Signal conditioners.

#### Module-3

#### OSCILLOSCOPES, AND SIGNAL GENERATORS:

- **Oscilloscopes**: Introduction, Basic principles, CRT features, Block diagram of Oscilloscope, Simple CRO, Vertical Amplifier, Horizontal Deflecting System, Sweep or Time Base Generator, Storage Oscilloscope, Digital Readout Oscilloscope.
- **Signal Generators**: Introduction, Fixed and Variable AF Oscillator, Standard Signal Generator, AF sine and Square Wave Generator, Function Generator, Square and Pulse Generator.

#### Module-4

#### MEASURING INSTRUMENTS, AND BRIDGES:

- **Measuring Instruments**: Output Power Meters, Field Strength Meter, Stroboscope, Phase Meter, Vector Impedance Meter, Q Meter, Megger, Analog pH Meter, Telemetry.
- **Bridges**: Introduction, Wheatstone’s bridge, Kelvin’s Bridge; AC bridges, Capacitance Comparison Bridge, Inductance Comparison Bridge, Maxwell’s bridge.

#### Module-5

#### TRANSDUCERS AND ACTUATORS:

- Introduction, transducers and actuators of electrical, inductive, capacitive, optical, piezoelectric, and photovoltaic. Thermistor, LVDT, Semiconductor photo diode and transistor.
Course Outcomes: At the end of the course the student will be able to:

- CO1: Differentiate accuracy and precision
- CO2: Explain various types of analog and digital measuring instruments.
- CO3: Analyse the performance of the AC and DC bridges.
- CO4: Analyse the performance characteristics of analog and digital measuring instruments.
- CO5: Recognize the importance of lifelong learning in the field of electronic instrumentation.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Electronics and Instrumentation</td>
<td>B.R. Gupta</td>
<td>S. Chand Limited</td>
<td>First Edition,</td>
</tr>
<tr>
<td>3</td>
<td>Electronic Instrumentation</td>
<td>H. S. Kalsi</td>
<td>McGraw Hill</td>
<td>Third Edition,</td>
</tr>
</tbody>
</table>
B. E. NANO TECHNOLOGY (NT)  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - IV

BIOCHEMISTRY AND MICROBIOLOGY

Course Code  
18NT45

CIE Marks  
40

Teaching Hours/Week (L:T:P)  
(3:0:0)

SEE Marks  
60

Credits  
03

Exam Hours  
03

Course Learning Objectives:
- To understand the basic concepts of biochemistry and pathways involved in metabolism.
- To study characteristics of microbes and microbial synthesis of nanomaterials.

Module-1
BIOMOLECULES AND BIOLOGICAL MEMBRANES:
Types of chemical reactions, pH, buffers and their properties, concentration of solutions. Brief description of the biomolecules: Carbohydrates; Proteins; Lipids; Nucleic acids (DNA & RNA). Classes of Enzymes with examples. Biological membranes: structure, permeability, properties, passive transport and active transport, facilitated transport, mechanism of Na\(^+\)/K\(^+\), glucose and amino acid transport.

Module-2
BIOENERGETICS AND METABOLISM:
Principle of bioenergetics – Bioenergetics and thermodynamics, phosphoryl group transfer and ATP, Biological oxidation and reduction reaction. Glycolysis, gluconeogenesis, Pentose phosphate pathway of glucose oxidation, Citric acid cycle. Photophosphorylation.

Module-3
STUDY OF MICROORGANISMS:

Module-4
MICROBIAL GROWTH AND CONTROL OF MICRO ORGANISM:
Growth curve patterns, physical conditions required for growth. Control of microorganism by physical agents (high temperature, low temperature, dessication, osmotic pressure, radiation); Control of microorganism by chemical agents; Antiobiotics and other chemotherapeutic agents.

Module-5
MICROBIAL SYNTHESIS OF NANO MATERIALS:
Biosynthesis of nanoparticles by bacteria and fungi (intracellular and extracellular synthesis). Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation of nanostructured materials by virus - TMV virus; Role of plants in nanoparticle synthesis – marigold, tulsi and aloe vera.

Course Outcomes: At the end of the course the student will be able to:
- CO1: Understand biomolecules and biological membranes
- CO2: Fundamental principles of bioenergetics and metabolism
- CO3: Basics of microbiology
- CO4: Understand microbiological growth and control of microorganisms
- CO5: Understand apply the knowledge of microbial synthesis of nanomaterials

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No   | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year
<table>
<thead>
<tr>
<th><strong>Textbook/s</strong></th>
<th><strong>Reference Books</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Microbiology</td>
<td>2 Biochemistry and Microbiology</td>
</tr>
<tr>
<td>Michael J Pelczar Jr, Chan ECS, Noel R Krieg</td>
<td>Shareefraza J. Ukkund, Abhinaya Nellerichale, Dr. Prasad Puthiyillam</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3 Principles of Biochemistry</th>
<th>4 NANO The Essential, understanding Nanoscience and Nanotechnology</th>
</tr>
</thead>
<tbody>
<tr>
<td>David L. Nelson, Michael M</td>
<td>T. Pradeep</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5 Nanobiotechnology- II, More Concepts and Applications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C. A. Mirkin, C. M. Niemeyer</td>
<td>WILEY-VCH, VerlagGmbH&amp;Co</td>
</tr>
</tbody>
</table>
### Course Learning Objectives:
- Understand the growth in the use of adhesives, especially in ever more technically demanding applications;
- The science and technology of additives, paints and lubricants, and the recent developments in nano technology towards engineering applications of adhesives, paints and lubricants.

#### Module-1
**INTRODUCTION TO ENGINEERING MATERIALS AND SURFACE COATINGS:**
Adhesives: Introduction, basic terminologies, history of adhesives, functions of adhesives, advantages and disadvantages; Criteria for selection of adhesives; Requirements of a good bond; Factors affecting adhesion strength; Fundamental aspects of adhesion: Forces available (primary chemical bonds, Van der Waals bonds, hydrogen bonds), surfaces, and change of phase; Mechanism of adhesive action: Specific adhesion, Mechanical adhesion, Diffusion adhesion, Electrostatic adhesion; Development of adhesive strength; Factors affecting adhesive action: Physical (interfacial tension, porosity, physical characteristics of adhesive films, effect of temperature, pressure, and time), and Chemical (degree of polymerization of polymeric resins, pH of the medium, polar characteristics, side chains) factors.

#### Module-2
**TYPES AND APPLICATIONS OF ENGINEERING ADHESIVES:** Types of glues: types (animal based, plant based, solvent type, and synthetic glues) and examples; Introduction and applications of Non-reactive adhesives (drying adhesives, pressure-sensitive adhesives, contact adhesives, hot-melt adhesives, RTV silicone adhesives) Reactive adhesives (multi-part adhesives, one-part adhesives); Types by origin: natural and synthetic; Structural adhesives: structure properties and applications of epoxies, urethanes adhesives, acrylic adhesives, and phenolic adhesives; Water-based adhesives.

#### Module-3
**ADDITIVES FOR ENGINEERING APPLICATIONS:** Introduction; Introduction, examples and importance of: plasticizers, impact modifiers, PVC stabilizers, antioxidants, UV absorbers, optical brightening agents, flame retardants, antistatic agents, smoke suppressants; Processing aids introduction to: viscosity depressants, mould release agents, slip agents, antiblocking agents; Colourants: Introduction, visual and processing requirements; Examples, advantages and limitations of inorganic, and organic pigments.

#### Module-4
**PAINTS AND LUBRICANTS:** Paints: Introduction; Components: Vehicle (Binder, thinner), Pigment and filler, Additives; Introduction to colour-changing paint; Varieties of paints: primer and its needs, emulsion paints, varnish resins, properties of shellac, anti-graffiti coatings (sacrificial coating, non-bonding coating), anti-climb paint, anti-fouling paint, luminous paints; paint and environment. Lubricants: Introduction; Properties (Formulation, Additives); Types of lubricants (Base oil groups, Bio-lubricants, Synthetic oils, Solid lubricants, Aqueous lubrication); Applications by fluid types; Glaze (Compacted oxide layer glaze).

#### Module-5
**APPLICATIONS OF NANOTECHNOLOGY IN ADHESIVES, PAINTS, AND LUBRICANT INDUSTRIES**
Importance of nano solder particles; nano-conductive Adhesives for nano-electronics, Interconnection: Introduction; nano isotropic conductive adhesives (nano-ICAs): with Ag nanowires, effect of Ag nanoparticles, Ni nano particles, with CNTs; Introduction to inkjet printable nano-ICAs and inks; Introduction to CNT-Based conductive nanocomposites for transparent, conductive, and flexible electronics. Importance of nanotechnology paints; nanomaterials in coatings and their functions (function, examples, and advantages); Potential...
environmental benefits of nanomaterials in coating: The nanolubricant approach: Examples and applications.

Course Outcomes: At the end of the course the student will be able to:
- CO1: Apply the concepts of adhesion
- CO2: Apply the knowledge of engineering adhesives
- CO3: Materials for adhesive applications
- CO4: Paints and Lubricants
- CO5: Recent developments in nanotechnology assisted adhesive, paints, and lubricant industries

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

Reference Books

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
**B. E. NANO TECHNOLOGY (NT)**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
**SEMESTER - IV**  
**ELECTRONIC INSTRUMENTATION LAB**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NTL47</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(0:2:2)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To realize and demonstrate that how different for finding out values of resistance, capacitance and inductance
- To interface sensors and demonstrate the method used in sensing temperature and pressure
- To study the working principle of data acquisition modules in electronic instrumentation

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To find the value of unknown resistor using Wheatstone bridge.</td>
</tr>
<tr>
<td>2</td>
<td>To find the value of unknown capacitance and inductance using Maxwell’s bridge</td>
</tr>
<tr>
<td>3</td>
<td>To find the value of unknown capacitance using Wein’s series and parallel bridge.</td>
</tr>
<tr>
<td>4</td>
<td>Measurement of frequency using Lissajous method</td>
</tr>
<tr>
<td>5</td>
<td>To study and verify characteristic of variable resistor transducer (strain gauge)</td>
</tr>
<tr>
<td>6</td>
<td>To study and verify characteristic of LVDT</td>
</tr>
<tr>
<td>7</td>
<td>To study characteristics of temperature transducer like thermocouple, thermistor and RTD with implementation of a small project using signal conditioning circuits like instrumentation amplifier</td>
</tr>
<tr>
<td>8</td>
<td>Measurement of pressure using piezoelectric pick up.</td>
</tr>
<tr>
<td>9</td>
<td>To interface temperature sensor to Data Acquisition Kit and display the temperature measured.</td>
</tr>
<tr>
<td>10</td>
<td>Study of distance measurement using ultrasonic transducer.</td>
</tr>
<tr>
<td>11</td>
<td>Measurement of power using ARDUINO</td>
</tr>
<tr>
<td>12</td>
<td>Measurement of energy using ARDUINO</td>
</tr>
</tbody>
</table>

**Course Outcomes:** At the end of the course the student will be able to:
- Students can learn the how to work with electronic instruments and bridge networks for sensing physical parameters
- Students will be able to demonstrate the working of sensors and interfacing circuits in measuring of physical parameters

**Conduct of Practical Examination:**
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

BIOCHEMISTRY AND MICROBIOLOGY LAB

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NTL48</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(0:2:2)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
Biochemistry is the study of chemical processes in living organisms. It deals with the structures and functions of cellular components such as proteins, carbohydrates, lipids, nucleic acids and other biomolecules. The experiments included in biochemistry lab are fundamentals in nature, dealing with the identification and classification of various carbohydrates, acid-base titration of amino acids, isolation of proteins from their natural sources.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Qualitative analysis of glucose</td>
</tr>
<tr>
<td>2</td>
<td>Iso-electric precipitation of proteins; casein from milk</td>
</tr>
<tr>
<td>3</td>
<td>Qualitative analysis of fructose</td>
</tr>
<tr>
<td>4</td>
<td>Separation of amino acids by thin layer chromatography</td>
</tr>
<tr>
<td>5</td>
<td>Estimation of saponification value of fats/oils</td>
</tr>
<tr>
<td>6</td>
<td>Detection of adulteration in milk</td>
</tr>
<tr>
<td>7</td>
<td>Qualitative analysis of amino acids</td>
</tr>
<tr>
<td>8</td>
<td>Estimation of iodine value of fat/oil</td>
</tr>
<tr>
<td>9</td>
<td>Titration curves of amino acids</td>
</tr>
<tr>
<td>10</td>
<td>Estimation of blood glucose by glucose-oxidase method</td>
</tr>
<tr>
<td>11</td>
<td>Estimation of acid value from castor oil/coconut oil</td>
</tr>
<tr>
<td>12</td>
<td>Quantitative estimation of amino acids by ninhydrin method</td>
</tr>
</tbody>
</table>

Course Outcomes: At the end of the course the student will be able to:
- By the end of the lab students will be able to identify and classify the various carbohydrates, acid-base titration of amino acid, and isolation of protein from their natural sources.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
B. E. Common to all Programmes
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - IV

ADDITIONAL MATHEMATICS – II
(Mandatory Learning Course: Common to All Programmes)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech. programmes)

Course Code: 18MATDIP41
CIE Marks: 40
Teaching Hours/Week (L:T:P): (2:1:0)
SEE Marks: 60
Credits: 0
Exam Hours: 03

Course Learning Objectives:

- To provide essential concepts of linear algebra, second & higher order differential equations along with methods to solve them.
- To provide an insight into elementary probability theory and numerical methods.

Module-1

Module-2

Module-3
Higher order ODE’s: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operators. [Particular Integral restricted to \( R(x) = e^{ax}, \sin ax, \cos ax \) \( f(D)y = \xi(x) \).]

Module-4
Partial Differential Equations (PDE’s): -Formation of PDE’s by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only.

Module-5

Course Outcomes: At the end of the course the student will be able to:
CO1: Solve systems of linear equations using matrix algebra.
CO2: Apply the knowledge of numerical methods in modelling and solving engineering problems.
CO3: Make use of analytical methods to solve higher order differential equations.
CO4: Classify partial differential equations and solve them by exact methods.
CO5: Apply elementary probability theory and solve related problems.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reference Books</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** END ****
### MANAGEMENT AND ENTREPRENEURSHIP

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT51</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(2:2:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

#### Course Learning Objective:
- To learn various aspects and principles of Management, Planning, and Organization.
- To learn the concepts of Entrepreneurship, and Project Management

#### Module-1
**MANAGEMENT:**

#### Module-2
**PLANNING:**
Introduction, Nature: rational approach, open system approach, flexibility of planning, and pervasiveness, importance and purpose of planning process - Objectives - Types of plans (Meaning only), Importance of planning, steps in planning, planning premises, Hierarchy of plans, Decision making: types of decisions, decision making process, and environment of decision making.

#### Module-3
**ORGANIZING AND STAFFING**
Nature and purpose of organization - Principles of organization - Types of organization - Departmentation - Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning only) Nature and importance of Staffing.

#### Module-4
**ENTREPRENEUR:**
Meaning of Entrepreneur; Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers.

#### Module-5
**PREPARATION OF PROJECT:**
Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of Business Opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

#### Course Outcomes:
At the end of the course the student will be familiar with:
- Management
- Planning
- Organization
- Entrepreneurship, and
- Project Management
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Entrepreneurship Development</td>
<td>S. S. Khanka</td>
<td>S. Chand &amp; Co</td>
<td>2007</td>
</tr>
</tbody>
</table>
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

QUANTUM MECHANICS AND SIMULATION TECHNIQUES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT52</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(3:2:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>04</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To understand the basic principles of quantum mechanics and simulation methods.
- To learn the application of the simulation techniques in biology and biomedical fields.

Module-1

PHYSICAL BASIS OF QUANTUM MECHANICS
Experimental background, inadequacy of classical physics, summary of principal experiments and inferences, Uncertainty and Complementarity. Wave packets in space and time, and their physical significance.
Schrödinger wave equation: Development of wave equation: One-dimensional and extension to three dimensions inclusive of forces. Ehrenfest’s theorem.

Module-2

THE BASIC PRINCIPLES OF QUANTUM MECHANICS
The fundamental postulates, expectation values and probabilities; quantum mechanical operators, explicit representation of operators, uncertainty principle. Matrix method solution of linear harmonic oscillator.

Module-3

QUANTUM COMPUTATIONAL SIMULATION
(Note: only qualitative approach)

Module-4

SURGICAL SIMULATION AND VIRTUAL ENVIRONMENT
Need, technology, volume image data file, human resources, interface and applications. Virtual environment (VE), technology, applications of VE, advantages of simulators and after effects of VE participation. Surgical nanorobots, Telesurgery, and endoscopy.

Module-5

SIMULATION METHODS AND BIOLOGICAL SYSTEMS
Simulations of Biological systems - Proteins: Alpha Helix, Beta Sheet, PDB, heme, Dock, DNA: B, Z, A.

Course Outcomes:
At the end of the course the student will be able to:
- CO1: Physical basics of quantum mechanics
- CO2: Basic principles of quantum mechanics
- CO3: Basics of Quantum computational simulation
- CO4: Basic principles of surgical simulation and virtual environment for biomedical applications
- CO5: Concepts of simulation methods and biological systems
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Reference Books</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module-1
INTRODUCTION TO CHARACTERIZATION TECHNIQUES:
Introduction to characterization techniques-types of characterization techniques, Basics, Importance, Structural and compositional characterization tools, resolution, resolving power-abbe criterion, Rayleigh criterion. Different types of sources used, electron lenses, scan coils, lens aberrations, electron diffraction-interference, types of detectors used.

Module-2
X-RAY BASED CHARACTERIZATION:
Basic Principles Instrumentation and applications of X-ray diffraction, powder (polycrystalline) and single crystalline XRD techniques; Debye-Scherrer equation. X-ray photoelectron spectroscopy – basic principle, instrumentation, X-ray absorption techniques: introduction to XANES, and EXAFS

Module-3
ELECTRON MICROSCOPY TECHNIQUES:

Module-4
SPECTROSCOPIC TECHNIQUES:
Principles, operation and applications of UV-VIS Spectrophotometers, IR/FTIR Spectrophotometers, and Raman spectroscopy. Optical microscope: Nanoparticle size measurement by Dynamic light scattering methods, zeta potential.

Module-5
ELECTRICAL MEASUREMENTS:
Introduction to Potentiometry. Basics of Voltammetric techniques: Linear and Cyclic voltammetry. IV, AC and DC electric measurements. Impedence Measurement and analysis.

Course Outcomes:
At the end of the course the student will be able to apply the knowledge of:
• CO1: Basics of characterization techniques
• CO2:X-ray based characterization
• CO3:Electron microscopy techniques
• CO4:Spectroscopic techniques
• CO5:Electrical measurements

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
• There will be two full questions (with a maximum of four sub questions) from each module.
• Each full question will have sub question covering all the topics under a module.
|---|---------------------------------------------------|---------------------------------|----------|-------------------|

**Reference Books**

|---|--------------------------------------------------|---------------------------------|-----------|-------------------|
# SYNTHESIS OF NANOMATERIALS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>CIE Marks</th>
<th>SEE Marks</th>
<th>Credits</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>18NT54</td>
<td>40</td>
<td>60</td>
<td>03</td>
<td>03</td>
</tr>
</tbody>
</table>

## Course Learning Objectives:
- To understand methods involved in the synthesis of nano materials
- To learn the techniques which are required for the synthesis of various nano materials

### Module-1

### Module-2

### Module-3
**SYNTHESIS OF OXIDE AND NON-oxide nanoparticles:** Introduction, Defining Oxide and Non-oxide Nanoparticles. Synthesis of Oxide nanoparticles - Magnetite Particles or magnetosomes, CoFe₂O₄, MnFe₂O₄ and CoCrFeO₄ nanoparticles. Different methods to synthesis Magnetite Particles (Procedure), comparison, Advantages and Drawbacks of Magnetite Particles. Different methods to for the Preparation of Isolated Oxide Nanoparticles - Hydrolysis, Oxidation and solvothermal methods. Potential Uses for Oxide and Non-oxide Nanoparticles.

### Module-4

### Module-5

## Course Outcomes:
At the end of the course the student will be able to apply the knowledge of:
- CO1: Synthesis of metal oxides and semiconductors
- CO2: Synthesis of quantum dots and metal nanoparticles
- CO3: Synthesis of oxide and non-oxide nanoparticles
- CO4: Synthesis of nanoporous materials
- CO5: Biological synthesis of nanoparticles.
Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

Reference Books

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V
MICRO FLUIDICS AND NANO FLUIDS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT55</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE Marks</td>
<td>40</td>
</tr>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(3:0:0)</td>
</tr>
<tr>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To study basic principles of micro and nano fluids.
- To understand the synthesis advantages and importance of micro and nanofluids.

Module-1
Nano fluids: Properties of nanofluids; thermophysical characteristics of nanofluids and factors affecting; Experimental methods of preparation of nano fluids; Theoretical models for thermal conductivity of nanofluids.

Module-2
BASIC PRINCIPLES OF MICROFLUIDICS: Laminar flow, Peclet number, Pressure driven flow, Electro-osmotic flow, Micropumps: Mechanical micropumps (Peristaltic pump, Centrifugal pump), Non-mechanical micropumps (Electrokinetic pump, Magneto-hydro dynamic (MHD) pump); Micromixers: Active micromixers (Planar laminar bubble mixer, MHD mixer), Passive micromixers (T-type mixers); Soft lithography and PDMS; Detection methods; Applications.

Module-3
MICROFLUIDICS IN BIO MEDICAL RESEARCH: Impact of microfluidics on biomedical research; microfluidics concepts: Laminar versus turbulent flow, Surface and interfacial tension, Capillary forces; Chemotaxis: Introduction, Agar-plate techniques, Two-chamber techniques, Boyden chamber, Bridge chambers, Capillary techniques, Other techniques, A case study in chemotaxis assays; Microfluidic device fabrication (polydimethylsiloxane (PDMS) based, Thermoplastics based, paper based, and wax based); Diagnostics for low-resource settings; Rapidly assaying biofluids with microfluidics; Organ-on-a-chip; Biomimetic blood vessel and capillary networks.

Module-4
MICRO AND NANO EMULSIONS: Emulsion: Appearance and properties, Emulsifiers, Mechanisms of emulsification, Uses; Microemulsions: Definition and History, types of microemulsions, Interaction energies, Packing parameter and microemulsion structures, Hydrophilic–Lipophilic Balance, Phase Inversion Temperature; Surfactant film properties: Ultra-low interfacial tension, Spontaneous curvature; Nano emulsions: Introduction; formation; differences between macro-, micro-, and nano-emulsions; Preparation of nanoemulsions; Droplet size control; Stability: Destabilization mechanisms, Controlling stability of nanoemulsions; Properties: Droplet size and stability, Tunable rheology; Applications of nanoemulsions: in drug delivery, in food industry, as building blocks, in crystallization/pharmaceuticals industry.

Module-5
Course Outcomes: At the end of the course the student will be able to apply the knowledge of:

- CO1: Micro fluidics and Nano fluids
- CO2: Basic principles of micro fluidics
- CO3: Micro fluidics in biomedical research
- CO4: Micro and nano emulsions
- CO5: Preparation and applications of nano fluids

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
B. E. NANO TECHNOLOGY (NT)  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - V

<table>
<thead>
<tr>
<th>NANO-PYTHON PROGRAMMING LANGUAGE FOR AUTOMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code</td>
</tr>
<tr>
<td>CIE Marks</td>
</tr>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
</tr>
<tr>
<td>SEE Marks</td>
</tr>
<tr>
<td>Credits</td>
</tr>
<tr>
<td>Exam Hours</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To understand the programming python programming language
- To study implementation of python programmes for automation

**Module-1**
**PYTHON — OVERVIEW:** History of Python, Python Features.

**Module-2**

**Module-3**
**PYTHON — DECISION MAKING:** If Statement, If else Statement, The else if Statement, Single Statement Suites
**PYTHON — LOOPS:** While Loop, the Infinite Loop, using else Statement with Loops, Single Statement Suites, For Loop, Iterating by Sequence Index, Using else Statement with Loops, Nested Loops, Loop Control Statements, Break Statement, Continue Statement, Pass Statement.

**Module-4**
**PYTHON — NUMBERS and STRINGS:** Number Type Conversion, Random Number Functions, Trigonometric Functions, Mathematical Constants.  
**PYTHON — STRINGS:** Accessing values in strings, updating strings, escape characters, string special operators, string formatting operator, triple quotes, unicode string and built-in string methods – capitalize – center – count – decode - encode.

**Module-5**
**PYTHON — LISTS & TUPLES**

**ROLE OF NANO IN PYTHON**

**Course Outcomes:** At the end of the course the student will be able to apply the knowledge of:
- CO1: Understand the basic syntax of python programming language
- CO2: Understand and apply the basic operation of python programming language
- CO3: Understand and apply the python decision making and python loops
- CO4: Understand and apply the python numbers and strings
- CO5: Understand and apply the python lists and tuples, and correlation of nanotechnology and python programming

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Textbook/s</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Reference Books</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B. E. NANO TECHNOLOGY (NT)  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - V  

NANOMATERIALS SYNTHESIS LAB

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NTL57</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(0:2:2)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To understand the chemical approach to synthesize nano particles.
- To synthesize nano materials by various chemical methods.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Synthesis of Ferro fluids by chemical method</td>
</tr>
<tr>
<td>2</td>
<td>Synthesis of Ag metal nano particles by Chemical reduction method</td>
</tr>
<tr>
<td>3</td>
<td>Synthesis of TiO$_2$ nano particles by Solvothermal method.</td>
</tr>
<tr>
<td>4</td>
<td>Synthesis of Fe$_2$O$_3$ nano particles by Co-precipitation method</td>
</tr>
<tr>
<td>5</td>
<td>Synthesis of Mn$_3$O$_4$ nano particles by Co-precipitation method</td>
</tr>
<tr>
<td>6</td>
<td>Synthesis of CuO nanoparticles by green synthesis</td>
</tr>
<tr>
<td>7</td>
<td>Synthesis of ZnS/MoS nano particles by microwave Solvothermal method</td>
</tr>
<tr>
<td>8</td>
<td>Synthesis of CuO nano particles by reverse microemulsion method</td>
</tr>
<tr>
<td>9</td>
<td>Synthesis of MoS$_2$ nano particles by ultra-sonication method.</td>
</tr>
<tr>
<td>10</td>
<td>Synthesis of monodisperse copper nano particles by chemical reduction method.</td>
</tr>
<tr>
<td>11</td>
<td>Synthesis of CdS by chemical method</td>
</tr>
<tr>
<td>12</td>
<td>Synthesis of nano crystalline AgS</td>
</tr>
<tr>
<td>13</td>
<td>Synthesis of ZnO by chemical method</td>
</tr>
<tr>
<td>14</td>
<td>Green synthesis of Ag nano particles</td>
</tr>
</tbody>
</table>

Course Outcomes: At the end of the course the student will be able to:
- Learn the different methods to synthesis nano materials.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Determination of electromagnetic properties of N-type and P-type semiconductors.</td>
</tr>
<tr>
<td>2</td>
<td>Determination of ionic conductivity of a given sample.</td>
</tr>
<tr>
<td>3</td>
<td>Determination of thermal conductivity of thin films.</td>
</tr>
<tr>
<td>4</td>
<td>Determination of optical properties of a given sample.</td>
</tr>
<tr>
<td>5</td>
<td>Measurement of mechanical properties of a given sample.</td>
</tr>
<tr>
<td>6</td>
<td>Determination of magnetic properties of a given liquid sample.</td>
</tr>
<tr>
<td>7</td>
<td>Determination of efficiency of a given solar cell.</td>
</tr>
<tr>
<td>8</td>
<td>Determination of ultrasonic sound velocity of given liquid samples.</td>
</tr>
<tr>
<td>9</td>
<td>Identification of unknown sample by arc spectrum method.</td>
</tr>
<tr>
<td>10</td>
<td>Resistivity determination for a semiconductor wafer using Four probe method.</td>
</tr>
<tr>
<td>11</td>
<td>To trace the hysteresis loop for a magnetic material.</td>
</tr>
<tr>
<td>12</td>
<td>Determination of wavelength of the given LED.</td>
</tr>
<tr>
<td>13</td>
<td>Measurement of thickness of a given thin film by air wedge method.</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To understand the mechanical, optical, magnetic, thermal, ionic and electromagnetic properties of materials and semiconductors when they experience external fields like electric field and magnetic field.
- To determine the thickness of thin films, working of a solar cell and to identify the unknown materials.

**Course Outcomes:**
At the end of the course the student will be able to:
- Students can able to understand the materials behaviour like mechanical, optical, electrical, thermal, ionic and electromagnetic properties at micro scale level.
- Students can also learn effect of temperature, electric field and magnetic fields on the different types of materials.
- Students can also learn the materials behaviour with respect to the change in voltage and magnetic field.

**Conduct of Practical Examination:**
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
# ENVIRONMENTAL STUDIES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>CIE Marks</th>
<th>SEE Marks</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>18CIV59</td>
<td>40</td>
<td>60</td>
<td>02</td>
</tr>
</tbody>
</table>

### Module - 1
**Ecosystems** (Structure and Function): Forest, Desert, Wetlands, Riverine, Oceanic and Lake. 02 Hrs
**Biodiversity:** Types, Value; Hotspots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

### Module - 2
**Advances in Energy Systems** (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, OTEC, Tidal and Wind. 02 Hrs
**Natural Resource Management** (Concept and case-studies): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

### Module - 3
**Environmental Pollution** (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.
**Waste Management & Public Health Aspects:** Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

### Module - 4
**Global Environmental Concerns** (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

### Module - 5

**Field work:** Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Wastewater treatment Plant; ought to be Followed by understanding of process and its brief documentation.

**Course Outcomes:** At the end of the course, students will be able to:
- CO1: Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale,
- CO2: Develop critical thinking and/or observation skills and apply them to the analysis of a problem or question related to the environment.
- CO3: Demonstrate ecology knowledge of a complex relationship between biotic and a biotic component.
- CO4: Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.

**Question paper pattern:**
- The Question paper will have 100 objective questions.
- Each question will be for 01 marks.
- Student will have to answer all the questions in an OMR Sheet.
- The Duration of Exam will be 2 hours.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Environmental Studies</td>
<td>S M Prakash</td>
<td>Pristine Publishing House, Mangalore</td>
<td>3rd Edition 2018</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------</td>
<td>-------------</td>
<td>------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>3</td>
<td>Environmental Studies – From Crisis to Cure</td>
<td>R Rajagopalan</td>
<td>Oxford Publisher</td>
<td>2005</td>
</tr>
</tbody>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Course Code 18NT61  CIE Marks  40
Teaching Hours/Week (L:T:P) (3:2:0)  SEE Marks  60
Credits  04  Exam Hours  03

Course Learning Objectives:
• To learn the science of surface and the technological aspects of thin films

Module-1
INTRODUCTION
Introduction to surface, classification, importance. Absorption and adsorption; physic-sorption and chemisorption; factors affecting the adsorption of gases on solid; Adsorption from the Solutions and its importance; applications of adsorption. Colloids: Introduction; differences between colloids and suspension; important properties of true solutions, colloids, and suspensions; types of colloidal solutions and their examples; classification of colloids based on the interactions; Applications of colloidal solutions; colloidal silver and its drawbacks; colloidal gold and its applications. Interfaces: introduction, types, surface energy and energetics, surface tension and effect of surfactants, importance of surface tension in case of nanoparticles, atomic structure of clean surfaces and with adsorbates, surface defects (Terrace, Ledges, Kinks and Adatoms), surface property and bulk property.

Module-2
THIN FILMS AND COATING

Module-3
THIN FILM DEPOSITION: PHYSICAL VAPOUR DEPOSITION
Introduction to PVD: vacuum thermal evaporation: resistance heating technique, electron beam heating techniques, Advantages and limitations of vacuum thermal evaporation, applications; Sputter deposition: basic principle, magnetron sputtering, advantages and limitations of sputter deposition, applications; Evaporation (deposition): physical principle, equipment, optimization, applications, comparison.

Module-4
ATOMIC LAYER DEPOSITION AND CHEMICAL BATH DEPOSITION
Atomic layer deposition: Introduction; History; Surface reaction mechanisms: Thermal Al₂O₃ ALD, Metal ALD, Catalytic SiO₂ ALD; ALD applications: Microelectronics applications (Gate oxides, Transition-metal nitrides, Metal films, Magnetic recording heads, and DRAM capacitors), Biomedical applications, and Quality and quality control; Advantages and limitations (Economic viability, Reaction time, and Chemical imitations) of ALD. Chemical bath deposition: Introduction, reaction mechanism, advantages and limitations.

Module-5
ANTI-REFLECTIVE COATING, SELF-CLEANING GLASS, AND NANO INDENTATION
Nano indentation: Introduction, process, applications.
Course Outcomes: At the end of the course the student will be able to understand:

- CO1: Surface science and interfaces,
- CO2: Thin films and coating,
- CO3: Thin film deposition,
- CO4: Atomic layer deposition,
- CO5: Mechanism of anti-reflective coating and self-cleaning glass, and nano indentation.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

Reference Books

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI
MEMS AND NEMS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT62</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(3:2:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>04</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To understand the basic components of MEMS and NEMS
- To study, design the MEMS and NEMS based devices

**Module-1**

**INTRODUCTION**
Miniaturization, Integrated Circuits, Microsensors, Microactuators, Thermal MEMS, Micro-Opto Electro mechanical Systems (MOEMS), Magnetic MEMS, Microfluidics, RF MEMS, Packaging.

**MICRO SENSORS & ACTUATORS**
Principle of sensing and actuation, silicon capacity sensors, piezo-resistive sensors, electrostatic comb drive, magnetic microrelay, piezo-inkjet printer, micromirrors, array sensors, microgrippers, gyroscopes, micro beams and cantilever.

**Module-2**

**TRANSDUCTION PLATFORMS**

**Module-3**

**MICROMACHINING**
Types of wafers, orientation, Photolithography, Etching methods, Silicon polishing, surface and bulk micromachining, Thin film deposition techniques sputtering, CVD, epitaxial growth, thermal oxidation, wafer bonding.

**MEMS MATERIALS**
Single crystal silicon, poly silicon, SiO₂, SiN, Germanium based materials, metals, SiC, diamond III-V materials, piezoelectric materials.

**Module-4**

**INTEGRATION OF MEMS DEVICES**
Microsystem packaging, packaging technologies, reliability, failure mechanisms, CMOS, stability, transient properties and performance, traceability and calibration, scaling effects, signal amplifiers, transmitters, signal conditioning, basics of control theory, case studies.

**Module-5**

**NANOELECTROMECHANICAL SYSTEMS (NEMS)**
Introduction- Nano machining of NEMS based upon electron beam lithography, Nano electromechanical systems fabrication, nano imprint lithography, polymeric nano fibre templates, focused ion beam doping and wet chemical etching, stencil lithography and sacrificial etching, large scale integration, future challenges, applications.

**Course Outcomes:** At the end of the course the student will be able to understand:
- CO1: Microsensors and Actuators
- CO2: Transduction platforms
- CO3: Micromachining and MEMS materials
- CO4: Integration of MEMS devices
- CO5: NEMS
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI
NANO-PHOTONICS

Course Code: 18NT63
CIE Marks: 40
Teaching Hours/Week (L:T:P): (3:2:0)
SEE Marks: 60
Credits: 04
Exam Hours: 03

Course Learning Objectives:
- To understand the basic principles of Photonics and its importance
- To study the nano-photonics its fabrication and applications

Module-1
INTRODUCTION TO OPTICS, PHOTONICS AND NANO-PHOTONICS:
Different quantities associated with light; Properties of Light; Reflection; Refraction; Interference & Diffraction; Absorption & Scattering. Photonics: Introduction, history; Classical optics, and modern optics; Applications of photonics; Emerging fields of photonics: light sources, photonic systems, Photonic integrated circuits; Organic photonics; Optoelectronics: Introduction, classification with examples.Nanophotonics: Introduction, Principles: Plasmons and metal optics, Near-field optics, and Metamaterials.

Module-2
FOUNDATIONS OF NANO-PHOTONICS:

Module-3
FABRICATION AND APPLICATIONS OF PHOTONIC CRYSTALS AND DEVICES:
Thermal, mechanical and chemical properties of optical materials; Optical coatings and methods; Optical Filters; Surface quality of optical components. Choices of materials in photonic crystals: semiconductors, amorphous, and polymers, fabrication of photonic crystals structures (1-D, 2-D); Couplers; Waveguides; Photonic crystals fibres; Tunable Photonic crystal filter; High-Q cavities.

Module-4
NANOPHOTONIC DEVICES
Evanescent Wave and an Optical Near Field, Generation and observation of optical near field, Real and virtual exciton–polaritons, Quantitative innovation, Nanophotonics for realizing qualitative innovation. Optical Near-Fields and Effective Interactions, Nanometric Subsystem and Macroscopic Subsystem, Basic Ideas of Nanophotonic Devices, Cellular Automation, Phonon and Near-Field Nanofabrication, Device Operation, Interconnection with Photonic Devices (Optical nano-fountain), nanophotonic devices for room-temperature operation.

Module-5
FUNDAMENTALS OF NANO-PHOTONIC FABRICATION AND NANO-PHOTONIC SYSTEMS:
Adiabatic nanofabrication – Non-adiabatic nano-fabrication: near field optical CVD and near field photolithography – Self assembling method via optical near field interactions – Regulating the size and position of nanoparticles using size dependent resonance – Size controlled, position controlled and separation controlled alignment of nanoparticles.
Course Outcomes: At the end of the course the student will be able to:
- CO1: Optics, photonics, and nano-photonics
- CO2: Foundations of nano-photonics
- CO3: Fabrication and applications of photonic crystal devices
- CO4: Fundamentals of nano-photonic fabrication
- CO5: Fundamentals of nano-photonic systems

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Principals of Nanophotonics (Optics and Optoelectronics)</td>
<td>M. Ohtsu, K. Kobayashi, T. Kawazoe and T. Yatsui</td>
<td>University of Tokyo, Japan.</td>
<td>First Edition, 2003</td>
</tr>
</tbody>
</table>
Course Code: 18NT641  
CIE Marks: 40  
See Marks: 60  
Credits: 03  
Exam Hours: 03  

Course Learning Objectives:
- Composites are a relatively wide used class of materials.
- In this course the students learn about the benefits of combining different materials to a composite to obtain desired properties.
- The motive of this course is to make the students understand different processing methods, issues, properties and testing methods of different composite materials.

Module-1

**INTRODUCTION TO COMPOSITES:** Definition and Fundamentals of composites and Nanocomposites. Need for composite materials. Classification of composites; Matrix: Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC); Reinforcement: particle reinforced composites, Fibre reinforced composites. Applications of composites. Fibre production techniques for glass, carbon and ceramic fibres.

Module-2

**POLYMER MATRIX COMPOSITES:** Polymer resins: thermosetting resins, thermoplastic resins; reinforcement fibres: rovings, woven fabrics, non-woven random mats, various types of fibres. Processing of PMC: hand layup process, spray up process, compression moulding, reinforced reaction injection moulding, resin transfer moulding, Pultrusion, Filament winding, Injection moulding. Fibre reinforced plastics (FRP), Glass Fibre Reinforced Plastics (GFRP). Applications of PMC in aerospace, automotive industries: Applications of polymer nanocomposites.

Module-3

**METAL MATRIX COMPOSITES:** Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Applications of Metal matrix nanocomposites. Reinforcements: particles, fibres. Effect of reinforcement: volume fraction, rule of mixtures. Processing of MMC: powder metallurgy process, diffusion bonding, stir casting, squeeze casting, a spray process, Liquid infiltration In-situ reactions, Interface-measurement of interface properties.

Module-4


Module-5

**LAMINATES AND MECHANICAL PROPERTIES OF COMPOSITES:** Laminates: Stacking Sequence Notation; Classification of Laminates: Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates; Mechanical Property Characterization: Strain Measurements, Tensile Testing, Compression Testing; Composite laminate; Joining of Composites: Classification of Joints, Types of Load Carrying Joints, Requirements of the joint design; Mechanically Fastened Joints; Factors affecting Mechanical Performance of composites: Fibre Factors, Matrix Factors, Biological Attack, Moisture and Weathering, Fluids, Temperature Effects, Overheat Conditions, Effect of Ultra Violet Radiation

Course Outcomes: At the end of the course the student will be able to apply the knowledge of:
- CO1: Different composites and fibre production techniques
- CO2: Polymer matrix composites
- CO3: Metal matrix composites
- CO4: Ceramic fabric composites and Special composites
CO5: Mechanical properties of composites

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

Reference Books

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Composite materials</td>
<td>Sharma, S.C.</td>
<td>Narosa Publications</td>
<td>First Edition,</td>
</tr>
</tbody>
</table>
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - VI

BIOMATERIALS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT642</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(3:0:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To understand the fundamental principals in material science and chemistry, and how they contribute to biomaterial development and performance.
- To apply the science and engineering knowledge gained in the course to biomaterial selection and design for specific biomedical uses.

Module-1

**FUNDAMENTALS OF BIOMATERIALS SCIENCE**: Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance. Disinfection and sterilization of biomaterials. Physico-chemical properties of biomaterials: mechanical (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear resistance), tribological (friction, wear, lubricity), morphology and texture, physical (electrical, optical, magnetic, thermal), chemical and biological properties.

Module-2

**ELEMENTS IN CONTACT WITH THE SURFACE OF A BIOMATERIAL**: Blood composition, plasma proteins, cells, tissues. Phenomena at the biointerfaces. Molecular and cellular processes with living environment, blood-materials interaction, short and long term reactions to the body.


Module-3


Module-4

**POLYMERS IN BIOMEDICAL APPLICATIONS**: Polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization. Polymers as biomaterials, heparin and heparin-like polysaccharides, proteoglycans, structure and biological activities of native sulfated glycosaminoglycans, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins. Applications and Biocompatibility case studies of novel polymeric materials.

Module-5

**TECHNOLOGIES OF BIOMATERIALS PROCESSING**
As implants and medical devices; improvement of materials biocompatibility by plasma processing. Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, biodegradable polymers in drug delivery and drug carrier systems. Tissue properties of blood vessels, Treatments of atherosclerosis; Biomechanical design issues pertaining to stents, balloon angioplasty, and pacemakers. Soft Tissue Reconstruction; FDA requirements, standards on the biological evaluation of medical devices (ISO-10993) and implications to applications in human. Practical aspects of biomedical devices: manufacturing, storage quality, regulatory and ethical issues, price of implants and allocation of resources.
Course Outcomes: At the end of the course the student will be able to understand:
- CO1: Fundamentals of biomaterial science
- CO2: Elements in contact with the surface of a biomaterial, and testing of biomaterials
- CO3: Properties of implant materials
- CO4: Polymers in biomedical applications
- CO5: Technologies of biomaterial processing

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

Reference Books

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
Course Code: 18NT643
CIE Marks: 40
Teaching Hours/Week (L:T:P): (3:0:0) SEE Marks: 60
Credits: 03 Exam Hours: 03

Course Learning Objectives:
- Students can learn different techniques and methods to reduce the size, and flow measurements.
- Students can understand the different methods used in the filtration, agitation, mixing and sampling of the minute or micron particles.

Module-1
PARTICLE TECHNOLOGY, EQUIPMENTS AND ANALYSIS
Particle shape, particle size, different ways of expression of particle size, standard screen, screens – ideal and actual screens, differential and cumulative size analysis, specific surface of mixture of particles, Number of particles in a mixture, effectiveness of screen.
Industrial screening equipment, Motion of screen, Gyratory screen, Vibrating screen, Trommels, Sub sieve analysis – Air permeability method, Sedimentation and elutriation methods.

Module-2
FLOW MEASUREMENT
Introduction, Obstruction type flowmeter; Basic Principle, Orifice meter; Corrections, Nozzle Flow meter, velocity flow measurement devices; Pitot Tube, Hot Wire / Film probes, Variable Area flowmeters; Rotameter. Construction of the float, Electromagnetic Flowmeter, Turbine type Flowmeter, Vortex type Flowmeter.

Module-3
FILTRATION
Introduction, Classification of filtration, Cake filtration, Clarification, Batch and continuous filtration, pressure and vacuum filtration, Constant rate filtration, characteristics of filter media, industrial filters, sand filter, Filter press, leaf filter, Rotary drum filter, Horizontal belt filter, Bag filter, Centrifugal filtration – Suspended batch centrifuge, Filter aids, Application of filter aids.

Module-4
AGITATION AND MIXING
Application of agitation, Agitation equipment, Types of impellers – Propellers, Paddles and Turbines, Flow patterns in agitated vessels, Prevention of swirling, Standard turbine design, Power correlation and power calculation, Mixing of solids, Types of mixers – Change can mixers, Muller mixers, Mixing index, Ribbon blender, Internal screw mixer, Tumbling mixer.

Module-5
SAMPLING, STORING AND CONVEYING OF SOLIDS
Sampling of solids, storage of solids, Open and closed storage, Bulk and bin storage, Conveyors – Belt conveyor, Chain conveyor, Apron conveyor, Bucket conveyor, Bucket elevator, Screw conveyor, Slurry transport, Applications of fluidization, Pneumatic conveying.

Course Outcomes: At the end of the course the student will be able to understand:
- CO1: The particle size analysis by different models and methods
- CO2: Different types of flow measurement methods and techniques.
- CO3: The filtration methods, classification, importance and applications
- CO4: The agitation and mixing aspects and applications.
- CO5: The sampling, storing of solid samples.

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI
MECHANICAL OPERATIONS
<table>
<thead>
<tr>
<th>Textbook/s</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Reference Books</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
</table>
INTRODUCTION TO NANOSCIENCE AND NANO TECHNOLOGY

Course Code: 18NT651
CIE Marks: 40

Teaching Hours/Week (L:T:P): (3:0:0) SEE Marks: 60
Credits: 03 Exam Hours: 03

Course Learning Objectives:
- To introduce the concept of nanoscience and nanotechnology.
- To understand the importance and applications of nanotechnology.
- To know the physical and chemical methods of synthesis of nanomaterials.
- To learn about different nanomaterials and their applications.

Module-1
INTRODUCTION AND SCOPE
History, background and interdisciplinary nature of nanoscience and nanotechnology, challenges of Richard Feynman, scientific revolutions, nanosized effects surface to volume ratio, examples of surface to volume ratio, atomic structure, Bohr atomic model, molecules and phases, introduction to classical physics and quantum mechanics, importance of nanoscale materials and their devices.

Module-2
CLASSIFICATION OF NANOSTRUCTURES
Zero dimensional, one-dimensional and two dimensional nanostructure materials - classification of solids: conductor, semiconductors, insulator, types of semiconductor, doping, diodes, current flow in semiconductors, ceramics and nanocomposites, quantum size effect (QSE) in 1D, 2D, 3D nanomaterials, quantum dots, nanowires, nanotubes, nanosheets, top down and bottom up approach.

Module-3
SYNTHESIS OF NANOMATERIALS – PHYSICAL METHODS

Module-4
SYNTHESIS OF NANOMATERIALS - CHEMICAL METHODS
Spray pyrolysis method, flame spray pyrolysis, gas phase synthesis, gas condensation process, chemical vapor condensation. Fundamental aspects of VLS (Vapor-Liquid-Solid) and SLS (Solution-Liquid-Solid) processes – VLS growth of Nanowires – Control of the size of the nanowires – Precursors and catalysts – SLS growth – Stress induced recrystallization.

Module-5
ENGINEERING APPLICATIONS OF NANO TECHNOLOGY
NT in civil engineering applications: Nanotechnology for green building: Introduction, Coatings: self-cleaning coatings, anti-stain coatings, De-polluting surfaces, Scratch-resistant coatings, Anti-fogging and anti-icing coatings, Antimicrobial coatings, UV protection, Anti-corrosion coatings, and Moisture resistance. NT in automobile applications: Functionalities of nanotechnologies (mechanical, geometric effect, electronic/magnetic, optical, and chemical); Applications of NT towards car body shell, car body, car interior, chasis and tyres, electrics and electronics, engine and drive train. NT in aerospace applications: Potential applications in space craft and space structures, Requirements for future space systems, Radiation shielding (Thermal protection), Space elevator, Space elevator (electromagnetic).

Course Outcomes: At the end of the course the student will be able to:
- CO1: Understand the concepts of Nanoscience and Nanotechnology.
- CO2: Understand the classification of nanostructures.
- CO3: Understand physical methods of synthesis of nanomaterials.
- CO4: Understand the chemical methods of synthesis of nanomaterials.
- CO5: Engineering applications of nanomaterials.

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
### Course Code: 18NT652

<table>
<thead>
<tr>
<th>Course Code</th>
<th>CIE Marks</th>
<th>SEE Marks</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>18NT652</td>
<td>40</td>
<td>60</td>
<td>03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching Hours/Week (L:T:P)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(3:0:0)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Credits</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td></td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
To understand the importance of nanomaterials and their applications in Photovoltaics, Batteries, and Fuel Cells; Electrical and electronics; Chemical industry; Food industry and Agriculture; Textile and Cosmetics

#### Module-1
**NANOMATERIALS FOR PHOTOVOLTAICS, BATTERIES, AND FUEL CELLS APPLICATIONS:**

#### Module-2
**NANOMATERIALS FOR ELECTRICAL AND ELECTRONICS APPLICATIONS**
Energy transmissions: Applications of nanotechnology to energy production, Nanoscale materials; General energy applications: lighting, heating, transportation, capacitors, power chips; Nanoparticles for energy transmission development: wires and cables; electrical transmission infrastructure: transformers, substations, and sensors. Single electron transistors: introduction, Coulomb blockade, miniature flash memory, and Yano type memory. Quantum mechanical tunneling: RTDs and Esaki diodes. Introduction to spintronics, molecular nanoelectronics, fault tolerant designs, quantum cellular automata, and quantum computing. MEMS and MOEMS: introduction and applications.

#### Module-3

#### Module-4
**APPLICATIONS OF NANOMATERIALS IN AGRICULTURE AND FOOD TECHNOLOGY**

#### Module-5
**NANOMATERIALS FOR TEXTILES AND COSMETICS APPLICATIONS:** Nanofibre production - Electrospinning – Controlling morphologies of nanofibers – Tissue engineering application – Polymer nanofibers - Nylon-6 nanocomposites from polymerization - Nano-filled polypropylene fibers -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
Cosmetics – formulation of Gels, Shampoos, Hair-conditioners (Micellar self-assembly and its manipulation) –Sun-screen dispersions for UV protection using Titanium oxide – Color cosmetics
Course Outcomes: At the end of the course the student will be able to identify and apply different nanomaterials for the following applications:

- CO1: Photovoltaics, Batteries, Fuel Cells
- CO2: Electrical and electronics
- CO3: Chemical industry
- CO4: Food industry and Agriculture
- CO5: Textile and Cosmetics

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Textbook/s</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Reference Books</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>“How helpful is nanotechnology in agriculture?-Review”</td>
<td>Allah Ditta</td>
<td>Advances in natural sciences: Nanoscience and nanotechnology, IOP Publishing</td>
<td>2012</td>
</tr>
</tbody>
</table>
Course Code 18NT653
CIE Marks 40
Teaching Hours/Week (L:T:P) (3:0:0) SEE Marks 60
Credits 03 Exam Hours 03

Course Learning Objectives:
- To provide students with the knowledge of techniques used for synthesis and characterization of nanomaterials.

Module-1
TOP DOWN APPROACHES
Synthesis and nanofabrication, Bottom-Up versus Top-Down: Top-down approach with examples, Ball milling synthesis, Arc discharge, RF-plasma, Plasma arch technique, Inert gas condensation, electric explosion of wires, Ion sputtering method, Laser pyrolysis, Molecular beam epitaxy and electrodeposition. Electro spinning, Physical vapors Deposition (PVD) – Chemical vapour Deposition (CVD) - Atomic layer Deposition (ALD).

Module-2
BOTTOM UP APPROACHES
Chemical precipitation methods-co-precipitation, arrested precipitation, sol-gel method, chemical reduction, photochemical synthesis, electrochemical synthesis, Microemulsions or reverse micelles, Sonochemical synthesis, Hydrothermal, solvothermal, supercritical fluid process, solution combustion process, spray pyrolysis method, flame spray pyrolysis, chemical vapour synthesis, gas phase synthesis, gas condensation process, chemical vapour condensation.

Module-3
BIOLOGICAL SYNTHESIS
Biosynthesis of nanoparticles by bacteria and fungi (intracellular and extracellular synthesis). Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation of nanostructured materials by virus - TMV virus; Synthesis process and application, Role of plants in nanoparticle synthesis – marigold, tulsi and aloevera.

Module-4
CHARACTERIZATION TECHNIQUES - I

Module-5
CHARACTERIZATION TECHNIQUES - II

Course Outcomes: At the end of the course the student will be able to:
- CO1: Experiment Top-down approaches: physical techniques used for synthesis and processing of nanomaterials
- CO2: Analyze Bottom-Up Approaches: chemical methods used for synthesis and processing of nanomaterials
- CO3: Select biological methods used for synthesis and processing of nanomaterials;
- CO4: Test Characterization of nanoparticles
- CO5: Electron-microscopy characterization
Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
### Course Code: 18NTL66

#### Course Learning Objectives:
- To study about the surface characterization of nanomaterials
- To learn about the thin film device fabrication.
- To prepare nanocomposite thin films.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Calculate the wear rate from wear track depth 2D images.</td>
</tr>
<tr>
<td>2</td>
<td>Calculation of the Area under the curve for a specified element/compound for a Raman data by filling</td>
</tr>
<tr>
<td>3</td>
<td>Analyse of the amount of elastic and plastic deformation from a Nanohardness test (NHT) data using origin pro.</td>
</tr>
<tr>
<td>4</td>
<td>Analyse the average particle size and shape of the particles for a given image using image J software. (Average Diameter of Spherical shape particles, Average length and width of a rod/wire shaped).</td>
</tr>
</tbody>
</table>
| 5       | Get the tafel plot for a given Electrochemical potential studies sample data and find out  
- $\beta_a$ and $\beta_c$  
- $E_{corr}$ and $I_{corr}$  
- Corrosion resistance (CR) in mmpy. |
| 6       | Get the Raman plot from the given data and find out the FWHM and Sp^2/Sp^3 ratio for DLC (Diamond like carbon) coated sample. |
| 7       | Get the COF vs Sliding Distance & wear loss vs sliding distance for a given two different samples data for wear studies and analyse, calculate the sliding distance manually. |
| 8       | Get the XRD peaks from the given ASCII file and find the FWHM and calculate interplanar distance “d” using Bragg’s equation. |
| 9       | Thin film Dye Sensitised Solar cell fabrication |
| 10      | Thin film Gas and Bio-chemical sensor fabrication |
| 11      | Thin film nanomaterial based super capacitor |
| 12      | Preparation of thin film ceramic based nanocomposites, metal-polymer nanocomposites, metal-biopolymer nanocomposites |

#### Course Outcomes: At the end of the course the student will be able to:
- Prepare nanomaterials, and their composites.
- Prepare nanotechnology-based devices
- Characterize the nanomaterials

#### Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
## MEMS SIMULATION LAB

**Course Code** 18NTL67  
**CIE Marks** 40  
**Teaching Hours/Week (L:T:P)** (0:2:2)  
**SEE Marks** 60  
**Credits** 2  
**Exam Hours** 03

### Course Learning Objectives:
To understand the simulation programmes for the MEMS characteristics; To study about MEMS devices and calculations by using MEMSolver software; To understand the simulation at atomic and molecular level by using softwares; To study about the nucleic acids, proteins, superimposition of molecules and building the phylogenetic tree.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Calculation &amp; Simulation of burst pressure, non-linearity &amp; plot graph for sensitivity for Piezoresitive pressure sensor with (i) square diaphragm, (ii) round diaphragm, (iii) rectangular diaphragm.</td>
</tr>
<tr>
<td>2</td>
<td>Calculation &amp; Simulation of maximum acceleration, maximum sensitivity, non-linearity &amp; plot graph for acceleration V/S displacement of capacitive accelerometer for static signal.</td>
</tr>
<tr>
<td>3</td>
<td>Calculation &amp; Simulation of (i) maximum acceleration, maximum displacement &amp; plot graph for acceleration V/S displacement of capacitive accelerometer for step signal, (ii) time duration of pulse &amp; plot graph for acceleration V/S time of capacitive accelerometer for pulse signal, (iii) output current, output voltage, piezoelectric capacitance &amp; plot graph for output V/S frequency of piezoelectric accelerometer under longitudinal load.</td>
</tr>
<tr>
<td>4</td>
<td>Calculation &amp; Simulation of (i) output current, output voltage, piezoelectric capacitance &amp; plot graph for output V/S frequency of thin film based piezoelectric accelerometer, (ii) pull in voltage, actuation force, balanced displacement &amp; plot graph for force V/S displacement of parallel plate actuator for normal motion.</td>
</tr>
<tr>
<td>5</td>
<td>Calculation &amp; Simulation of (i) balanced displacement, actuation force, normal spring constant &amp; plot graph for voltage V/S displacement of comb drive actuator for lateral motion, (ii) tip deflection, tip force &amp; plot graph for deflection V/S film thickness of cantilever based bimetallic thermal actuator, (iii) deflection, tip force &amp; plot graph for deflection V/S beam length of thermal bimorph actuator.</td>
</tr>
<tr>
<td>6</td>
<td>Calculation &amp; Simulation of maximum deflection, response time, maximum temperature change &amp; plot graph for transient response of thermal bent beam actuator.</td>
</tr>
<tr>
<td>7</td>
<td>Calculation &amp; Simulation of (i) actuator displacement, actuator force, electric field strength &amp; plot graph for actuator force of longitudinal piezoelectric actuator, (ii) actuator displacement, actuator force, electric field strength &amp; plot graph for actuator displacement of transverse piezoelectric actuator.</td>
</tr>
<tr>
<td>10</td>
<td>Sequence retrieval from nucleic acid and protein data base using NCBI, Multiple alignment of sequence and pattern determination by NCBI and Clustal Omega Prosite software.</td>
</tr>
<tr>
<td>11</td>
<td>Evolutionary studies / phylogenetic analysis by phylowin software and Visualization by TreeView software; Secondary structure prediction of proteins by Sopma software.</td>
</tr>
<tr>
<td>12</td>
<td>Identification of functional sites in gene / genome by Gen Sean and ORF finder software; Superimposition of molecular structures and calculation of RMSD by SPDBV software; PDB structure retrieval and visualization; analysis of homologous structure by RASMOL software.</td>
</tr>
</tbody>
</table>
Course Outcomes: At the end of the course the student will be able to:
- Understand the simulation programmes for the MEMS characteristics.
- Study about MEMS devices and calculations by using MEMSolver software.
- The simulation at atomic and molecular level by using softwares.
- About the nucleic acids, proteins, superimposition of molecules and building the phylogenetic tree.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
B. E. NANO TECHNOLOGY (NT) 
Choice Based Credit System (CBCS) and Outcome Based Education (OBE) 
SEMESTER -VI

MINI PROJECT

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NTMP68</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>(0:0:2)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours/Batch</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course Outcomes: At the end of the course the student will be able to:
- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habitudated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Mini - Project:
The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25. The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination
SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.
All the students admitted to III year of BE/B. Tech. shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail and shall have to complete during subsequent University examinations after satisfying the internship requirements.

Course Code
Refer to VIII semester scheme
CIE Marks | 40
Duration of internship
04 weeks
SEE Marks | 60
Credit
Exam Hours/
Batch | 03

Course Learning Objectives:
Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,
• To put theory into practice.
• To expand thinking and broaden the knowledge and skills acquired through course work in the field.
• To relate to, interact with, and learn from current professionals in the field.
• To gain a greater understanding of the duties and responsibilities of a professional.
• To understand and adhere to professional standards in the field.
• To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
• To identify personal strengths and weaknesses.
• To develop the initiative and motivation to be a self-starter and work independently.

Internship: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to
• Present the seminar on the internship orally and/or through power point slides.
• Answer the queries and involve in debate/discussion.
• Submit the report duly certified by the external guide.
The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.
**Course Outcomes:**  
At the end of the course the student will be able to:  
- Gain practical experience within industry in which the internship is done.  
- Acquire knowledge of the industry in which the internship is done.  
- Apply knowledge and skills learnt to classroom work.  
- Develop a greater understanding about career options while more clearly defining personal career goals.  
- Experience the activities and functions of professionals.  
- Develop and refine oral and written communication skills.  
- Identify areas for future knowledge and skill development.  
- Expand intellectual capacity, credibility, judgment, intuition.  
- Acquire the knowledge of administration, marketing, finance and economics.  

<table>
<thead>
<tr>
<th>Continuous Internal Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE marks for the Internship shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairman.</td>
</tr>
<tr>
<td>The CIE marks awarded shall be based on the evaluation of Internship Report, Presentation skill and Question and Answer session in the ratio 50:25:25.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester End Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEE marks for the Internship shall be awarded based on the evaluation of Internship Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.</td>
</tr>
<tr>
<td>Course Code</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>CIE Marks</td>
</tr>
<tr>
<td>SEE Marks</td>
</tr>
<tr>
<td>Credits</td>
</tr>
<tr>
<td>Exam Hours</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To understand the basic concepts of nano-electronics
- To learn the techniques which are used for developing devices which are developed by nanotechnology.

**Module-1**
**QUANTUM ELECTRONICS AND SINGLE ELECTRON TRANSISTOR**
Introduction, Quantum Electronic Devices, Examples of quantum Electronics Device – Short Channel MOS transistor, Split Gate Transistor, Electronic spin Transistor, Quantum Cellular Automata and Quantum dot array.
Single electron transistor: principles of SET, SET circuit design and Applications, molecular SETs, and molecular electronics

**Module-2**
**CNT AND NANOELECTRONIC DEVICES**
- **Carbon Nanotube**: Introduction, properties, characterization and application of carbon nano tube.
- **Introduction to Nano devices**: Graphene transistors, Nanowire FET, quantum Dot devices, Quantum Dot FET, Organic transistors, CNTFET, FinFETs.

**Module-3**
**CARBON NANOTUBE FETS**
Introduction, Single Wall Nano Tube (SWNT), Double Wall Nano Tube (DWCNT), IV characteristics of P- CNTFET, N-CNTFET, small signal model for CNTFET, electrical equivalent of CNTFET, design of inverter using CNTFET, CNTFET based digital and analog circuits, memory cell using CNTFET.

**Module-4**
**NANO ELECTRONICS WITH TUNNELING DEVICES**
Tunnelling Diode, Resonant Tunnelling Diode (RTD), Three Terminal Resonant Tunnelling devices, Technology of RTD, Digital Circuit Based On RTDs – Memory Application, Basic Logic Circuits, Dynamic Logic Circuits and Digital circuits Based on the RTBT.

**Module-5**
**TUNNEL JUNCTIONS**
Tunnel junctions and applications of tunnelling, tunnelling through potential barrier, potential energy profiles, applications of tunnelling, field emission, gate oxide tunnelling, hot electron effects in MOSFETs, coulomb blockade, blockade in nano capacitor, tunnel junctions, blockade in quantum dot circuits.

**Course Outcomes:** At the end of the course the student will be able to understand:
- CO1: Quantum electronics and single electron transistor
- CO2: CNT and nanoelectronic devices
- CO3: CNT FETs
- CO4: Nanoelectronics with tunnelling devices
- CO5: Tunnel Junctions

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Textbook/s</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Reference Books</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Molecular and Quantum Devices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current at the Nanoscale</td>
<td>Colm Durkan</td>
<td>Imperial College Press</td>
<td>First Edition, 2007</td>
</tr>
</tbody>
</table>
B. E. NANO TECHNOLOGY (NT)  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - VII  
MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Course Code 18NT72  
CIE Marks 40  
Teaching Hours/Week (L: T :P) (4:0:0) SEE Marks 60  
Credits 04  
Exam Hours 03

Course Learning Objectives:  
- To develop skills of the students in understanding the basics of Molecular Biology and Genetic engineering.  
- To provide basic knowledge on replication, Transcription and Translation.  
- To provide knowledge on methods of cloning, construction of DNA libraries and applications of rDNA technology.

Module-1  
MOLECULAR GENETICS  
DNA as genetic material, classical experiments – Hershey and chase; AveryMcLeod& McCarty. Bacterial conjugation, transduction and transformation, prokaryotic and eukaryotic genome organization.

Module-2  
REPLICATION AND TRANSCRIPTION  
Replication in prokaryotes and eukaryotes - D-loop and rolling circle mode of replication, replication of linear viral DNA. Transcription- initiation, elongation, termination, features of promoters and enhancers, transcription factors, inhibitors, post-transcriptional modification - RNA splicing, ribozyme, RNA editing.

Module-3  
TRANSLATION  
Elucidation of genetic code, Process of translation in prokaryotes and eukaryotes, posttranslational modifications, Suppressor mutations, Regulation of gene expression - Lac and Trp operons.

Module-4  
RECOMBINANT DNA TECHNOLOGY  
DNA cloning, vectors, restriction enzymes, Construction of cDNA and genomic libraries. Screening of libraries with probes – Northern, Southern and Western blotting. PCR- Principle, application and types. RAPD, Site Directed Mutagenesis. Restriction mapping.

Module-5  
APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY  
Cloning in plants, transgenic and knockout animals. Recombinant cytokines and antibodies, vaccines, gene-therapy, stem cell therapy. In-vitro fertilization, embryo transfer technology. GMO detection, identification and quantification methods.

Course Outcomes:  
At the end of the course the student will be able to:  
- CO1: Understand molecular genetics  
- CO2: Understand replication and transcription  
- CO3: Understand translation  
- CO4: Understand recombinant DNA technology  
- CO5: Apply the knowledge of rDNA technology

Question paper pattern:  
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.  
- There will be two full questions (with a maximum of four sub questions) from each module.  
- Each full question will have sub question covering all the topics under a module.  
- The students will have to answer five full questions, selecting one full question from each module.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
Course Code 18NT731
CIE Marks 40
Teaching Hours/Week (L: T: P) (3:0:0) SEE Marks 60
Credits 03 Exam Hours 03

Course Learning Objectives:
- Describe, Illustrate and Analyze MOS transistor theory, MOS VI characteristics, NMOS and PMOS transistor and CMOS technology
- Define and describe realization of digital circuits using CMOS technology
- Describe, Demonstrate, Analyze and Design of Mealy and Moore Models, Synchronous Sequential Circuits, State diagrams and Registers and Counters.

Module-1
MOSFETs
MOSFET: Basic Construction, Types of MOS, NMOS, PMOS, Basic Operation and Characteristics, VI Characteristics, Fabrication process of MOS transistors, N-well process, twin well process, SOI process.
MOSFET models: Small signal model, introduction to second order effects: body effect, channel length modulation, sub threshold conduction.

Module-2
CMOS TECHNOLOGY
CMOS inverters, voltage transfer characteristics, propagation delay, power dissipation equation, MOSFET scaling and its impact on current and power equation
MOS capacitance, MOS modelling, Spice Models
Realization of digital circuits using CMOS technology: NAND Gate, NOR Gate, CMOS transmission gates, Multiplexer, 2:1, 4:1, XOR gate, XNOR gate, Complex logic circuits, AOI gate, OAI gate.

Module-3
CMOS SEQUENTIAL CIRCUITS
1-bit Latch, SR latch, gated SR latch. D-latch, positive triggered latch, negative triggered latch, master-slave register, flip flop, edge triggered register, JK flip flop, Latch vs Registers
Timing Diagram: Timing definitions, setup time, hold time, clock to q delay, maximum clock frequency, mux based latch, CMOS Schmitt trigger, ring oscillator.

Module-4
REGISTERS AND COUNTERS
Registers: Introduction, Registers: Four Bit Latch, Shift Register, Serial In Serial Out Shift Register: Left-Shift Serial-In Serial-Out Register with D Flip-Flop, Serial-In Parallel-Out Shift Register, Parallel-In Serial-Out Shift Register: PISO Left-Shift Register, Ring Counter, Johnson Counter.

Module-5
FINITE STATE MACHINES
Introduction, Mealy machine, Moore machines, sequence detector, examples of sequence detector of 4 bit sequence, representing counters using FSM diagrams.

Course Outcomes: At the end of the course the student will be able to:
- CO1: Construction and working of MOSFETs
- CO2:CMOS technology and Realization of digital circuits using CMOS technology
- CO3:CMOS sequential circuits
- CO4:Registers and Counters
- CO5: Interpretation of performance characteristics of Mealy and Moore Models

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>SI No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th>SI No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
Course Code: 18NT732
CIE Marks: 40

Teaching Hours/Week (L: T: P) (3:0:0)
SEE Marks: 60
Credits: 03
Exam Hours: 03

Module-1

INTERMOLECULAR INTERACTIONS AND SUPRAMOLECULAR STRUCTURES

Module-2

NANOPARTICLES IN AGRICULTURAL AND FOOD DIAGNOSTICS

Module-3

NANOTECHNOLOGY IN FOOD PRODUCTION
Food and New Ways of Food Production - Efficient Fractionation of Crops - Efficient Product Structuring - Optimizing Nutritional Values - Applications of Nanotechnology in Foods: Sensing, Packaging, Encapsulation, Engineering Food Ingredients to Improve Bioavailability - Nanocrystalline Food Ingredients - Nano-Emulsions - Nano-Engineered Protein Fibrils as Ingredient Building Blocks - Preparation of Food Matrices - Concerns about Using Nanotechnology in Food Production.

Module-4

NANOTECHNOLOGY IN FOOD PACKAGING

Module-5

TOXICOLOGY OF NANOMATERIALS IN FOOD

Course Outcomes: At the end of the course the student will be able to understand:
- CO1: Intermolecular interactions and supramolecular structures
- CO2: Nanoparticles in agriculture and food diagnostics
- CO3: Nanotechnology in food production
• CO4: Nanotechnology in food packaging
• CO5: Toxicology of nanomaterials in food

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
• There will be two full questions (with a maximum of four sub questions) from each module.
• Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

Reference Books

B. E. NANO TECHNOLOGY (NT)  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - VII  
NANODEVICES AND APPLICATIONS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT733</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L: T: P)</td>
<td>(3:0:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To understand the fundamental concepts of nanosensors and devices.
- To understand the working and circuitry of nanosensors and devices.

Module-1  
FUNDAMENTALS OF NANOSensor DEVICES  
Micro and nano-sensors, biosensor. Thermal energy sensors: temperature sensors, heat sensors, electromagnetic sensors, electrical resistance sensors, electrical current sensors, electrical voltage sensors, electrical power sensors, magnetic sensors, Mechanical sensors, pressure sensors, gas and liquid flow sensors, position sensors, chemical sensors, optical and radiation sensors- gas sensor.

Module-2  
NANO BASED INORGANIC SENSOR DEVICES  
Density of states (DOS) – DOS of 3D, 2D, 1D and 0D materials, one dimensional gas sensors:- gas sensing with nanostructured thin films, absorption on surfaces, metal oxide modifications by additives, surface modifications, Nano optical sensors, nano mechanical sensors, plasmon resonance sensors with nano particles.

Module-3  
NANOELECTROMECHANICAL SYSTEMS (NEMS)  
Introduction- Nano machining of NEMS based upon electron beam lithography, Nano electromechanical systems fabrication, nano imprint lithography, polymeric nanofiber templates, focused ion beam doping wet chemical etching, stencil lithography and sacrificial etching, large scale integration, future challenges.

Module-4  
NANOPARTICLES FOR SENSORS AND CIRCUITRY, AND NANO-BIOLOGICAL SENSOR DEVICES  
Photoinduced Electron Transport in DNA: Electronic Devices Based on DNA, Charge Transport, DNA-Based Nanoelectronics, Electrical Manipulation of DNA on Metal Surfaces, DNA-Gold nanoconjugates; Noninvasive Biosensors in Clinical Analysis. Applications of Biosensor-based instruments for the bioprocess industry. Application of Biosensors for environmental samples. Introduction to Biochips and their application to genomics. BIAcore, an optical Biosensor.

Module-5  
NANOMATERIALS FOR SUPERCAPACITOR DEVICES  
Super Capacitor - Electrochemical Double Layer, Pseudo, Hybrid, Asymmetric, Selection of Electrode Materials for ASCs, Anode - Carbon-Based Material (AC, CNTs, Graphene), Metal Oxides, Metal Nitrides, Cathode - Conducting Polymers, Metal Oxides (RuO₂, MnO₂, V₂O₅, Ni(OH)₂), Emerging 2D Supercapacitor Electrodes, Materials for Supercapacitor - Electrodes of Super Capacitor, EDLC, pseudocapacitance, hybrid capacitors; Electrolytes for Supercapacitors, Separators, ASC Devices, Sandwich-Type (Carbon-Cloth-Material, Carbon Paper, Metal Scaffolds Configuration), Fiber-Type Supercapacitor Devices: Side-by-Side, Twist-Type, Coaxial-Helix Type, Wrap-Type; Applications of Supercapacitors.

Course Outcomes: At the end of the course the student will be able to understand:
- CO1: Fundamentals of nanosensors devices
- CO2:Nano based inorganic sensor devices
- CO3: Nanoelectromechanical systems
- CO4: Nanoparticles for sensor and circuitry, and nano-biological sensor devices
- CO5: Nanomaterials for Supercapacitors
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
FUNDAMENTALS OF THERMODYNAMICS

Course Code: 18NT741
CIE Marks: 40
SEED Marks: 60
Credits: 03
Exam Hours: 03

Module-1
FUNDAMENTAL CONCEPTS, WORK AND HEAT
Fundamental Concepts: Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and noncyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Zeroth law of thermodynamics.

Work and Heat: Mechanics-definition of work and its limitations. Thermodynamic definition of work. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Heat. Comparison between work and heat. (Note: Numerical problems are not included)

Module-2
FIRST LAW OF THERMODYNAMICS:
Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non-cyclic processes, energy, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat at constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications. (Note: Numerical problems are not included)

Module-3
SECOND LAW OF THERMODYNAMICS AND ENTROPY
Second Law of Thermodynamics: Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; Clausius statement of Second law of Thermodynamics, Equivalence of the two statements. Entropy: Clausius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy. (Note: Numerical problems are not included)

Module-4
PURE SUBSTANCES, IDEAL GASES, THERMODYNAMIC RELATIONS
Pure Substances & Ideal Gases: Mixture of ideal gases and real gases, ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality). Thermodynamic relations: Maxwells equations, Tds relations, evaluation of thermodynamic properties from an equation of state. (Note: Numerical problems are not included)

Module-5
GAS CYCLES
Efficiency of air standard cycles, Carnot, Otto, Diesel cycles, P-V & T-S diagram, calculation of efficiency;
Carnot vapour power cycle, simple Rankine cycle, Analysis and performance of Rankine Cycle, Ideal and practical regenerative Rankine cycles – Reheat and Regenerative Cycles, Binary vapour cycle. (Note: Numerical problems are not included)

Course Outcomes: At the end of the course the student will be able to understand:
- CO1: Fundamental concepts of thermodynamics, work and heat
- CO2: First law of thermodynamics
- CO3: Second law of thermodynamics and entropy
- CO4: Pure substances, ideal gases, thermodynamic relations
- CO5: Gas cycles

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
### Course Learning Objectives:
- To understand the eco-friendly nature of nanotechnology and the Nanomaterials.
- To study nanotechnology and nanodevices which are environmentally friendly.

### Module-1
**GREEN MANUFACTURING TRENDS**
Green Manufacturing - Fundamentals and Applications - basic definitions and issues surrounding green manufacturing at the process, machine and system - government motivations for green manufacturing - traditional manufacturing to green manufacturing - economic issues surrounding green manufacturing – the areas of automotive - semiconductor and medical areas and also supply chain and packaging areas.

### Module-2
**SUSTAINABLE GREEN MANUFACTURING**
Green manufacturing sustainability - processes - requirements, and risk – The sustainable lean and green audit process - International green manufacturing standards and compliance - Green rapid prototyping and rapid manufacturing - Green flexible automation - Green collaboration processes - Alternative energy resources - Sustainable green manufacturing system design.

### Module-3
**WASTE MANAGEMENT**
Sustainability and global conditions - Material and solid waste management - Energy management - chemical waste management and green chemistry – Climate change and air emissions management - Supply water and waste water management - Environmental business management.

### Module-4
**INDUSTRIAL ECOLOGY**

### Module-5
**GREEN PLASTICS MANUFACTURING**
Introduction to commercial plastics and elastomers - Natural Rubber (NR), modified NR and blends - Polyesters from microbial and plant biofactories (polyactic acid and poly hyroxyalkanoates) -Plastics from vegetable oils – Cellulose and starch based materials - Natural fillers, fibres, reinforcements and clay nanocomposites - Biodegradability, life cycle assessment and economics of using natural materials.

### Course Outcomes:
At the end of the course the student will be able to understand:
- **CO1**: Green manufacturing trends
- **CO2**: Sustainable green manufacturing
- **CO3**: Waste management
- **CO4**: Industrial ecology
- **CO5**: Green plastic manufacturing
**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

**Reference Books**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Green chemistry</td>
<td>James Clark</td>
<td>Blackwell publishing</td>
<td>First Edition,</td>
</tr>
<tr>
<td>5</td>
<td>Sustainable manufacturing</td>
<td>Paulo Davim</td>
<td>Wiley publications</td>
<td>First Edition,</td>
</tr>
</tbody>
</table>
**B. E. NANO TECHNOLOGY (NT)**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
**SEMESTER - VII**  
**NANOTECHNOLOGY IN BIOMEDICAL ENGINEERING**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT743</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L: T: P)</td>
<td>(3:0:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To learn the basic importance and applications of Nanotechnology medical and biological fields.
- To understand techniques and design the nanostructures, nanodevices, nano-based diagnostics techniques, therapeutics, and devices as implants, drug delivery devices.

**Module-1**  
**INTRODUCTION**

**Module-2**  
**IMPACT OF NANOTECHNOLOGY ON SURGERY**

**Module-3**  
**SENSING APPLICATIONS**

**Module-4**  
**NANO-ARTIFICIAL CELLS AND BIONANOMACHINES**

**Module-5**  
**NANOPARTICLES IN DRUG DELIVERY DEVICES**

**Course Outcomes:** At the end of the course the student will be able to understand:
- CO1: DNA nanotechnology
- CO2: Impact of nanotechnology in surgery
- CO3: Sensing applications
- CO4: Nano-artificial cells and bionanomachines
- CO5: Nanoparticles in drug delivery devices
Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ISBN: 978-613-9-83115-9</td>
<td></td>
</tr>
</tbody>
</table>
**APPLICATIONS OF NANOTECHNOLOGY IN ELECTRONICS**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT751</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE Marks</td>
<td>40</td>
</tr>
<tr>
<td>Teaching Hours/Week (L: T: P)</td>
<td>(3:0:0)</td>
</tr>
<tr>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To understand the basics of nanotechnology and its perspective in electrical and electronics industry
- To comprehend and investigate role of nanotechnology in energy production, storage, distribution and conversion
- To study and review nanotechnology trends in telecommunication industry

**Module-1**

**ENERGY PRODUCTION, ENERGY STORAGE AND DISTRIBUTION**

**Module-2**

**ENERGY CONVERSION AND HARVESTING, NANOENABLED MATERIALS**

**Module-3**

**FUNDAMENTALS OF NANOSENSOR DEVICES**
Micro and nano-sensors, biosensor. Thermal energy sensors: temperature sensors, heat sensors, electromagnetic sensors, electrical resistance sensors, electrical current sensors, electrical voltage sensors, electrical power sensors, magnetic sensors, chemical sensors, optical and radiation sensors- gas sensor.

**Module-4**

**NANOELECTROMECHANICAL SYSTEMS (NEMS)**
Introduction- Nano machining of NEMS based upon electron beam lithography, Nano electromechanical systems fabrication, nano imprint lithography, polymeric nanofiber templates, focused ion beam doping wet chemical etching, stencil lithography and sacrificial etching, large scale intergration, future challenges, applications.

**Module-5**

**CNT AND NANOELECTRONIC DEVICES**
*Introduction to Nano devices:* Graphene transistors, Nanowire FET, quantum Dot devices, Quantum Dot FET, Organic transistors, CNTFET, FinFETs.

**CARBON NANOTUBE FETS**
Introduction, Single Wall Nano Tube (SWNT), Double Wall Nano Tube (DWCNT), design of inverter using CNTFET, CNTFET based digital and analog circuits, memory cell using CNTFET.

**Course Outcomes:** At the end of the course the student will be able to:
- Understand the fundamentals of nanotechnology and importance of nanotechnology in electrical and electronics industry.
- Evaluate and determine the standards, technological challenges and future trends of nanotechnology in electronics and electrical engineering.
- Initiate, innovate and develop nanotechnology-based solutions in the field of electronics and electrical...
The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
## Course Information

**Course Code**: 18NT752  
**CIE Marks**: 40  
**Teaching Hours/Week (L: T: P)**: (3:0:0)  
**SEE Marks**: 60  
**Credits**: 03  
**Exam Hours**: 03

### Course Learning Objectives:

- To understand the applications of nano technology in mechanical engineering & the mechanics of nanomaterials.
- To understand the concept of nano tribology & fracture mechanics and advancement in nano materials.

### Module-1  
**NANOTECHNOLOGY IN MECHANICAL ENGINEERING**


### Module-2  
**INTRODUCTION TO NANO MECHANICS**


### Module-3  
**INTRODUCTION TO NANOTRIBOLOGY, NANOMATERIALS CHARACTERIZATION**

Definition of Nanotribology, need of nano tribology. Understand nano tribology. Introduction to Atomic Force Microscope (AFM), surface force apparatus (SFA) and FFM to understand Nano tribology. Measurement of Surface roughness, friction force, Scratching, wear and machining, Surface potential measurements, Nano indentation measurements, Boundary lubrication measurements, selection of low friction and better adhesion for nanotechnology applications, Present Applications of nanotribology.

### Module-4  
**FRACTURE OF NANO MATERIALS**

Nano indentation method to evaluate toughness for thin films-understanding fracture toughness-methods, fracture mechanism of brittle thin films, fracture of mono & multi layers of gold nano particles, hollow silica nano particles, fracture mechanism of solid lubricant nanoparticles, fracture mode of ultrasonic treated nickel nano particles.

### Module-5  
**ADVANCED NANO MATERIALS**


### Course Outcomes:

At the end of the course the student will be able to:

- Applications of nano materials in mechanical engineering,
- Understand Mechanics of nano materials
- Understand nano-tribology
- Understand Failure modes in nanostructures
- Advancements in nanomaterials
Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Advanced Analytical Methods in Tribology</td>
<td>Martin Dienwiebel, Maria-Isabel De Barros Bouchet</td>
<td>Springer</td>
<td>First Edition, 2018</td>
</tr>
</tbody>
</table>

Reference Books

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
Course Code: 18NT753
CIE Marks: 40
Teaching Hours/Week (L: T: P) (3:0:0) SEE Marks: 60
Credits: 03 Exam Hours: 03

**Course Learning Objectives:**

- To learn the importance of nanotechnology in Civil Engineering.
- To understand how nanomaterials can be used in construction materials.
- To understand the latest development nanotechnology for civil and environmental engineering application.

**Module-1**

**INTRODUCTION:**
Introduction to Nanoscience and Technology, basic principles and important Concept of Nanotechnology, Nanomaterial, Nano size effect, Surface area, Surface to volume ratio, Property of Nanomaterials- Mechanical, Electrical, optical, Thermal, Magnetic and Catalytic. Awareness and Existing activities of nanotechnology relevant to construction - desk study. Understanding phenomena of traditional construction materials at nanoscale.

**Module-2**

**NANOTECHNOLOGY IN CONSTRUCTION MATERIALS:**

**Module-3**

**NANOTECHNOLOGY IN STRUCTURAL MATERIAL:**
Nanotechnology and Steel, Applications in steel structures, for strength, corrosion resistance, improving strength of steel with nanomaterials, effect of copper nanoparticles of strength of steel. MMFX steel and application. Applications in welds and joints, weld ability, delayed fracture, strengthening of steel bolts, vanadium and molybdenum nanoparticles to improve delayed fracture. Wood as structural material, nanomaterials to improve the structural performance and serviceability of wood, nanocomposites, polymer-nanocomposite.

**Module-4**

**NANOTECHNOLOGY AND COATINGS:**

**Module-5**

**NANOTECHNOLOGY IN ENVIRONMENTAL ENGINEERING:**
Course Outcomes: At the end of the course the student will be able to:

- CO1: To learn the basic concepts of Nanotechnology.
- CO2: To understand nanomaterial properties useful in construction materials.
- CO3: Able to understand nanotechnology application in civil engineering.
- CO4: Use nanomaterials in Environmental engineering.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Nanostructures and Nanomaterials synthesis, properties and</td>
<td>G Cao</td>
<td>Imperial College press</td>
<td>First Edition, 2004</td>
</tr>
<tr>
<td>4</td>
<td>Environmental Application and Risks of Nanotechnology</td>
<td>JieZhuang and Randall W. Gentry</td>
<td>ACS Symposium Series; American Chemical Society; Washington, DC</td>
<td>First Edition, 2011</td>
</tr>
</tbody>
</table>
MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

Course Code  18NTL76  
CIE Marks  40  
Teaching Hours/Week (L: T: P) (0:0:2)  
SEE Marks  60  
Credits  01  
Exam Hours  03

Course Learning Objectives:
• To understand the cell structure and organization of cell components.
• To isolate the genetic materials like DNA and RNA from different microbes, plants and also learn molecular biology techniques.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Study of divisional stages in Mitosis.</td>
</tr>
<tr>
<td>2</td>
<td>Study of divisional stages in Meiosis.</td>
</tr>
<tr>
<td>3</td>
<td>Study of slides of human cells</td>
</tr>
<tr>
<td>4</td>
<td>Study of Polytene and Lampbrush chromosomes using permanent slides</td>
</tr>
<tr>
<td>5</td>
<td>Isolation of genomic DNA from onion</td>
</tr>
<tr>
<td>6</td>
<td>Isolation of plasmid DNA from bacteria</td>
</tr>
<tr>
<td>7</td>
<td>Isolation of genomic DNA from banana</td>
</tr>
<tr>
<td>8</td>
<td>Agarose gel electrophoresis and quantification of nucleic acids (colorimetric, ethidium bromide dot blot</td>
</tr>
<tr>
<td>9</td>
<td>Isolation of RNA from yeast</td>
</tr>
<tr>
<td>10</td>
<td>Study of conjugation in E.coli</td>
</tr>
<tr>
<td>11</td>
<td>Amplification of DNA by PCR</td>
</tr>
<tr>
<td>12</td>
<td>Preparation of DNA for PCR applications- Isolation, purity &amp; quantification</td>
</tr>
</tbody>
</table>

Course Outcomes: At the end of the course the student will be able to:
• Students can able to understand organization and different components at molecular scale level.
• Students can also learn different techniques used for the isolation of the genetic materials like DNA and RNA.
• Students can also learn the most advanced techniques like PCR, Gel Electrophoresis which are important techniques of molecular biology.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

PROJECT WORK PHASE - 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NTP77</th>
<th>CIE Marks</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L: T: P)</td>
<td>(0:0:2)</td>
<td>SEE Marks</td>
<td>--</td>
</tr>
<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours/Batch</td>
<td>--</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course Outcomes: At the end of the course the student will be able to:
- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habitudated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Project Work Phase - 1:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
Course Code 18NT81  CIE Marks 40
Teaching Hours/Week (L: T: P) (3:0:0) SEE Marks 60
Credits 03 Exam Hours 03

Course Learning Objectives:
• To learn the basics of Nanobiotechnology, the devices of Nanobiotechnology and their applications to the different fields.
• To understand and fabricate the nanostructures and nano containers for several applications.

Module-1
FUNCTIONAL PRINCIPLES OF BIO-NANOTECHNOLOGY
Basic terms; Features and functions of DNA, RNA, and Artificial nucleic acids; Bio-nanotechnology and nano-biotechnology; Information driven nano-assembly; genetic information transfer, construction of proteins, storage of information; Energetics: approaches for powering chemical reactions, light dependent and independent reactions, electron carriers, storage of energy; Chemical transformations: reduction of entropy, chemical stabilization, specialized chemical tools; Biomaterials: introduction, biomineralization, biocompatibility and biopolymers, use of biomaterials; Self-replication; Machine-phase bio-nanotechnology.

Module-2
STRUCTURAL PRINCIPLES OF BIO-NANOTECHNOLOGY
Introduction; Natural bio-nanomachinery and specific environment; Strategies of construction of nanomachines: sequential covalent synthesis, covalent polymerization, self-organizing synthesis, and self-assembly; Biomolecular structure and stability: covalent bonds, dispersion and repulsion forces, hydrogen bonds, electrostatic interactions, and hydrophobic effects; Protein folding: Introduction, globular proteins, chaperons, stability, rigidity and disorder; Self-assembly: design principles, point group symmetries (cyclic, dihedral, and cubic), translational symmetry (line symmetry, plane symmetry, and space group symmetry), quasi-symmetry, crowded conditions; Self organization: introduction, self-organization of lipids; Molecular recognition: introduction, Crane principles. Flexibility and design of bio-nanomachines.

Module-3
BIO-NANOMACHINES
Introduction; Nanoscale effect on gravity, inertia, atomic granularity, thermal motion; Bionanomachines and water environment; Modern biomaterials and molecular plans: proteins (glycine and proline; carbon rich amino acids; phenylalanine, tyrosine, tryptophan; serine, threonine, histidine, aspartagine, glutamine; cysteine, methionine), nucleic acids, polysaccharides, and lipids; Evolution of bio-nanomachines; Bio-nanomachines: Thymidylate synthase, DNA, Ribosome, ATP synthase, Actin and Myosin, Opsin, Triskelion molecules, and Collagen.

Module-4
BIOMEDICAL APPLICATIONS
Medical diagnostics: targeted and sustained drug delivery; Transdermal drug release; Nanoscale device for drug delivery; Nano-medicine and nano-surgery: Respirocytes and Microbivores, Surgical nanorobotics, nanorobotics advantages and disadvantages; Nanobased therapy of cancer; nanopathology; nanosurgery; Applications of DNA based bionanotechnology; Biosensors; antibodies, detection of glucose level, detection of specific DNA sequences; Medical imaging techniques: MRI, Ultrasound imaging.

Module-5
BIO-NANOTECHNOLOGY; TODAY AND THE FUTURE
Basic capabilities: simplification of natural proteins, design of proteins, construction of protein with non-natural amino acids, peptide nucleic acids; Nanomedicine; computer aided drug design, immunotoxins, Liposomes as vesicles. Artificial blood, Gene therapy, personalized medicine; Biomolecular sensing: smell and taste, light, motion, chemical gradients; A Timetable for bionanotechnology; Lessons for Molecular
Course Outcomes: At the end of the course the student will be able to understand:
- CO1: Functional principles of bio-nanotechnology
- CO2: Structural principles of bio-nanotechnology
- CO3: Bio-nanomachines
- CO4: Biomedical applications
- CO5: On-going Research in Bio-nanotechnology

Question paper pattern:
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>

Reference Books

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
## Course Learning Objectives:
- To design sub systems using combinational circuits and sequential circuits
- To design digital systems using CMOS logic and understand the physical structure of digital systems in its transistor schematic form
- To learn Verilog HDL programming and model digital systems using high level language

### Module-1

**FUNDAMENTALS OF DIGITAL SYSTEMS:**
- Combinational circuits, sequential circuits, basic gates, realization of logic using NAND, NOR and 2:1 Multiplexers, design of half adder, full adders, full subtractor, 1-bit comparator, decoders and encoders.
- Introduction to Verilog HDL, coding types, behavioural, structural and data flow, modelling of basic gates, half adder and full adder using Verilog HDL.

### Module-2

**DESIGNING WITH COMBINATIONAL CIRCUITS:**
- 4-bit Ripple carry adder, 4-bit carry look ahead adder, 4-bit carry select adder, 4-bit comparator using 2-bit comparator, seven segment display controllers using encoders and decoders, parity generators and 3-bit shifters/rotators using multiplexers, barrel shifter/rotator using 2:1 multiplexer. Writing Verilog code for 4-bit ripple carry adder, parity generators.

### Module-3

**DESIGNING WITH SEQUENTIAL CIRCUITS:**
- SR latch, SR-D Latch, T-Latch, flip flops using positive triggered and negative triggered latch, designing N-bit synchronous and asynchronous counters, up-down counters, designing clock dividers using counters, shift registers, SISO, SIPO, PISO, PIPO, 1-bit memory unit with read and write enable, 4-bit memory unit with address decoder.

### Module-4

**DIGITAL CIRCUIT DESIGN USING MOS TRANSISTOR:**
- MOS transistor, NMOS and PMOS transistor, CMOS inverter circuit, CMOS circuit design for NAND, NOR, AND, OR, XOR, XNOR gate, transmission gate using CMOS, 2:1 multiplexer design using CMOS transmission gate, 1-bit latch using CMOS (2:1 multiplexer), 1-bit flip flop using CMOS latch. Introduction to propagation delay, rise time, fall time, noise margin for CMOS inverter. Introduction to power dissipation in CMOS circuits, dynamic power, static power, leakage power.

### Module-5

**SUBSYSTEM DESIGN AND MODELLING:**
- writing Verilog code using data flow description for D-latch, JK-flip flop, counters, 2-Bit Magnitude comparators, 4x4 memory with read and write ports, behavioural model for 4-bit ALU design using Verilog HDL, writing test bench wave forms for functional verification of 4-bit adders and ALU. Introduction to programmable logics such as PLA, PAL and FPGAs.

### Course Outcomes:
- At the end of the course the student will be able to understand:
  - CO1: Fundamental of digital systems
  - CO2: Design of sub systems using combinational circuits
  - CO3: Design of sub systems using sequential circuits
  - CO4: Digital circuit design using MOS transistor
• CO5: Apply the Verilog programming skills in modelling digital sub systems.

**Question paper pattern:**
• The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
• There will be two full questions (with a maximum of four sub questions) from each module.
• Each full question will have sub question covering all the topics under a module.
• The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Textbook/s</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reference Books</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B. E. NANO TECHNOLOGY (NT)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VIII

NANO TOXICOLOGY

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NT822</th>
<th>CIE Marks</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L: T: P)</td>
<td>(3:0:0)</td>
<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To learn the basic importance and regulations of nanotoxicology in biological fields.
- To understand toxicity produced by nanostructures and methods to reduce their toxicity.

Module-1
INTRODUCTION

Module-2
NANOMATERIAL POLLUTION, PUBLIC PERCEPTIONS, AND EDUCATION
Nanomaterials pollution: Nanomaterials in Environment - Toxicology of Airborne – Effect of Nanomaterials in the environment. Safety and pollution Control techniques-handling, storage, packaging, transportation and disposal. Public perceptions & education: Communicating Nanotechnological Risks - Understanding of Nanotechnology's Social Impacts - Nanotechnology in the Media. Educating Undergraduate Nanoengineers,

Module-3
HUMAN EXPOSURE TO NANOSIZED MATERIALS
Biological Activities of Nanomaterials and Nanoparticles - Respiratory Tract – Efficient deposition of inhaled NSPs. - Disposition of NSPs in the respiratory - Disposition of NSPs in the respiratory -Epithelial translocation - Translocation to the circulatory system - Neuronal uptake and translocation -Translocation of NSPs in the blood circulation to bone marrow in mice - Studies of neuronal translocation of UFPs from respiratory tract - Exposure via GI Tract and Skin.

Module-4
ECONOMIC IMPACTS OF NANOTECHNOLOGY
Socio-Economic Impact of Nanoscale Science - Managing the Nanotechnology Revolution: Consider the Malcolm - Transcending Moore’s Law with Molecular Electronics and Nanotechnology - Semiconductor Scaling as a Model for Nanotechnology Commercialization - Nanotechnology and Zettabits - Sustaining the Impact of Nanotechnology - Non-Nano Effects of Nanotechnology on the Economy.

Module-5
ETHICS LAWS AND REGULATIONS

Course Outcomes: At the end of the course the student will be able to:
- CO1: To learn the basic concepts of nanobiotoxicology.
- CO2: To understand nanomaterial pollution, public perceptions & education
- CO3: To study the human exposure to nanosized materials
- CO4: To do risk economic impacts of nanotechnology
- CO5: To study ethics laws and regulations of nanomaterials and their toxicity
**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nanotoxicology: Interactions of Nanomaterials with</td>
<td>Yuliang Zhao and Hari Singh Nalwa</td>
<td>American Scientific Publishers</td>
<td>First Edition, 2018</td>
</tr>
<tr>
<td></td>
<td>Biological Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reference Books</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Microcontrollers and Interface

**Course Code:** 18NT823  
**CIE Marks:** 40  
**Teaching Hours/Week (L: T: P):** (3:0:0)  
**SEE Marks:** 60  
**Credits:** 3  
**Exam Hours:** 3

**Course Learning Objectives:**
- To study basic principles of micro-controllers family.
- To understand designing and interfacing the devices with micro controllers.

#### Module-1
**Microprocessors and Microcontroller**

#### Module-2
**Addressing Modes and Instruction Set**
Introduction, Instruction syntax, Data types, Subroutines, addressing modes: Immediate addressing, Register addressing, Direct addressing, Indirect addressing, relative addressing, Absolute addressing, Long addressing, Indexed addressing, Bit inherent addressing, bit direct addressing. Data transfer instructions, Arithmetic instructions.

#### Module-3
**8051 Instruction Set**
Instruction timings, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction.

**Interfacing**
Interfacing stepper motor – program to rotate stepper motor, interfacing DC motor – program to control the speed of DC motor, interfacing serial A/D converter, interfacing D/A converter using parallel ports – program to generate square wave by interfacing DAC08 with parallel port.

#### Module-4
**Microcontroller PIC16F84**
Introduction, CISC, RISC, Applications, Clock/instruction cycle, Pipelining, Pin description, Clock generator – oscillator, Reset, Central processing unit, Ports, Memory organization, Interrupts, Free timer TMR0, EEPROM Data memory.

**PIC16CXX Instruction Set**
Introduction to instruction set in pic16cxx microcontroller family, data transfer, arithmetic and logic, bit operations, directing the program flow, instruction execution period.

#### Module-5
**Overview of the AVR Family**
History, AVR feature’s, AVR family overview – classic AVR – Mega AVR – Tiny AVR – Special purpose AVR.

**AVR Architecture**
The general-purpose registers in the AVR, AVR data memory, instructions with the data memory, AVR status register, AVR data format and directives.
**Course Outcomes:** At the end of the course the student will be able to understand:
- CO1: Microprocessors and microcontrollers
- CO2: Addressing modes
- CO3: 8051 Instruction set, interfacing
- CO4: Microcontroller PIC 16F84, PIC16CXX Instruction Set
- CO5: Overview of AVR family, AVR architecture

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
</table>
Course Code 18NTP83
Contact Hours/Week 02
Credits 08
CIE Marks 40
SEE Marks 60
Exam Hours/Batch 03

Course Learning Objectives:
- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course Outcomes: At the end of the course the student will be able to:
- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Project Work Phase - 2:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

Semester End Examination
SEE marks for the project (60 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) as per the University norms by the examiners appointed VTU.
B. E. NANO TECHNOLOGY (NT)  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER -VIII  

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18NTS84</th>
<th>CIE Marks</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Hours/Week</td>
<td>02</td>
<td>SEE Marks</td>
<td>--</td>
</tr>
<tr>
<td>Credits</td>
<td>01</td>
<td>Exam Hours</td>
<td>--</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, shall choose, preferably, a recent topic of his/her interest relevant to the Course of Specialization.

- Carryout literature survey organize the seminar content in a systematic manner.
- Prepare the report with own sentences, avoiding cut and paste act.
- Type the matter to acquaint with the use of Microsoft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

**Course Outcomes:** At the end of the course the student will be able to:

- Attain, use and develop knowledge in the field of engineering and other disciplines through independent learning and collaborative study.
- Identify, understand and discuss current, real-time issues.
- Improve oral and written communication skills.
- Explore an appreciation of the self in relation to its larger diverse social and academic contexts.
- Apply principles of ethics and respect in interaction with others.

**Evaluation Procedure:**
The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three teachers from the department with the senior most acting as the Chairman.

**Marks distribution for CIE of the course:**
Seminar Report: 50 marks  
Presentation skill: 25 marks  
Question and Answer: 25 marks.