1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To prepare students to outshine in academics and research in different motifs of Nanoscience and Nanotechnology through post graduate education.
2. To provide students with a solid foundation in Synthesis and Characterization of novel nanomaterials with multiple applications and further train them with good theoretical and practical knowledge to comprehend, analyze, design, and create novel products and solutions for the real life problems.
3. To coach students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate nanotechnology to address environmental issues.
4. To provide students with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career

2. PROGRAMME OUTCOMES (POs):

On successful completion of the M.Tech. Nanoscience and technology programme:

<table>
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<tr>
<th>PO</th>
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<tbody>
<tr>
<td>1.</td>
<td>Graduates will demonstrate good knowledge of Physics, Chemistry, Synthesis &amp; Characterization of Nanomaterials to solve engineering and research problems</td>
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<tr>
<td>2.</td>
<td>They will be able to design and conduct experiments, analyze and interpret data</td>
</tr>
<tr>
<td>3.</td>
<td>The graduates will be capable of demonstrating an ability to design an experiment, component or process as per needs and specifications.</td>
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<tr>
<td>4.</td>
<td>An ability to independently carry out research/investigation and development work to solve practical problems</td>
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<tr>
<td>5.</td>
<td>An ability to write and present a substantial technical report/document</td>
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<td>6.</td>
<td>Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program</td>
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### 3. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

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### 4. MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

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# ANNA UNIVERSITY::CHENNAI 600025
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS 2021
M. TECH. NANO SCIENCES AND TECHNOLOGY
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABUS

## SEMESTER I

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*Audit Course is optional

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**TOTAL NO. OF CREDITS: 70**

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**TOTAL CREDITS** 19

### LIST OF PROFESSIONAL ELECTIVE COURSES

#### SEMESTER I, ELECTIVE I

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### AUDIT COURSES - I (AC)

REGISTRATION FOR ANY OF THESE COURSES IS OPTIONAL TO STUDENTS

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## LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

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COURSE OBJECTIVES:
This course will help the students to
- Acquire the knowledge of solving system of linear equations using an appropriate numerical methods.
- Approximate the functions using polynomial interpolation numerical differentiation and integration using interpolating polynomials.
- Acquire the knowledge of numerical solution of ordinary differential equation by single and multistep methods.
- Obtain the solution of boundary value problems in partial differential equations using finite differences.
- Study simulation and monte-carlo methods and their applications.

UNIT I MATRICES AND LINEAR SYSTEMS OF EQUATIONS

UNIT II INTERPOLATION, DIFFERENTIATION AND INTEGRATION

UNIT III DIFFERENTIAL EQUATIONS

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

UNIT V SIMULATION AND MONTE CARLO METHODS

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

TOTAL: 60 PERIODS
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**NT4101 QUANTUM MECHANICS**

**COURSE OBJECTIVES:**
- To learn basics of Quantum mechanics.
- To know more about approximation methods, time dependent and independent Schrodinger equation.
- To know the concept of Quantum computation

**UNITI BASICOS OF QUANTUM MECHANICS**
9
Wave-particle duality, group velocity, Phase velocity, De-Broglie wavelength, Uncertainty principle and Schrödinger equation.

**UNITII TIME DEPENDENTSCHRÖDINGER EQUATION**
9
Solutions of the one-dimensional Schrödinger equation for free-particle, particle in a box, particle in an infinitely deep well-potential, linear harmonic oscillator. Reflection and transmission by a potential step.

**UNITIII TIME INDEPENDENTSCHRÖDINGER EQUATION**
9

**UNITIV APPROXIMATE METHODS**
9
Time independent and time dependent perturbation theory foron-degenerate and degenerate energy levels, the variational method, WK B approximation, adiabatic approximation, sudden approximation

**UNITV QUANTUM COMPUTATION**
9
Concept of quantum computation, Quantum Q-bits, Introduction to nuclear spin, quantum confinement, quantum devices, single electron devices.
**COURSE OUTCOMES:**

**CO1:** Gaining knowledge about basics of wave-particle duality and Quantum mechanics  
**CO2:** Acquire knowledge about wave function and free electron theory  
**CO3:** Acquire knowledge about Quantum computation and approximation methods

**REFERENCES:**

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NT4102       PHYSICS AND CHEMISTRY OF MATERIALS       L T P C
                        3 0 0 3

COURSE OBJECTIVES:
- To gain knowledge on Physical and chemical aspects of Nanomaterials.
- To know about diffusion and surface defects, nanostructures and Nanosystems.

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

UNITII      CHEMISTRY ASPECTS

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

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

UNITV       NANOSYSTEMS

TOTAL: 45PERIODS

COURSE OUTCOMES:
CO1: Gaining knowledge on physical and chemical aspects of Nanomaterials
CO2: Students will understand about the diffusion and surface defects in nanomaterials
CO3: Students will learn about various kinds of nanostructures and Nanosystems

REFERENCES:
7. AtkinsPeter, PaulaJulio Physical Chemistry,
CO2: Students will understand about the diffusion and surface defects in nanomaterials 3 3 3 3
CO3: Students will learn about various kinds of nanostructures and Nanosystems 3 3 3 3
Overall CO 3 3

NT4103 BIOLOGICAL NANOSTRUCTURES L T P C 3 1 0 4

COURSE OBJECTIVES:
- Impart knowledge on the nanostructures and nanoscale phenomenon in cells.
- To understand the different three-dimensional DNA nanostructures and their uses.
- Familiarize the concepts involved in protein corona with reference to protein nanoparticles and enzyme nanotechnology.
- Acquaint with the glyco-metal, glyco-carbon nanoparticles and their fate.
- Explain the synthesis and applications of lipid-based nanostructures

UNIT I  CELLULAR NANOSTRUCTURES 12
Cellular elements in developing functional nanostructures and nanomaterials–Nanopatterning – Cytoskeletal nanomechanics – Bacterial and viral nanostructured materials – Plant-derived nanostructures: types, evolution and applications – Phytochemicals in the genesis of nanoparticles.

UNIT II  DNA NANOARCHITECTURE 12

UNIT III  PROTEIN AND ENZYME NANO PARTICLES 12
Proteins: Structure, classification and functions – Protein nanoparticles: Designing, synthesis strategy, ligands used and their applications – Enzymes and Enzyme nanoparticles: properties, structure:Preparation, immobilization, kinetic properties and applications of enzyme nanoparticles in day-day to life– Synzymes, ribozymes.

UNIT IV  CARBOHYDRATES AND GLYCO NANO PARTICLES 12

UNIT V  LIPIDS AND LIPID BASED NANO PARTICLES 12
Structure, function and significance of lipids and membrane transport–Membranous nanostructures and their role in cellular traffic –Different types of lipid nanostructures: Preparation, applications – Lipid-based nanomaterials-Lipid-polymer nanoparticles and solid lipid nanoparticles–.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1: Comprehend the nanoscale phenomenon associated with cellular nanostructures
CO2: To reveal the nature of DNA nanostructures like DNA bricks, aptamers and origami
CO3: Design and utilize protein and enzyme based nanostructures
CO4: Classify glycol nanostructures based on their binding ligands
CO5: Have knowledge about membranetransportandmembrane based nanostructures and their uses
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<td>Design and utilize the protein and enzyme based nanostructures</td>
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<td>Classify glycol nanostructures based on their binding ligands</td>
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<td>CO5</td>
<td>Have knowledge about membrane transport and membrane based nanostructures and their uses</td>
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| Overall CO      | 3 PO2 3 PO3 2 PO4 2 PO5 2 PO6 2 |

RM4151 RESEARCH METHODOLOGY AND IPR

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

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

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

UNIT IV INTELLECTUAL PROPERTY RIGHTS

UNIT V PATENTS

TOTAL : 30 PERIODS

REFERENCES:

NT4111 COMPUTATION AND SIMULATION LABORATORY L T P C 0 0 4 2

COURSE OBJECTIVES:
• To Acquire knowledge on various scientific modelling and simulation techniques.
• To Understand various syntax and command code for wide used modelling and simulation softwares.
• To Acquire knowledge to theoretically simulate the physical and chemical properties of various nanomaterials based on available data

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1: Gaining knowledge on modeling and simulation of equations using MATLAB
CO2: Acquiring knowledge on image processing and analysis
CO3: Able to interpret the TEM, STEM and AFM images

Course Articulation Matrix:

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<td>CO2</td>
<td>Acquiring knowledge on image processing and analysis</td>
<td>PO3 3, PO4 3</td>
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<tr>
<td>CO3</td>
<td>Able to interpret the TEM, STEM and AFM images</td>
<td>PO5 3, PO6 3</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CO2: Able to synthesis metal oxide nanomaterials by bottom up synthesis method

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1: Thorough hands on training and knowledge and skills on Nano materials synthesis using various chemical and physical methods
CO2: Able to synthesis metal oxide nanomaterials by bottom up synthesis method
CO3: Able to synthesis metal oxide nanomaterials by top down method

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SEMESTER II

NT4201 IMAGING TECHNIQUES FOR NANOTECHNOLOGY

OBJECTIVE
- This course introduces the student to the most important techniques available for micro and nano materials characterization necessary for the development of micro- and nano- manufacturing
UNIT I  OPTICAL MICROSCOPY
Concept of resolution and depth of field/focus in imaging, types of aberrations (spherical, chromatic, diffraction and astigmatism), Optical microscopy (OM) – reflected/transmitted light microscopy, theoretical and practical resolution of an optical microscope, numerical aperture, principles of image formation, dark field, polarized light and phase contrast microscopy and applications of each in metallurgical and materials engineering, sample preparation for optical microscopy and limitations.

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

UNIT III  TRANSMISSION ELECTRON MICROSCOPY

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

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

COURSE OUTCOMES:
CO1: Upon completion of the course, the students will be able to: - describe fundamental principles of operation of four materials characterization techniques, namely optical microscopy, scanning electron microscopy, transmission electron microscopy and scanning probe microscopy
CO2: Explain the production of x-rays, electrons and the electron-specimen interaction mechanisms
CO3: Select appropriate characterization methods to the analysis and characterization of materials and apply the microstructural characterization techniques to the analysis of materials at the micro and nano-scale

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<td>CO2</td>
<td>Explain the production of x-rays, electrons and the electron-specimen interaction mechanisms</td>
<td>3 3 3 3</td>
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<td>CO3</td>
<td>Select appropriate characterization methods to the analysis and characterization of materials and apply the microstructural characterization techniques to the analysis of materials at the micro and nano-scale</td>
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**NT4202 PHYSICOCHEMICAL CHARACTERIZATION OF NANOMATERIALS**  
**OBJECTIVES**  
- To learn advanced analytical method used to study nanomaterials.  
- To know about qualitative and quantitative analysis techniques employed for studying nanomaterials.  
- To understand the mechanical analytical techniques used to study nanomaterials.

**UNIT I SPECTROSCOPIC TECHNIQUES**  

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

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

**UNIT IV QUALITATIVE AND QUANTITATIVE ANALYSIS**  

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

TOTAL :45 PERIODS

COURSE OUTCOMES:
CO1: Students will learn about advanced analytical techniques for nanomaterials
CO2: Students will learn about qualitative and quantitative analysis techniques employed for studying nanomaterials
CO3: Understand the mechanical analytical techniques used to study nanomaterials

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NT4203 SYNTHESIS OF NANOMATERIALS L T P C 3 0 0 3

OBJECTIVES
- To explore the basic concepts and ideas involved in the synthesis of nanomaterials and to implement different strategies for synthesizing 0, 1D, 2D nanomaterials.
- To explore the role and application of nanomaterials in various fields.

UNIT I MECHANICAL ALLOYING AND MILLING 9
Introduction to synthesis of nanostructure materials, bottom-up approach and top-down approach—equipment for mechanical alloying, process variables in milling, Mechanism of alloying, Mechanochemical processing - Thermodynamic Aspects, Powder Contamination, Safety Hazards Related to Mechanical Alloying Processes.

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

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

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

**UNIT V APPLICATION OF NANOMATERIALS**
Overview of nanomaterials properties and their applications, nanopaints, nano coating, nanomaterials for renewable energy, Nanoelectronics – Nanobots- Biological Applications.

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**
CO1: At the end of the course the student would Gain knowledge on the various process techniques to synthesis nanostructured materials by clear understanding of growth controlling factors of nanomaterial
CO2: The students acquire knowledge about various kind of nanoporous materials
CO3: The course also gives clear knowledge on the application and implementation of nanomaterials to solve the societal problems

**REFERENCES:**
1. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and

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NT4211  MATERIALS STRUCTURAL CHARACTERIZATION LABORATORY  L T P C 0 0 4 2

OBJECTIVES
- To learn imaging techniques to study structural morphology of nanomaterials.
- To analysis the crystal structure and interpretation via XRD analysis

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1: Will get experience in analysing the nanomaterials
CO2: Able to interpret SEM and AFM images
CO3: XRD interpretations of Nanopowders are gained and crystallanity can be analysed

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OBJECTIVES
- To learn spectroscopic analysis and interpretation of Nanostructures
- To fabricate the DSSC, supercapacitor and analyse the performance analysis

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

TOTAL : 60 PERIODS

COURSE OUTCOMES:
CO1: Students can able to analyze and interpret various spectroscopic techniques
CO2: Optical properties of QDs and graphene based materials can be analysed
CO3: Able to characterize the fabricated device and interpret the results

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

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

TOTAL : 180 PERIODS

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

NT4312 INTERNSHIP

OBJECTIVE:
To train the students in the field work so as to have a firsthand knowledge of practical problems

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

OUTCOME:
On completion of the course, the student would be able to
CO1: practically handle the machines in which he/she got trained
CO2: Generate and analyse
COE: Prepare technical report and present

NT4411 PROJECT WORK II

OBJECTIVES
The course aims to
• train students to analyze the problem/ think innovatively to develop new methods/product/process
• make them understand how to find solutions/ create products economically and in an environmentally sustainable way
• enable them to acquire technical and experimental skills to conduct experiment, analyze the results and prepare project report
• enable them to effectively think about strategies to commercialize the product.

TOTAL :360 PERIODS

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

COURSE OUTCOMES
At the end of the project the student will be able to
CO1 Formulate and analyze problems for developing new methods/solutions/processes.
CO2 Plan and conduct experiments to find solutions in a logical manner
CO3 Analyze the results, interpret and prepare project report/know the strategies for commercialization
ELECTIVES
NT4001 LITHOGRAPHY AND NANOFABRICATION L T P C
3 0 0 3

OBJECTIVES
- To learn lithographic techniques.
- To obtain knowledge on nanofabrication of devices using lithography.

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

UNIT II PHOTOLITHOGRAPHY AND PATTERNING OF THIN FILMS

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

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

UNIT V NANOIMPRINT LITHOGRAPHY AND SOFT LITHOGRAPHY

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Will realize the importance of miniaturization and nanofabrications
CO2: Will learn about various types of lithographic techniques
CO3: The students will able to understand the merits and de-merits of each lithographic techniques used for nanofabrication

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NT4002      NANOCOMPOSITE MATERIALS       L T P C 3 0 0 3

OBJECTIVES:
- To learn about Fundamentals aspects of nanocomposites and explore the fabrication technologies of nanocomposites.
- To elucidate on advantages of nanotechnology based applications in each industry.

UNIT I     BASICS OF NANOCOMPOSITES

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

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

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

UNIT V    NANOCOMPOSITE TECHNOLOGY
COURSE OUTCOMES:
CO1: The students will learn about fundamental aspects and fabrication technologies of nanocomposites
CO2: Will gain knowledge about applications of nanocomposites in various industries
CO3: At the end of this course students would be able to design, build nanocomposite materials for engineering applications

REFERENCES:
5. The search for novel, superhard materials- Stan Vepřek (Review Article) JVST A, 1999

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<td>CO2</td>
<td>Will gain knowledge about applications of nanocomposites in various industries</td>
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NT4003 NANOELECTRONICS AND SENSORS L T P C
OBJECTIVES:
• To learn about overview of nanoelectronics.
• To study the basic components of electronic systems.
• To learn about sensor fabrication and applications.

UNIT I OVERVIEW OF NANO-ELECTRONICS 9
Nano-scale electronics; Foundation of nano-electronics – low dimension transport, quantum confinement, Coulomb blockade and quantum dot; Ballistic transport and Quantum interferences; Landauer formula, quantization of conductance, example of Quantum point contact.
UNIT II     TWO-TERMINAL JUNCTION TRANSISTORS
Basic CMOS process flow; MOS scaling theory; Issues in scaling MOS transistors; Requirements for non-classical MOS transistor; PMOS versus NMOS; Design and construction of MOS capacitor; Integration issues of high-k MOS – interface states, bulk charge, band offset, stability, reliability; MOS transistor and capacitor characteristics.

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

UNIT IV     SENSORS AND ACTUATOR CHARACTERISTICS

UNIT V     MEMORY DEVICES AND SENSORS

TOTAL :45 PERIODS

COURSE OUTCOMES:
CO1: Students will gain knowledge in basics of nanoelctronics
CO2: Students will gather idea about materials and techniques used for sensor components
CO3: Students will acquire information about fabrication of different sensors

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OBJECTIVES:
- To study the basic interaction of different molecules which are helpful in both food and agricultural activities
- To understand the importance of nanomaterials and devices in precision farming, advanced materials used in agriculture and food industries.

UNIT I  NANOTECHNOLOGY IN CROP PRODUCTION 9  
Fertilizer – types and mode of action; Nanofertilizer – nanourea and mixed fertilizers; Nanomaterials as soil conditioners – zeolites, nanoclays, superabsorbent polymers, nanocomposites; Nanoemulsion based antitranspirants; Nanosensors for monitoring soil moisture; Effect of nanoparticles in seed – carbon based, TiO₂, aluminium, silver, copper, ZnO nanoparticles; Smart delivery systems for nanofertilizer release;

UNIT II  NANOTECHNOLOGY IN PEST MANAGEMENT 9  
Introduction to pest management; nanomaterials for pest management; Nanoherbicide, nanopesticide and nanofungicide- its application, mode of action and evaluation; nanoparticles and mesoporous nano materials for smart delivery; Nanosensors for pest management; Assessment of efficacy and safety on nontarget organisms;

UNIT III  NANOTECHNOLOGY IN FOOD PROCESSING 9  
Introduction and scope; Nanobased smart delivery system for nutraceuticals and its release mechanism; Nano cochleates – formulation methods and mechanism of release; Nanoclusters; Nanolaminates- properties, preparation and application; Nanoemulsions – preparation and application; Nanoencapsulation technology- materials used, principle, release mechanism and advantages;

UNIT IV  NANOTECHNOLOGY IN FOOD PACKAGING 9  
Nanocomposites; Nanostructured layers; Nanomaterials for food preservation; Nanopackaging for enhanced shelf life; Nanotechnology in intelligent packaging; Nanosensors for food safety monitoring.

UNIT V  IMPACTS OF NANOAPPLICATION 9  
Nanoparticles – mode of action, bioaccumulation and its interaction with biological systems; Fate of nanoparticles in the environment; Health hazards of nanomaterials in the workplace; Nanoethics, safe handling and precautionary protocol.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Student will learn the basic interaction of different molecules which are helpful in both food and agricultural activities
CO2: Understand the importance of nanomaterials and devices in precision farming
CO3: Students will understand the importance of advanced materials used in agriculture and food industries

REFERENCES:
6. Monique A. V. Axelos (Editor), Marcel Van de Vooorde (Editor), Nanotechnology in Agriculture and Food Science; ISBN: 978-3-527-69773-1; March 2017; 450p
Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Student will learn the basic interaction of different molecules which are helpful in both food and agricultural activities</td>
<td>PO1 3 PO2 3 PO3 3 PO4 PO5 PO6 3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the importance of nanomaterials and devices in precision farming</td>
<td>3 3 3</td>
</tr>
<tr>
<td>CO3</td>
<td>Students will understand the importance of advanced materials used in agriculture and food industries</td>
<td>3 3 3</td>
</tr>
</tbody>
</table>

| Overall CO      | 3 3 3 |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES:
- To be aware of the challenges and demand for Energy
- To study about the nanomaterials used in Energy applications
- To enhance our knowledge on the role of nanomaterials in remediation applications and its impact on the environment.

UNIT I INTRODUCTION
Sustainable energy - Materials for energy - Green house effect - CO₂ emission - Energy demand and challenges.

UNIT II RENEWABLE ENERGY TECHNOLOGY

UNIT III NANOMATERIALS IN FUEL CELL AND STORAGE TECHNOLOGY

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

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Students will gain familiarity with renewable energy technologies updated with nano devices and different fabrication methodologies
CO2: Kinetic studies of dye degradation using nanophotocatalysts will be learned
CO3: Students get acquainted with the application of nanomaterials and its impacts in environmental systems

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<td>CO1</td>
<td>Students will gain familiarity with renewable energy technologies updated with nano devices and different fabrication methodologies</td>
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<tr>
<td>CO2</td>
<td>Kinetic studies of dye degradation using nanophotocatalysts will be learned</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Students get acquainted with the application of nanomaterials and its impacts in environmental systems</td>
<td>3</td>
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<td>Overall CO</td>
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NT4006 NANO BIOPHOTONICS  L T P C  3 0 0 3

OBJECTIVES:
- To learn about Fundamentals of light and optics
- To study the concepts of optical based imaging techniques.
- To learn about recent development in optical sensors.

UNIT I BASICS OF LIGHT AND OPTICS  9
Interaction of light with cells, tissues, non-linear optical processes with intense laserbeams, photo-induced effects in biological systems.

UNIT II IMAGING TECHNIQUES  9

UNIT III SINGLE MOLECULE SPECTROSCOPY  9
UV-VIS spectroscopy of biological systems, single molecule spectra and characteristics – IR and Raman spectroscopy and Surface Enhanced Raman Spectroscopy for single molecule applications.

UNIT IV OPTICAL FORC E SPECTROSCOPY  9
Generation optical forces – Optical trapping and manipulation of single molecules and cells in optical confinement - Laser trapping and dissection for biological systems – single molecule biophysics, DNA protein interactions.
Biosensors, fluorescence immunoassay, flow cytometry, Fluorescence correlation spectroscopy, Fluorophores as cellular and molecular tags.

**COURSE OUTCOMES:**
- **CO1:** Students will gain knowledge in basics of optics
- **CO2:** Students will gather idea about imaging techniques
- **CO3:** Students will acquire information about Biophotonics and advanced optical sensors

**REFERENCES:**

**Course Articulation Matrix:**

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<td>PO1  PO2  PO3  PO4  PO5  PO6</td>
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<tr>
<td><strong>CO1</strong></td>
<td>Students will gain knowledge in basics of optics</td>
<td>3    3    3</td>
</tr>
<tr>
<td><strong>CO2</strong></td>
<td>Students will gather idea about imaging techniques</td>
<td>3    3    3</td>
</tr>
<tr>
<td><strong>CO3</strong></td>
<td>Students will acquire information about Biophotonics and advanced optical sensors</td>
<td>3    3    3</td>
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<td><strong>Overall CO</strong></td>
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**NT4007 ADVANCED DRUG DELIVERY SYSTEMS**

**OBJECTIVES:**
- To learn about Fundamentals of drug delivery systems
- To study the materials and techniques used in Delivery systems
- To learn about Recent development in the area of devices and therapy.

**UNIT I THEORY OF ADVANCED DRUG DELIVERY**


**UNIT II POLYMERS**

UNIT III  LIPID BASED NANOCARRIERS  9
Liposomes, niosomes and solid lipid nanoparticles. Ligand based delivery by liposomes. Cubosomes.

UNIT IV  MICROBES AND ANTIBODY BASED NANOCARRIERS  9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Students will gain knowledge in basics of drug delivery systems
CO2: Students will gather idea about materials and techniques used for drug coating and delivery
CO3: Students will acquire information about recent trends equipments and delivery systems

REFERENCES:

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<tr>
<td>CO1</td>
<td>Students will gain knowledge in basics of drug delivery systems</td>
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<td>3    3    2    3</td>
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<tr>
<td>CO2</td>
<td>Students will gather idea about materials and techniques used for drug</td>
<td></td>
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<tr>
<td></td>
<td>coating and delivery</td>
<td>3    3    2    3</td>
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<tr>
<td>CO3</td>
<td>Students will acquire information about recent trends equipments and</td>
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<td></td>
<td>delivery systems</td>
<td>3    3    2    3</td>
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<td>Overall CO</td>
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<td>3    3    2    3</td>
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NT4008  PROCESSING AND PROPERTIES OF NANOSTRUCTURED MATERIALS  L T P C  3 0 0 3

OBJECTIVES
- To learn basic material science with special emphasize on nanomaterials
- To know about processes in handling polymers and nanostructured materials.
- To understand various forms of nanomaterials and polymers for special applications.

UNIT I  DEFORMATION PROCESSING AND METAL FORMING  9
Classification of engineering materials - Tensile testing – Stress strain curve – Flow stress -

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

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

UNIT IV PROCESSING OF POWDERS OF METALS AND CERAMICS

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Will acquire knowledge about the deformation and microstructural properties of the nanomaterials
CO2: Gaining knowledge about processes of polymers and nanostructured materials
CO3: Will understand the functional properties of nanomaterials and polymers for various applications

REFERENCES
5. H. Gleiter, “Nanocrystalline Materials”, Progress in Materials Science Vol. 33,

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<td>3</td>
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<tr>
<td>CO2</td>
<td>Gaining knowledge about processes of polymers and nanostructured materials</td>
<td>3</td>
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<td>CO3</td>
<td>Will understand the functional properties of nanomaterials and polymers for various applications</td>
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<td><strong>Overall CO</strong></td>
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**NT4009 MEMS AND NEMS**

**OBJECTIVES:**
- To learn about Micro fabrication and scaling of MEMS
- To study the Microsystems and materials used in MEMS Technology
- To learn about Biological MEMS Technology

**UNIT I MEMS MICROFABRICATION**

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

**UNIT III MICROSYSTEMS**

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

**UNIT V COMMERCIAL AND TECHNOLOGICAL TRENDS**

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**
- **CO1:** Students would gain knowledge in microfabrication techniques and scaling process
- **CO2:** Would acquire knowledge about the Microsystem and materials used in MEMS Technology
- **CO3:** Students would acquire information about recent trends in MEMS and BioMEMS techniques

**REFERENCES:**
2. MEMS and Microsystems design and manufacture, Tai-Ran Hsu,Tata Mc Graw Hill 2011.

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<tbody>
<tr>
<td>CO1</td>
<td>Students would gain knowledge in microfabrication techniques and scaling process</td>
<td>PO1 3  PO2 3  PO3  PO4 3  PO5  PO6 3</td>
</tr>
<tr>
<td>CO2</td>
<td>Would acquire knowledge about the Microsystem and materials used in MEMS Technology</td>
<td>PO1 3  PO2 3  PO3  PO4 3  PO5  PO6 3</td>
</tr>
<tr>
<td>CO3</td>
<td>Students would acquire information about recent trends in MEMS and BioMEMS techniques</td>
<td>PO1 3  PO2 3  PO3  PO4 3  PO5  PO6 3</td>
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<tr>
<td>Overall CO</td>
<td></td>
<td>PO1 3  PO2 3  PO3  PO4 3  PO5  PO6 3</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4010  SEMICONDUCTOR NANOSTRUCTURES  L T P C

3 0 0 3

OBJECTIVES:
- To gain knowledge about basic semiconductor metals & its characteristics
- To know the physical & quantum aspects of semiconductor
- To obtain a basic idea about energizing material & its effects

UNIT I  SEMICONDUCTOR FUNDAMENTALS  9

UNIT II  SEMICONDUCTOR NANOPARTICLE SYNTHESIS  9
Cluster compounds, quantum-dots from MBE and CVD, wet chemical methods, reverse micelles, electro-deposition, pyrolytic synthesis, self-assembly strategies.

UNIT III  PHYSICAL PROPERTIES  9
Melting point, solid-state phase transformations, excitons, band-gap variations-quantum confinement, effect of strain on band-gap in epitaxial quantum dots, single particle conductance.

UNIT IV  SEMICONDUCTOR NANOPARTICLES – APPLICATIONS  9
Optical luminescence and fluorescence from direct band gap semiconductor nanoparticles, surface-trap passivation in core-shell nanoparticles, carrier injection, polymer-nanoparticle, LED and solar cells, electroluminescence, barriers to nanoparticle lasers, doping nanoparticles, Mn-Zn-
Se phosphors, light emission from indirect semiconductors, light emission form Si nanodots.

UNIT V SEMICONDUCTOR NANOWIRES
Fabrication strategies, quantum conductance effects in semiconductor nanowires, porous Silicon, nanobelts, nanoribbons, nanospings.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Overall the students will get idea about basic and advanced concepts in electronics and quantum physics
CO2: Will acquire knowledge about the physical and quantum aspects of semiconductors
CO3: Students will acquire the ideas about optical applications of semiconductor nanostructures

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<td>PO1</td>
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<tr>
<td>CO1</td>
<td>Overall the students will get idea about basic and advanced concepts in electronics and quantum physics</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Will acquire knowledge about the physical and quantum aspects of semiconductors</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Students will acquire the ideas about optical applications of semiconductor nanostructures</td>
<td>3</td>
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<tr>
<td>Overall CO</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

NT4011 NANOTOXICOLOGY L T P C 3 0 0 3

OBJECTIVES:
- To make students learn various concepts of toxicity, and its effects.
- To help them gain knowledge about the toxicity in Nanoscience, and their effects on Human.
- To enhance knowledge on the nanotoxicology - prevention and remedies.

UNIT I INTRODUCTION TO TOXICOLOGY
UNIT II    NANOTOXICOLOGY  9

UNIT III    PROTOCOLS IN TOXICOLOGY STUDIES  9

UNIT IV    ANIMAL MODELS  9
Types, species and strains of animals used in toxicity studies. Dosing profile for animal models. Studies on toxicology, pathology and metabolism in mouse and rat. Laws and Regulations Governing Animal Care and Use in Research.

UNIT V    RISK ASSESSMENT AND EXECUTION  9

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Students will get knowledge on nanotoxicology and their effects on human and animals
CO2: They will acquire knowledge about various prevention methods
CO3: Gaining knowledge on the remedies for nanotoxicology

REFERENCES:

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<td>CO1</td>
<td>Students will get knowledge on nanotoxicology and their effects on human and animals</td>
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</tr>
<tr>
<td>CO2</td>
<td>They will acquire knowledge about various prevention methods</td>
<td>3</td>
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</table>
CO3 | Gaining knowledge on the remedies for nanotoxicology | 3 | 3 | 3
---|---|---|---|---
**Overall CO** | 3 | 3 | 3 |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

**NT4012**  
**NANOTECHNOLOGY IN HEALTH CARE**  
**L T P C**  
**3 0 0 3**

**OBJECTIVES**
- To be introduced to recent advancements in nano medicine.
- To learn about nano diagnostics.
- To learn developments in nanostructured materials used for medical implants.

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

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

**UNIT III**  
**NANOTECHNOLOGY BASED MEDICAL DIAGNOSTICS**  

**UNIT IV**  
**PROSTHETIC AND MEDICAL IMPLANTS**  

**UNIT V**  
**BIOMEDICAL APPLICATIONS OF NANOTECHNOLOGY**  

**COURSE OUTCOMES:**
- CO1: Comprehend the nanoparticles-based gene therapy, nanoprobing and profiling techniques and their application
- CO2: Understand the use of metal nanoparticles and antibodies in diagnosis of biomarkers with high sensitivity
- CO3: Be aware of the principle and uses of cantilever sensors and imaging of plaques and tumors
- CO4: Completely understand the ocular, cochlear, dental implants and nanofiber technology
- CO5: Have knowledge on functionalised nanoscaffolds, magnetic, organic and inorganic nanoparticles

**REFERENCES:**
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<td>Comprehend the nanoparticles- based gene therapy, nanoprobing and profiling techniques and their application</td>
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<td>CO2</td>
<td>Understand the use of metal nanoparticles and antibodies in diagnosis of biomarkers with high sensitivity</td>
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<tr>
<td>CO3</td>
<td>Be aware of the principle and uses of cantilever sensors and imaging of plaques and tumors</td>
<td>3 3 3</td>
</tr>
<tr>
<td>CO4</td>
<td>Completely understand the ocular, cochlear, dental implants and nanofiber technology</td>
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<tr>
<td>CO5</td>
<td>Have knowledge on functionalised nanoscaffolds, magnetic, organic and inorganic nanoparticles</td>
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<td><strong>Overall CO</strong></td>
<td>3 3 3</td>
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### NT4013 NANO BIOSENSORS

**OBJECTIVES:**
- To learn about principles, components and fabrication of biosensors
- To study about various types of biosensors
- To learn about recent development and application of biosensors.

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

**UNIT II PROTEIN BASED BIOSENSORS**

**UNIT III DNA BASED BIOSENSOR**
Heavy metal complexing with DNA and its determination, sensing in water and food samples – DNA zymo Biosensors.
UNIT IV SENSING OF CELLS AND PATHOGENS
Nanoscale biosensors. Nanobiosensors for cellular biosensing and sensing of rare cells. Detection of pathogens in food and water samples.

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Students will acquire knowledge in basics of Biosensors
CO2: Students will gain idea about fabrication techniques of biosensors
CO3: Students will gain information about recent trends in nanobiosensors and application in various fields

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<tr>
<td>CO2</td>
<td>Students will gain idea about fabrication techniques of biosensors</td>
<td>3    3    3</td>
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<tr>
<td>CO3</td>
<td>Students will gain information about recent trends in nanobiosensors</td>
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<td>and application in various fields</td>
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NT4014 NANOTECHNOLOGY IN TISSUE ENGINEERING

OBJECTIVES:
- To learn about nanomaterials for tissue engineering
- To study about various types of nanobiomaterials
- To learn about recent development and application of tissue engineering

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

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

UNIT III REGENERATION OF SENSORY SYSTEM 9

UNIT IV BIOMIMETIC NANOFIBERS FOR MUSCULOSKELETAL TISSUE ENGINEERING 9
Structural and Functional Requirements for Musculoskeletal Tissues, Nanofibers as 3D Scaffolds for Tissue Regeneration, Extracellular Matrix Analogs for Cartilage Regeneration, Bioactive Nanofibers and Methods of Immobilizing Biomolecules, Gene Delivery Through Nanofibers, Techniques to Improve Porosity and Cell Infiltration on Nanofiber Scaffolds, Nanofiber Scaffolds for Interface Regeneration

UNIT V DERMAL TISSUE ENGINEERING: CURRENT TRENDS 9
Introduction, Nanotopography-Guided Skin Tissue Engineering, Stem Cells for Skin Tissue Engineering, Scarless Fetal Skin Wound Healing, Preparation of Self-Assembled Hydrogels, Hydrogels Characteristics for Cells, Self-Assembled Hydrogels, Significance of Natural and Synthetic Polymer for Hydrogels, Recent Development of Self-Assembled Hydrogel, Future of Nanotechnology in Tissue Engineering

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Students will acquire knowledge in basics of nanotechnology tissue engineering
CO1: Students will acquire knowledge of regeneration tissue engineering of sensory system
CO3: Students will gain information about recent trends in application of tissue engineering

REFERENCES:

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<td>CO2</td>
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<td>3</td>
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<tr>
<td>CO3</td>
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<td>3</td>
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<td>Overall CO</td>
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OBJECTIVES:
- Study of this subject provides an understanding of the scope of an entrepreneur
- Study of this subject provides business ideas and Motivation to the students for start Business

UNIT I ENTREPRENEURSHIP

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

UNIT III BUSINESS

UNIT IV FINANCING AND ACCOUNTING

UNIT V SUPPORT TO ENTREPRENEURS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Students get knowledge business
CO2: Students Know details about Entrepreneur
CO3: Students get Motivation

REFERENCES:
AUDIT COURSES

AX4091  ENGLISH FOR RESEARCH PAPER WRITING  L T P C

2 0 0 0

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

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

UNIT II   PRESENTATION SKILLS  6

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

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

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

TOTAL: 30 PERIODS

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

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

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

UNIT II  REPERCUSSIONS OF DISASTERS AND HAZARDS

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

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

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

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

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

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

UNIT II  PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III  CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

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

UNIT V  LOCAL ADMINISTRATION

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

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

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

1. தகுணிப்பு தலைக் குருவெ– பதொருள், பாடல், பாப்பொர்
2. மருந்து (82)
- பித்துவர் தில்லியாக அறிக்கை
3. நூலின் பாடல் பாப் கான்கை
4. புதுக்கடை (95,195)
- பாப்பொர் தில்லியாக மற்றொரு

UNIT II

1. தொற்று அரசன் விளையாட்டு meanings
- எழுத்து, பாடல், பாப்பொருள்
2. பிற அரசன் - தோற்று முறை
- பாயுக்கக்கடை, தில்லியாக, அரசன் காரண
(tamilvarnam எழுத்துக்களைத் தேர்வு)

UNIT III

1. குறிஞ்சிப் பொட்டியானவள்ளு
- குறிஞ்சிப் பொட்டியானவள்ளு
2. குறிஞ்சிப் பொட்டியானவள்ளு மற்றொரு
- மற்றொரு குறிஞ்சிப் பொட்டியானவள்ளு

UNIT IV

1. குருசமேருகம்பொட்டியானவள்ளு
- பாடல் பாப்பொருள் வரும் காரண
2. குருசமேருகம்பொட்டியானவள்ளு
- குருசமேருகம்பொட்டியானவள்ளு
3. குருசமேருகம்பொட்டியானவள்ளு (617, 618)
- குருசமேருகம்பொட்டியானவள்ளு
4. குருசமேருகம்பொட்டியானவள்ளு
- குருசமேருகம்பொட்டியானவள்ளு
5. குருசமேருகம்பொட்டியானவள்ளு
- குருசமேருகம்பொட்டியானவள்ளு
6. குருசமேருகம்பொட்டியானவள்ளு (4) - வாதிப்பு
- குருசமேருகம்பொட்டியானவள்ளு (11) - குருசமேரு
- குருசமேருகம்பொட்டியானவள்ளு (11) - பாப்பொர்
- குருசமேருகம்பொட்டியானவள்ளு 50 (27) - பாப்பொர்

UNIT V

1. குருசமேருகம்பொட்டியானவள்ளு
- குருசமேருகம்பொட்டியானவள்ளு
- குருசமேருகம்பொட்டியானவள்ளு
- குருசமேருகம்பொட்டியானவள்ளு
- பாப்பொர் குருசமேருகம்பொட்டியானவள்ளு
- பாயுக்கக்கடை
2. குருசமேருகம்பொட்டியானவள்ளு பாப்பொர் குருசமேருகம்பொட்டியானவள்ளு
3. குருசமேருகம்பொட்டியானவள்ளு பாப்பொர் குருசமேருகம்பொட்டியானவள்ளு
4. பல்ல விவாதிய விளையாட்டு நிறுவன விளையாட்டில் சேமிப்பு இடையில் பரப்பப்படும்
தமிழ் சூட்டிப்படியம்,
5. அரியநாயக தமிழ்,
6. விளையாட்டில் சேமிப்பு,
7. சுற்றுச்சூழல் சேமிப்பு சுற்று வேங்கியம்.

TOTAL : 30 PERIODS

தமிழ் விளையாட்டு தொழில்பாடு / பார்வக வழி

1. தமிழ் விங்கட நிதி நிறுவனம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியொ (Tamil Wikipedia)
   - https://ta.wikipedia.org
3. சக்கரவர திரு பள்ளிப்பு
4. பல்லத்திய கல்விக்கழகம்
   - சக்கரவர பல்கலைக்கழகம், திருவநகர்
5. தமிழ் வளர்சித் துறை (thamilvalarchithurai.com)
6. விளையாட்டு கல்விக்கழகம்
   - சக்கரவர பல்கலைக்கழகம், திருவநகர்
OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I  CONTEXT FOR IWRM  9
Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II  WATER ECONOMICS  9
Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III  LEGAL AND REGULATORY SETTINGS  9
Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV  WATER AND HEALTH WITHIN THE IWRM CONTEXT  9
Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V  AGRICULTURE IN THE CONCEPT OF IWRM  9
Water for food production: ‘blue’ versus ‘green’ water debate – Water foot print - Virtual water trade for achieving global water and food security — Irrigation efficiencies, irrigation methods - current water pricing policy- scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1 Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.

CO2 Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.

CO3 Apply law and governance in the context of IWRM.

CO4 Discuss the linkages between water-health; develop a HIA framework.

CO5 Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:
OBJECTIVES:
• Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario.

UNIT I FUNDAMENTALS WASH
Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH.

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT

UNIT IV GOVERNANCE
Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)- Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES
Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

OUTCOMES:
CO1 Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2 Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3 Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4 Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5 Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning:

Improving the Environment for learning: An Expanded Agenda


Third World Network.org (www.twn.org).

OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT

OBJECTIVES:
- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES


UNIT II PRINCIPLES AND FRAMEWORK


UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING


UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS

UNIT V  ASSESSING PROGRESS AND WAY FORWARD


TOTAL: 45 PERIODS

OUTCOMES:
- On completion of the course, the student is expected to be able to
  CO1 Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
  CO2 Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
  CO3 Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
  CO4 Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
  CO5 Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

OCE434  ENVIRONMENTAL IMPACT ASSESSMENT  L T P C  3 0 0 3

OBJECTIVES:
- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I  INTRODUCTION

UNIT II  IMPACT IDENTIFICATION AND PREDICTION

UNIT III SOCIAL-ECONOMIC IMPACT ASSESSMENT 8
Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9
Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9
Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

OUTCOMES:
• On completion of the course, the student is expected to be able to
  CO1 Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
  CO2 Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
  CO3 Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
  CO4 Document the EIA findings and prepare environmental management and monitoring plan
  CO5 Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:
1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India

OIC431 BLOCKCHAIN TECHNOLOGIES

COURSE OBJECTIVES:
• This course is intended to study the basics of Blockchain technology.
• During this course the learner will explore various aspects of Blockchain technology like application in various domains.
• By implementing, learners will have idea about private and public Blockchain, and smart contract.
UNIT I  INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN  9
Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II  BITCOIN AND CRYPTOCURRENCY  9

UNIT III  INTRODUCTION TO ETHEREUM  9
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV  INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING  10

UNIT V  BLOCKCHAIN APPLICATIONS  8
Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After the completion of this course, student will be able to
CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

OIC432  DEEP LEARNING  L T P C
3 0 0 3

COURSE OBJECTIVES:
- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing
UNIT I DEEP LEARNING CONCEPTS 6

UNIT II NEURAL NETWORKS 9

UNIT III CONVOLUTIONAL NEURAL NETWORK 10

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN 10

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 10

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Feature Extraction from Image and Video Data
CO2: Implement Image Segmentation and Instance Segmentation in Images
CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

REFERENCES
1. Deep Learning A Practitioner’s Approach Josh Patterson and Adam Gibson O’Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
OBJECTIVES
- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT- I  BASICS OF VIBRATION  9

UNIT- II  BASICS OF NOISE  9
Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra - Types of sound fields - Octave band analysis - Loudness.

UNIT- III  INSTRUMENTATION FOR VIBRATION MEASUREMENT  9

UNIT- IV  INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS  9
Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT- V  METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL  9

OUTCOMES:
On Completion of the course the student will be able to
1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:
OME432

ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat.
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement.

UNIT I

ENERGY SCENARIO


UNIT II

HEATING, VENTILLATION & AIR CONDITIONING


UNIT III

LIGHTING, COMPUTER, TV


UNIT IV

ENERGY EFFICIENT BUILDINGS


UNIT V

ENERGY STORAGE TECHNOLOGIES

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Understand technical aspects of energy conservation scenario.
- Energy audit in any type for domestic buildings and suggest the conservation measures.
- Perform building load estimates and design the energy efficient landscape system.
- Gain knowledge to utilize an appliance/device sustainably.
• Understand the status and current technological advancement in energy storage field.

REFERENCES:
6. (Could be downloaded from www.energymanagertraining.com)

OME433 ADDITIVE MANUFACTURING L T P C
UNIT I INTRODUCTION 3 0 0 3

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

UNIT III VAT POLYMERIZATION 9

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9
POWDER BASED PROCESS
UNIT V  CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES


TOTAL: 45 PERIODS

REFERENCES:

OME434 ELECTRIC VEHICLE TECHNOLOGY

UNIT I  NEED FOR ELECTRIC VEHICLES
History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II  ELECTRIC VEHICLE ARCHITECTURE
Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption. Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III  ENERGY STORAGE
Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV  ELECTRIC DRIVES AND CONTROL
Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor-drives and control, AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V  DESIGN OF ELECTRIC VEHICLES
Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque-speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity maximum gradability, Brake performance,
Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

REFERENCES:

OME435 NEW PRODUCT DEVELOPMENT

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
- Applying the principles of generic development process; and understanding the organization structure for new product design and development.
- Identifying opportunity and planning for new product design and development.
- Conducting customer need analysis; and setting product specification for new product design and development.
- Generating, selecting, and testing the concepts for new product design and development.
- Applying the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT

UNIT II OPPORTUNITY IDENTIFICATION & PRODUCT PLANNING

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS

UNIT IV CONCEPT GENERATION, SELECTION & TESTING

UNIT V INDUSTRIAL DESIGN & PROTOTYPING

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

REFERENCES:

OBA431 SUSTAINABLE MANAGEMENT LT P C 3 0 0 3
COURSE OBJECTIVES:
- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9
Management of sustainability - rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9
Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9
Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9
Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9
COURSE OUTCOMES:
CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C 3 0 0 3

COURSE OBJECTIVES
• To familiarize students with the theory and practice of small business management.
• To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9
Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9
Management and Leadership – employee assessments – Tuckman’s stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.
Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9
Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small
firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin - Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9
Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

COURSE OUTCOMES
CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

REFERENCES
3. Journal articles on SME's.

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

COURSE OBJECTIVE
➢ To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9
Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9
New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9
Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS 9
The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.
COURSE OUTCOMES
CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES
2. Intellectual Property rights and copyrights, EssEss Publications.

OBA434 ETHICAL MANAGEMENT

COURSE OBJECTIVE
➢ To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY
Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society’s expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS
Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT
Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT
Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS
Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.
COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

ET4251 IoT FOR SMART SYSTEMS LT P C 3 0 0 3

COURSE OBJECTIVES:
1. To study about Internet of Things technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9
Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9
PROTOCOLS:
NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9
Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.
Embedded processors for IOT: Introduction to Python programming -Building IOT with RASPBERRY PI and Arduino.
UNIT V  CASE STUDIES

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

REFERENCES:
COURSE OBJECTIVES:
The course is aimed at
1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS
Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS
Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1-score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naive Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS
Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS
State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

COURSE OUTCOMES (CO):
At the end of the course the student will be able to
CO1 : Illustrate the categorization of machine learning algorithms.
CO2: Compare and contrast the types of neural network architectures, activation functions
CO3: Acquaint with the pattern association using neural networks
CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks
CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

PX4012 RENEWABLE ENERGY TECHNOLOGY

OBJECTIVES:
To impart knowledge on
- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION
Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India - Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO2 Emission - importance of renewable energy sources, Potentials – Achievements – Applications.

UNIT II SOLAR PHOTOVOLTAICS

UNIT III PHOTOVOLTAIC SYSTEM DESIGN
Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS

UNIT V OTHER RENEWABLE ENERGY SOURCES
Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:
After completion of this course, the student will be able to:
CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources

REFERENCES:

PS4093 SMART GRID

COURSE OBJECTIVES
• To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
• To know about the function of smart grid.
• To familiarize the power quality management issues in Smart Grid.
• To familiarize the high performance computing for Smart Grid applications.
• To get familiarized with the communication networks for Smart Grid applications.

UNIT I
INTRODUCTION TO SMART GRID
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II
SMART GRID TECHNOLOGIES
Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III
SMART METERS AND ADVANCED METERING INFRASTRUCTURE
Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV
POWER QUALITY MANAGEMENT IN SMART GRID
Unit V  HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS  9
Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:
Students able to
CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5: Recommend suitable communication networks for smart grid applications

REFERENCES

COURSE OBJECTIVES:
- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I  SYSTEM SECURITY  9

UNIT II  NETWORK SECURITY  9

UNIT III  SECURITY MANAGEMENT  9

UNIT IV  CYBER SECURITY AND CLOUD SECURITY  9
UNIT V PRIVACY AND STORAGE SECURITY


COURSE OUTCOMES:
CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

MP4251 CLOUD COMPUTING TECHNOLOGIES

COURSE OBJECTIVES:
- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE

UNIT II CLOUD PLATFORM ARCHITECTURE
Cloud Computing: Definition, Characteristics Cloud deployment models: public, private,
hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III  AWS CLOUD PLATFORM - IAAS

UNIT IV  PAAS CLOUD PLATFORM

UNIT V  PROGRAMMING MODEL
Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

IF4072 DESIGN THINKING L T P C 3 0 0 3

COURSE OBJECTIVES:
• To provide a sound knowledge in UI & UX
• To understand the need for UI and UX
• Research Methods used in Design
• Tools used in UI & UX
• Creating a wireframe and prototype

UNIT I  
UX LIFECYCLE TEMPLATE  8

UNIT II  
CONTEXTUAL INQUIRY  10

UNIT III  
DESIGN THINKING, IDEATION, AND SKETCHING  9

UNIT IV  
UX GOALS, METRICS, AND TARGETS  8

UNIT V  
ANALYSING USER EXPERIENCE  10

SUGGESTED ACTIVITIES:
1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

COURSE OUTCOMES:
CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application
CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

TOTAL : 45 PERIODS
REFERENCES
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 PRINCIPLES OF MULTIMEDIA L T P C 3 0 0 3

COURSE OBJECTIVES:
- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION

Suggested Activities:
1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:
1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA
Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:
1. Flipped classroom on different file formats of various media elements.

Suggested Evaluation Methods:
1. Demonstration on after effects animations
2. Quizzes on file formats and color models.
UNIT III MULTIMEDIA TOOLS


Suggested Activities:
1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:
1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS


Suggested Activities:
1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:
1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS


Suggested Activities:
1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:
1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

COURSE OUTCOMES:
CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

TOTAL : 45 PERIODS
DS4015 BIG DATA ANALYTICS

COURSE OBJECTIVES:
• To understand the basics of big data analytics
• To understand the search methods and visualization
• To learn mining data streams
• To learn frameworks
• To gain knowledge on R language

UNIT I
INTRODUCTION TO BIG DATA

UNIT II
SEARCH METHODS AND VISUALIZATION

UNIT III
MINING DATA STREAMS

UNIT IV
FRAMEWORKS
MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V
R LANGUAGE

COURSE OUTCOMES:
CO1: understand the basics of big data analytics
CO2: Ability to use Hadoop, Map Reduce Framework.
CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4: gain knowledge on R language
CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL: 45 PERIODS
REFERENCE:

NC4201 INTERNET OF THINGS AND CLOUD L T P C
3 0 0 3

COURSE OBJECTIVES:
- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT

UNIT II PROTOCOLS FOR IoT

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS
Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION

UNIT V IOT AND CLOUD

TOTAL:45 PERIODS

COURSE OUTCOMES:
At the end of the course, the student will be able to:
CO1: Understand the various concept of the IoT and their technologies..
CO2: Develop IoT application using different hardware platforms
CO3: Implement the various IoT Protocols
CO4: Understand the basic principles of cloud computing.
CO5: Develop and deploy the IoT application into cloud environment
REFERENCES

MX4073 MEDICAL ROBOTICS

COURSE OBJECTIVES:
- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS
Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators
Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS
Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning
Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS
Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS
Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS
Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL: 45 PERIODS
COURSE OUTCOMES:
CO1: Describe the configuration, applications of robots and the concept of grippers and actuators
CO2: Explain the functions of manipulators and basic kinematics
CO3: Describe the application of robots in various surgeries
CO4: Design and analyze the robotic systems for rehabilitation
CO5: Design the wearable robots

REFERENCES

VE4202 EMBEDDED AUTOMATION L T P C 3 0 0 3

COURSE OBJECTIVES:
- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9
C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER 9
ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9
Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED
Displays: Seven Segment Displays, Dot Matrix Displays, LCD Displays, Driving Relays, Stepper Motor Interface, Serial EEPROM, Real Time Clock, Accessing Constants Table, Arbitrary Waveform Generation, Communication Links, System Development Tools

UNIT – IV  VISION SYSTEM
Fundamentals of Image Processing, Filtering, Morphological Operations, Feature Detection and Matching, Blurring and Sharpening, Segmentation, Thresholding, Contours, Advanced Contour Properties, Gradient, Canny Edge Detector, Object Detection, Background Subtraction

UNIT – V  HOME AUTOMATION
Home Automation, Requirements, Water Level Notifier, Electric Guard Dog, Tweeting Bird Feeder, Package Delivery Detector, Web Enabled Light Switch, Curtain Automation, Android Door Lock, Voice Controlled Home Automation, Smart Lighting, Smart Mailbox, Electricity Usage Monitor, Proximity Garage Door Opener, Vision Based Authentic Entry System

COURSE OUTCOMES:
On successful completion of this course, students will be able to
CO1: analyze the 8-bit series microcontroller architecture, features and pin details
CO2: write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

TOTAL: 45 PERIODS

REFERENCES: