Shivaji University, Kolhapur

Name of Department: School of Nanoscience & Technology

Name of Programme: B. Sc.-M. Sc. (5 years integrated course)

Vision:

To become a global center of multidisciplinary knowledge, skills and technologies in Nanoscience.

Mission:

We Endeavour to make this school an advanced centre of research and innovation in Nanoscience and Technology.

Program Outcomes (PO's):

PO 01 : Fundamental Understanding of Nanoscience & Nanotechnology :

Apply the knowledge of basic Physics, Chemistry, Biotechnology, Mathematics, Statistics, Electronics & Environmental Science as a foundation for the solution of complex Nanoscience & Nanotechnology problems.

PO 02 : Problem analysis :

Identify, formulate and analyze Nanoscience & Nanotechnology problems to arrive at substantiated conclusions using principles of basic and applied sciences.

PO 03 : Research based learning :

To use research-based training for designing scientific projects through experiments, analysis and interpretation of data and synthesis of the information to provide scientific conclusions.

PO 04 : Nanoscience for Society relevance :

Application of Nanoscience & Nanotechnology knowledge for the solutions of societal problems like environmental, industrial and health for sustainable development.

PO 05 : Research Ethics & Communication :

Apply research ethical principles and commit to professional ethics, responsibilities and norms of the scientific communication practice.

Program Specific Outcomes (PSO's):

PSO 01 :

To provide trained professional human resources in Nanoscience & Nanotechnology for capacity building of the Nation.

PSO 02 :

Capture and nurture rural students at an early stage to develop ignited manpower.

Course Outcomes (CO's):

B. Sc. Part-I Semester-I (DSC – 1A to 6A)

Course Code	Name of the Course	Course Outcomes (CO's)
DSC-1A-Phy.	**Mechanics**	**CO 01:** Understand basic concepts of vectors, differential equations, laws of motion and how fictitious forces arise in a frame. **CO 02:** Recall and relate basic knowledge of mechanics behind momentum and energy. Understand the analogy between translational and rotational dynamics and application of both motions. **CO 03:** Apply Kepler's law to describe the motion of planets and satellites through the law of gravitation. Explain the phenomena of simple harmonic motion and the concept of frequency of nanoscale matters. **CO 04:** Understand basic concepts of elasticity in nanoscale matters, surface tension, nanostructured surfaces, simple principles of fluid flow and fluid dynamics.
DSC- 1A-Phys.-LAB	**Mechanics**	**CO 01:** Understand basic kinematics and dynamics of linear and rotational motion. **CO 02:** Extend the skills and practical use of different types of pendulum, micrometer screw gauge, vernier calliper and

		travelling microscope. **CO 03:** Learn the concepts related to elasticity of materials and viscosity of fluids.
DSC-2A-Chem	**Atomic Structure, Bonding, General organic Chemistry and Aliphatic hydrocarbons**	**CO 01:** Explain the atomic structure, Quantum mechanics and their important concepts. **CO 02:** Define the Chemical bonding and Molecular structure with some important theories. **CO 03:** Demonstrate the fundamentals of Organic Chemistry and Stereochemistry. **CO 04:** How Aliphatic Hydrocarbons are prepared and their reactions.
DSC-2A-Chem. -Lab	**Chemistry Lab. 1**	**CO 01:** Experiment with given inorganic samples to determine different characteristics such as Normality, Concentration, Strength. **CO 02:** Experiments with Vinegar solution to determine the amount of acetic acid. **CO 03:** Identification of various cations from a given mixture by chromatography technique. **CO 04:** Estimation of amount of Aspirin from Aspirin tablets. **CO 05:** Identification of Organic compounds qualitatively.
DSC-3A-Biotech.	**Cell Biology**	**CO 01:** Understand basic architecture of cells, structures, functions and mechanisms involved in livingness of the cells.. **CO 02:** Know the cellular assemblies present in micro and nanoscale structures **CO 03:** Demonstrate the fundamentals of vascular systems of the cells as well as extracellular matrices with their regulations.

		CO 04: Understand the role of nanotechnology in the cancer, carcinogenesis and characteristics of cancer cells as well as the stem cells.
DSC-3A-Biotech.-Lab	**Biotechnology**	**CO 01:** Study the effect of temperature and organic solvents on semi permeability of cellular membranes, dialysis mechanisms as well as plasmolysis and deplasmolysis mechanisms. **CO 02:** Study the prokaryotic and eukaryotic cellular structures, their fractionations and bioactivities in different organelles. **CO 03:** Understand the microtome techniques using different tissue samples **CO 04:** Understand cellular division mechanisms.
DSC-4A-Maths.	**Differential Calculus**	**CO 01:** Learn some theoretical aspects of continuity and differentiability of the functions. **CO 02:** To be able to use the theory of complex numbers to find the roots of the certain polynomials. **CO 03:** To learn the numerical techniques to study the rate of change of the discrete functions that arises in the experimental set up. **CO 04:** To be able to study the surfaces in the three dimensional space and study the extreme values of such surfaces.

DSC-4A-Maths.	**Differential Calculus** **Lab course**	**CO 01:** To find the points of discontinuity and non-differentiability of the functions. **CO 02:** To find the roots of the various polynomials by using De Moivre's theorem. **CO 03:** To find the derivatives of the discrete functions by using various Numerical methods. **CO 04:** To find the points on the surfaces which are at the maximum or minimum level.
DSC-5A-Elect.	**Network Analysis and Analog Electronics**	**CO 01:** Understand the concepts of Voltage source, Current source, the network theorems and the two–port network parameters with an ability to analyze the electronic circuits using network theorems and find out/calculate two-port network parameters. **CO 02:** Describe the construction and working of different types of diodes, BJT, JFET & UJT. Also Comprehend the I-V characteristics of them. **CO 03:** Illustrate about rectifiers and transistor amplifiers & its biasing. Also calculate the parameter's values and compare the performances of them. **CO 04:** Memorizes the concepts of feedback and feedback amplifiers and Design the oscillators.
DSC-5A-Elect.-Lab	**Network Analysis and Analog Electronics -Lab Course**	CO 03: Choose the appropriate equipment and measuring instruments to supply and measure electrical quantities. Verify the network theorems and operation of electronic circuits. CO 04: Perform experiments for better understanding the behavior of semiconductor devices and examine the I-V characteristics of them to calculate various device parameters' values. Also Design & construct the oscillator.

AECC1-6-A-Eng.	**English-I**	**CO 01:** To enrich the vocabulary at this stage of education. Ultimate aim is accuracy and appropriateness. **CO 02:** Enhance narration skills. To know what is first person narration, second person narration and third person narration. Learn poetry. **CO 03:** To learn descriptive functions of language. Learn how to describe image, object, things, instrument, place, birds, animals, habits, routine and description of a person, etc. To learn the famous speech of Martin Luther King, Jr. **CO 04:** To study literary delights of Rabindranath Tagore and Iftikhar Rizvi.
B. Sc. Part-I Semester-II (DSC – 1B to 6B)		
DSC-1B-Phy.	**Electricity and Magnetism**	**CO 01:** Understand line, surface and volume integrals of vector fields, Gauss-divergence and Stoke's theorem. **CO 02:** Learn basic laws and theorems of electrostatic at nanoscale. **CO 03:** Verify various circuit laws, network theorems using simple electric circuits. Understand the basic concepts of memristor and spintronics. **CO 04:** Classify the laws of electromagnetic induction. Acquire basic knowledge of electromagnetic waves. Understand the concept of nanoelectrodynamics.
DSC-1B-Phys.-LAB	**Electricity and Magnetism**	**CO 01:** Understand basic concepts of electricity and magnetism and their applications. **CO 02:** Learn the use of multimeters for measuring resistances, AC and DC Voltages and checking electrical fuses. **CO 03:** Equips the student with required prerequisites to understand electrodynamic phenomena.

		CO 04: Extend the skills and practical use of sonometer, ballistic galvanometer and different types of LCR circuits.
DSC-2B-Chem.	**Chemical Energetics, Equilibria & Functional Organic Chemistry**	**CO 01:** Explain the concepts of Thermodynamics, Thermochemistry and Chemical Equilibrium. **CO 02:** Define the Ionic Equilibria with some important concepts. **CO 03:** How Aromatic Hydrocarbons, Alkyl and Aryl Halide are prepared and their reactions. **CO 04:** How Alcohol, Phenol and Ether are prepared and their reactions.
DSC-2B-Chem-Lab	**Chemistry Lab. 2**	**CO 01:** Preparation of standard and required pH buffer solutions. **CO 02:** Measurement of pH of different solutions like fruit juices, shampoos and soaps. **CO 03:** Determination of melting and boiling points of given samples **CO 04:** Preparation of organic compounds.
DSC-3B-Biotech.	**Mammalian Physiology**	**CO 01:** Understand basic concepts of digestion, exchange of gases, various fates of nanomaterials in body and mechanism of artificial respirocytes **CO 02:** Understand the Circulation and composition of blood, hematopoiesis, coagulations as wll as the working of the heart and Nanoparticles: Blood Components Interactions. **CO 03** Knowing Muscle physiology and osmoregulation and

		Role of nanotechnology in tissue engineering **CO 04:** study the Nervous and endocrine coordination as well as Nanotechnology in neuroscience
DSC-3B-Biotech.-Lab	**Biotechnology**	**CO 01:** Finding the coagulation time, groups as well as Haemoglobin concentrations of blood **CO 02:** Study and counting of mammalian RBCs **CO 03:** Determination of TLC and DLC **CO 04:** Demonstration of action of enzymes in blood.
DSC-4B-Maths.	**Differential Equations**	**CO 01:** Solve the differential equations arising in the study of Physics and Chemistry. **CO 02:** Solve differential equations using Laplace transform. **CO 03:** Find the numerical solutions of the differential equations. **CO 04:** Find the numerical solutions of the differential equations.
DSC-4B-Maths.	**Differential Equations** **Lab Course**	**CO 01:** **T**o formulate the differential equations associated with certain experiments. **CO 02:** Interpret the solutions of the differential equations to get back some information of the original experiment. **CO 03:** To learn various computational methods to solve certain differential equations.

DSC-5B- Elect.	**Linear and Digital Integrated Circuits**	**CO 01:** Recognize the DC and AC characteristics of CO1: Recognize the DC and AC characteristics of operational amplifiers and design the linear and non linear applications oriented circuits using Op-Amp. CO 02: Represent and convert the numbers in powers of base. Reduce/simplify Boolean expressions using the knowledge of basic logic gates, Boolean algebra & techniques. CO 03: Analyze and design the simple combinational and sequential logic circuits. CO 04: Understand the working and methods of D-A and A-D Conversion.
DSC-5B- Elect.-Lab	**Linear and Digital Integrated Circuits - Lab Course**	**CO 01:** Design and construct the circuits using Op-Amp for basic linear and non-linear applications. **CO 02:** Design and test the different types of combinational and sequential logic circuits. Compose the application oriented digital circuits and test it.
AECC1-6B-Eng.	**English II**	**CO 01:** To get acquainted with skills of telecommunications. Learn how to use the telephone effectively, listening, questioning and speaking. To make students familiar with personal and formal spoken English used in a variety of situations while communicating on telephone. To learn literary delights of Johannes V. Jensen and Robert Frost. **CO 02:** To understand the importance of English for Special Purposes. ESP training will equip students with linguistic abilities in order to use them in a specific field of inquiry, occupation or workplace. To learn a speech on 'Putting Data to Effective Use: A Great Challenge' by Satish K. Tripathi. **CO 03:** To learn what is advertising, different media for advertisement, structure of the advertisement and its

		techniques, and effective use of language devices. To learn literary delights from W. H. Davies **CO 04:** To learn literary delights from Nathaniel Hawthorne Desika Vinayakam Pillai.
B. Sc. Part-II Semester-III (DSC – 7C to 12C)		
DSC-7C-Phy	**Thermal Physics and Statistical Mechanics**	**CO 01:** Comprehend the basic concepts and laws of thermodynamics and their physical interpretation. **CO 02:** Learn Maxwell's thermodynamic relations, the real gas equations, Van der Waal equation of state and Joule Thompson effect. **CO 03:** Understand basic aspects of kinetic theory of gases. **CO 04:** Learn fundamental aspects of theory of radiation and statistical mechanics.
DSC- 7C-Phys.-LAB	**Thermal Physics and Statistical Mechanics**	**CO 01:** Extend the skills to perform experiments related to black body and thermal Physics, viz., determinations of Stefan's constant, coefficient of thermal conductivity, temperature coefficient of resistance. **CO 02:** Understand thermo-emf of a thermocouple.
DSC-8C-Chem	**Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II**	**CO 01:** Systematic and coherent understanding of the fundamental concepts in Physical Chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry and all other related allied chemistry subjects. **CO 02:** Measures and understands the conductivity, EMF and pH of electrolytes and Nanomaterial in solution phase. **CO 03:** Explain the synthesis and preparations of carboxylic acids, amines, amino acids and their use in

		Nanoscience. **CO 04:** Understand the structures, configurations and properties of the biomolecules. Synthesis of amino acids and peptides. Identify the biological sources for the synthesis of Nanomaterials.
DSC- 8C-Chem.-LAB	**Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II**	**CO 01:** Qualitative and Quantitative analysis of organic and inorganic compounds. **CO 02:** Prepare organic and inorganic compounds. **CO 03:** Measures and identifies the concentrations of solution using a Conductometer and pH-meter.
DSC- 9C-Biotech	**General Microbiology, Biochemistry and Nanobiotechnology**	**CO 01:** Understanding the fundamentals of General Microbiology- History and Microbial evolution,taxonomy,classification, Prokaryotic and Eukaryotic cells with examples **CO 02:** This unit includes the cultivation and maintenance of microorganisms, nutritional requirements, microbial growth and factors affecting it, Bacterial reproduction and control measures of microorganisms **CO 03:** The unit deals with basic study of biomolecules including structure, classification and significance of carbohydrates, lipids, proteins, enzymes, nucleic acids, vitamins and minerals. **CO 04:** It is dedicated to the nanobiotechnology- including role of microbes in synthesis of nanomaterial, principle, mechanism and applications

DSC-9C-Biotech.-LAB	**General Microbiology, Biochemistry and Nanobiotechnology**	**CO 01:** Understand and perform the preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources and study of colony characteristics, bacterial staining, etc. **CO 02:** Separation of Amino acids by paper chromatography **CO 03:** Demonstration of Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study the relation between absorbance and % transmission. **CO 04:** Estimation of amino acid, proteins, carbohydrates by different methods
DSC-11C- Elect. Theory	**Electronic Instrumentation**	**CO 01:** Understanding physical and technical knowledge of sensors, actuators, and signal conditioning systems **CO 02:** Describe basic laws and phenomena that define the behavior of sensors and actuators **CO 03:** Apply knowledge about the working principles and architecture of a large number of sensors and their elements. **CO 04:** Analyze various approaches, procedures, and results related to sensors, actuators, and signal conditioning systems.
DSC-11C-Lab	**Electronic Instrumentation**	**CO 01:** Apply knowledge of electronic instrumentation **CO 02:** Design experiments in laboratory on real components **CO 03:** Evaluate the sensors, actuators, and signal conditioning systems **CO 04:** Interpret the acquired data and measured results

AECC- (2-12C)	**Environmental Science/Studies**	**CO 01:** Rendering about the environment's importance & our role for conservation and understanding the background of concept, structure and function of ecosystem **CO 02:** Learning pollution problems its sources and impacts and traditional mitigation techniques in air, water and soil pollution **CO 03:**· Understanding Natural Resources and Associated Problems for water , forest , food and mineral resources , also gain knowledge about non- renewable resources and their benefits **CO 04:**· learning about global and local Biodiversity its importance and way of conservation and understanding about Social Issues related to the environment with legal aspects to it.
B. Sc. Part-II semester-IV (DSC – 7D to 12D)		
DSC-7D-Phy.	**Waves and Optics**	**CO 01:** Understand the principle of superposition of waves. **CO 02:** Learn the basic concept of surface tension and viscosity of liquid and sound. **CO 03:** Explain the concepts of wave nature of light and interference. **CO 04:** Describe the polarization and diffraction of light.
DSC-7D-Phys.-LAB	**Waves and Optics**	**CO 01:** Understand various optical phenomena, principles, working and applications of optical instruments. **CO 02:** Analyze wave motion and its properties. **CO 03:** Broaden the expertise to perform experiments related to diffraction, interference and radiation. **CO 04:** Hands-on experience of using various optical instruments.

DSC-8C-Chem	**Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics**	**CO 01:** Systematic and fundamental understanding of the transition metals and their properties. Importance of metal and metal oxide in Nanoscience. **CO 02:** Explain the importance of collision theory in catalysis and Nanocatalysis on the basis of kinetic theory of gases. **CO 03:** Understanding and measuring the viscosity and surface tension of liquids, crystal lattice of solids. Synthesis and preparation of aromatic hydrocarbons, alkyl halides, etc. **CO 04:** Understand the Significance of the order of reactions and collision and activated complex theory for the qualitative treatment.
DSC-8D-Chem.-LAB	**Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics**	**CO 01:** Measures the density, viscosity and surface tension of various liquids. Identify the concentrations of solutions using potentiometer. **CO 02:** Solve and measure the order of reaction, rate constant and energy of activation for the chemical reactions. **CO 03:** Understand the quantitative analysis of the inorganic compounds by gravimetric analysis.
DSC-9D-Biotech.	**Immunology and Medical Nanotechnology**	**CO 01:** The unit comprises basics of Immunology terms and concepts- Immunity, Immune system, cells and organs of the immune system, Antigen, Antibody, etc. **CO 02:** It deals with T- lymphocytes and B-lymphocytes immune response, gene rearrangements, Antibody affinity maturation class switching MHC complexes, Autoimmune & Immunodeficiency diseases, Vaccines, Vaccination, ELIZA, RIA, etc. **CO 03:** It displays different techniques and applications of nanoparticles, nanochips, nanobiosensor, nanoprobes, etc in nanodiagnostics of different diseases.

		CO 04: It exhibits understanding regarding applications of nano in biology. Approach to developing nanomedicines, nano-devices for drug delivery and theranostics, applications and challenges of nanomedicine.
DSC-9D-Biotech.-LAB	**Immunology and Medical Nanotechnology**	**CO 01:** Demonstrating immunodiffusion assays **CO 02:** Understanding and performing double diffusion, **CO 03:** Demonstration of ELISA **CO 04:** Understanding and performing radial immunodiffusion assay
DSC-11D- Elect.: Theory	**Analytical Instrumentation**	**CO 01:** Knowledge of operating principles and techniques of analytical instrumentation **CO 02:** Understanding how light interacts with matter and how it can be used for quantitative analysis **CO 03:** Apply problem-solving skills to various scientific domains **CO 04:** Analyze the basic components of spectroscopic instrumentation.
DSC-11D-Lab.:	**Analytical Instrumentation Lab**	**CO 01:** Knowledge and understanding of basic concepts of instrumentation, data acquisition, and data processing **CO 02:** Apply a working knowledge of UV-Vis spectroscopy, IR spectroscopy, RAMAN spectroscopy, XRD, SEM, FESEM, and AFM **CO 03:** Evaluate the acquired data and measured results **CO 04:** Provide practical experience in selected instrumental methods of analysis

AECC- (2-12D)	**Environmental Science/Studies**	**CO 05:**· learning about Social Issues and the Environment connection and it's mitigation **CO 06:**· Knowledge of sustainable technique and eco friendly solutions for environmental problems. **CO 07:**· Understanding global Environmental issues their impact and possible solutions **CO 08:**· Provide practical and field experience in Water, Air and Soil Quality monitoring, social and flora fauna survey and possible solutions through Project.
B. Sc. Part-III semester-V (DSE – 1E to 6E)		
DSE-1E-Phy	**Classical Mechanics, Classical Electrodynamics and Quantum Mechanics**	**CO 01:** Understand fundamentals laws and principles of classical mechanics and their applications in appropriate physical problems. **CO 02:** Apply basic techniques of calculus of variation and Charged Particles Dynamics**.** **CO 03:** Understand the basics of matter waves and Schrodinger's wave equation with the help of different concepts and experiments. **CO 04:** Understand the definition of different operators and Schrodinger's equation to solve problems of Quantum Mechanics.
DSE-1E-Phy.-Lab	**Physics Lab. 5**	**CO 01:** Understand the concept of resonance. **CO 02:** Calculate and draw the diffraction pattern, aberration, cardinal points of the optics. **CO 03:** Determine the value of Plank's constant.

DSE-3E Biotech.-Lab. :	**Biotechnology Lab. 5**	**CO 01:** Performing the basic qualitative test for enzyme activity **CO 02:** Demonstrating the the effect of various physical parameters on enzyme activity **CO 03:** Determining the kinetic parameters for enzyme activity **CO 04:** Introducing the basic, hands on training of bioinformatics tools
DSE-3E-Biotech.:	**Fundamentals of Enzymology and Nanoenzymology**	**CO 01:** Understanding the fundamentals of enzymes as biocatalysts, their importance in living system, their industrial applications **CO 02:** Understanding the techniques of enzymes purification and characterization **CO 03:** Understanding the kinetics of enzymes catalyzed reaction and its application **CO 04:** **C**oncept of nanoenzymes, understanding the activity of nanomaterials as enzymes and their applications
SEC1-6E	**Environmental Nanotech**	**CO 01:** Learn the environmental pollution problems and traditional mitigation techniques in water and soil pollution, as well as present and future nanotechnology techniques for solving these problems in a better way with legal aspects. **CO 02:**· Understanding the background of traditional Methods of detecting, Environmental Contaminants in air, nanotoxicology and possible control measures by using sustainable nanotechnology. **CO 03:** Understanding the basic concepts of Chemical and Biological Sensors,Detector and energy and learning the Simple traditional Nanotechnology. **CO 04:** Knowledge of green and eco-friendly nanotechnology to solve environmental problems.

B. Sc. Part-III Semester-VI (DSE – 1F to 6F)		
DSE-1F-Phy	**Solid State Physics and Nuclear and Particle Physics**	**CO 01:** Understand fundamentals of crystal structure of the material with the help of X-ray diffraction. **CO 02:** Understand the magnetic properties of matter and superconductors. **CO 03:** Understand the concept of band theory of solids. **CO 04:** Understand the general properties of the Nuclei and Nuclear model and explain the concept of particle accelerators.
DSE-1F-Phy.-Lab	**Physics Lab. 6**	**CO 01:** Calculate the lattice constant using XRD pattern, the bandgap of the material, e/m of the electron. **CO 02:** Draw I-V characteristics and polar graphs using a solar cell. **CO 03:** Understand the use of ballistic galvanometer.
DSE-2F-Chem	**Physical Chemistry (Elements of Quantum Mechanics, Chemical Kinetics, Thermodynamics, Chemistry of Solutions, Solid State Chemistry, Electrochemistry, Spectroscopy and Photochemistry)**	**CO 01:** Understanding of elementary quantum mechanics, thermodynamics and chemical kinetics principles. **CO 02:** Knowledge about Solid State Chemistry, Solutions, Phase Equilibria and Distribution Law. **CO 03:** Increased Knowledge about Electrochemistry, Spectroscopy and Photochemistry. **CO 04:** Application of basic and applied physical chemistry concepts to qualitative and quantitative analysis.

DSE-2F-Chem.	**Lab: Chemistry Lab. 6**	**CO 01:** Knowledge about determination of partition coefficient, viscosity of chemical substances. **CO 01:** Knowledge about determination of solubility and adsorption phenomenon of chemical substances. **CO 02:** Increased understanding about chemical kinetics of simple reactions. **CO 04:** Application of instrumental techniques such as Potentiometry, colorimetry, refractometry, pH metry for quantitative analysis.
DSE-3F-Biotech	**Molecular biology and genetic engineering**	**CO 01:** Understanding the fundamentals of central dogma of molecular biology and mechanisms **CO 02:** Understanding the mechanisms of DNA replication, transcription and translation **CO 03:** Understanding of Nucleic Acids and Allied Techniques **CO 04:** Understanding the possible application of nanomaterials for nucleic acid delivery
DSE-3FBiotech.-Lab.:	**Biotechnology Lab. 6**	**CO 01:** Demonstration and learning the techniques of nucleic acid purification, analysis and amplification **CO 02:** Demonstration and learning the techniques of protein purification and analysis **CO 03:** Learning the techniques of isolation of plamids and preparation of competent cells **CO 04:** Learning the protein separation of techniques by SDS and Native PAGE

DSE-4E - Phy & Chem. at Nanoscale	**Physics and Chemistry at Nanoscale**	**CO 01:** Introduction to the fundamental principles of nanotechnology, the history of nanoscience and technology followed by recent nanotechnology based products. **CO 02:** Comprehensive understanding of state-of-the-art nano-fabrication methods with Top down and Bottom up approach. **CO 03:** Detailed knowledge of nanoscience and nanotechnology, including natural and man made nanomaterials. **CO 04:** In-depth understanding of virtualization techniques like STM, AFM etc.
DSE-4E - Phy & Chem. at Nanoscale	**Laboratory course IV**	**CO 01:** Synthesis of nanomaterials using colloidal and sol-gel method. **CO 02:** Synthesis of thin films using electrodeposition and hydrothermal technique.
DSE-4F- Phy. & Chem. Prop. of Nanamat.	**Physical and Chemical Properties of Nanomaterials**	**CO 01:** Explore the new phenomenon originated at nanoscales like, LSPR, Quantum tunnelling, superparamagnetic state of materials, Single electron field effect transistors, GMR effect etc. **CO 02:** Have a working knowledge of how the properties of materials changes once entered into the nanoscale, including theory and experiment. **CO 03:** Evaluate and analyse the structural, morphological, optical and magnetic properties of bulk nanostructured materials and nanocomposites. **CO 04:** Apply in depth understanding of the Size and Shape dependent properties of nanomaterials for practical applications.

DSE-4F- Phy. & Chem. Prop. of Nanamat.	**Laboratory course IV**	**CO 01:** Calculation of crystallite size and band gap of nanomaterials having difference size. **CO 02:** Calculation of Size dependent magnetic parameters using M-H hysteresis loops **LO 03:** Size and Shape dependent calculation of surface area to volume ratio using TEM images.
M. Sc. Part-I semester-VII (CP – 1to 6)		
SNST – 701 T	**Semiconductor Physics**	**CO 01:** Identify and describe the fundamental properties of semiconductors materials and Physics behind them through solving problems. **CO 02:** Apply the quantitative and qualitative understanding of semiconductors for designing the electronic devices under various fields. **CO 03:** Apply in depth understanding of the basic physics behind the semiconducting P-N junctions and their applications. **CO 04:** Understand the basic physics behind implementation of various types of contacts and heterojunctions for designing and fabrication of electronic devices.
SNST – 711 P	**Semiconductor Physics** **Laboratory Course- I**	**CO 01:** Identify and understand the concepts of Semiconductor materials. **CO 02:** Design, apply and analyse the physics of semiconducting materials with calculations.
SNST – 702 T	**Carbonaceous Materials**	**CO 01:** Understand the basic structures and applications of carbonaceous materials mainly Graphene and Carbon nanotubes. **CO 02:** Apply the structure property relationship concept to understand the applications of Graphene and Carbon

		nanotubes . **CO 03:** In depth understanding of synthesis of Graphene and Carbon nanotubes **CO 04:** Understanding of applications of Graphene and Carbon nanotubes in important technological fields
SNST – 712 P Laboratory Course-II	**Carbonaceous Materials**	**CO 01:** Interpretation of IR spectra of carbonaceous materials such as Graphene and Carbon nanotubes. **CO 02:** Interpretation of Raman spectra of carbonaceous materials such as Graphene and Carbon nanotubes. **CO 03:** Modeling simulation of Graphene and Carbon nanotubes, their structures and related applications. **CO 04:** Synthesis of functionalized Graphene and functionalized Carbon nanotubes and their characterization.
SNST–703 T	**Functional Nanomaterials**	**CO 01:** Apply the theory to analyse growth mechanism of semiconductor quantum dots, their synthesis approaches and application for societal issues such as bioimaging **CO 02:** Thorough learning of synthesis techniques of functional one-dimensional nanomaterials, nanotubes and nanowires, their physicochemical properties, and effective use in addressing environmental and societal problems such as water pollution, energy crisis, etc. **CO 03:** In depth study of electrospinning synthesis of nanofibers for biomedical issues **CO 04:** Understanding of synthesis and properties of metal organic frameworks, and their utilisation for mitigating environmental issues **CO 05:** Comprehensive learning of synthesis approaches and properties of polymers and polymer composites, and their use in addressing environmental and societal

		problems
SNST–713 P	**Functional Nanomaterials & Nanocoatings**	**CO 01:** Apply the theory to synthesise semiconductor quantum dots, nanofibers, nanotubes **CO 02:** Identify the physicochemical properties of synthesised nanomaterials. **CO 03:** Application, understanding electrochemical process for MnO_2 electrodeposition. **CO 04:** Application, understanding electrochemical process for anodization of TiO_2.
SNST-704T	**Nanocoatings and Applications**	**CO 01:** Understanding fundamentals of nanocoatings, impact on society, critical parameters controlling nanocoating formulations. Applications and future Prospects. Define and classify anti-fingerprint and anti-corrosion nanocoatings. Analyze nanomaterials used for such applications. **CO 02:** Define and classify self-cleaning, anti-fouling, easy to clean, abrassion and wear resistant nanocoatings. Application of sol gel coating techniques to obtain such properties and anti-corrosion nanocoatings. Analyze nanomaterials used for such applications. **CO 03:** Define and classify anti-icing, thermal barrier ,flame retardant, anti-microbial nanocoatings. Application of sol gel coating techniques to obtain such properties and anti-corrosion nanocoatings. Analyze nanomaterials used for such applications. **CO 04:** Define and classify anti-icing, thermal barrier ,flame retardant, UV-resistant, conductive and

		superhydrophobic nanocoatings. Application of sol gel coating techniques to obtain such properties and anti-corrosion nanocoatings. Analyze nanomaterials used for such applications.
M. Sc. Part-I semester-VIII (CP-7-12)		
SNST – 801 T	**Solid-state electronic devices**	**CO 01:** Identify, describe and analyse the transistors and microwave devices **CO 02:** Identify, describe and analyse the photonic devices **CO 03:** Identify, describe and analyse the Nano-piezotronics and nano-generators devices **CO 04:** Identify, describe and analyse the Micro-Electro-Mechanical-Systems (MEMS) devices
SNST – 811P	**Solid-state electronic devices** **Laboratory Course – I**	**CO 01:** Analyse, evaluate the various electronic transistors, photonic, and microwave devices. **CO 02:** Identify, analyse and evaluate the various electronic transistors and microwave devices
SNST–802 T	**Energy Conversion and Storage Devices**	**CO 01:** Analyse the various COses P-N junction solar cell, and design for high output energy **CO 02:** Compare various types of energy conversion devices alternative to P-N junction solar cells for mitigating energy crisis **CO 03:** In depth study of battery as an electrochemical energy storage device, chemical reactions involved in storage mechanism, governing parameters, their types and day-to-day life applications

		CO 04: Comprehensive understanding of supercapacitor as an electrochemical energy storage device, energetics and kinetic theory involved, their types, useful metal oxide materials for supercapacitor device
SNST–812 P	**Energy Conversion and Storage Devices**	**CO 01:** Apply the theory to synthesise semiconductor thin films **CO 02:** Fabrication and performance investigation of devices such as supercapacitor, solar cells, etc.
SNST–803T	**Nanocatalysis**	**CO 01:** Definition, classification of catalysis and nanocatalysis. Principles of isotherm and their significance in nanocatalysis mechanism. Understanding of chemical kinetics and their temperature dependence. Reaction mechanisms. **CO 02:** Difference between bulk catalytic activity and nanocatalytic activity. Formulate Langmuir-Hinshelwood mechanism, mass transportation, catalytic efficiency, turnover frequency and inhibition. Application of metal nano structures as nanocatalyst for organic reactions and environmental remediation. **CO 03:** Understanding of photochemistry, photocatalysis and electrocatalysis on the basis of fundamental principles and laws. Application of semiconductor as photocatalyst and their mechanism. Advantage of good photocatalysis and classifications. **CO 04:** Designing of photocatalyst for application in self-cleaning, purification of water, air. Photoreduction of CO_2. Analysis of water purification and fabrication. Industrial designing of photocatalyst and its future prospects.

SNST–813P	**LaboratoryCourse-III**	**CO 01:** Develop experimental data through theoretical knowledge of photocatalyst and data analysis. **CO 02:** Experiments with adsorption isotherms and data analysis. **CO 03:** Demonstrate homogeneous catalysis, evaluate, data collection and data analysis. **CO 04:** Plan real time monitoring of nanocatalysis and data analysis by understanding fundamental principles.
SNST- 804-T	**Nanomagnetism and Spintronics**	**CO 01:** Understand the fundamentals of magnetism and Physics behind Nanomagnetism through solving problems. **CO 02:** Understand and apply the basics of spin electronics and details of Giant magnetoresistance (GMR). **CO 03:** Understand, apply and analyse the concept of magnetic data storage in depth with their various applications. **CO 04:** Understand the basic physics and biology behind the nanobiomagnetism and their implementation in design and fabrication of biotherapeutic devices.
SNST-813-P	**Nanomagnetism and Spintronics** **Lab Course III**	**CO 01:** Analyse, evaluate and create the various electronic and magnetic devices. **CO 02:** Identify, analyse and evaluate the various biomagnetic and nanomagnetic devices

M. Sc. Part-II semester-IX (CP – 13 & 14)		
Course code	Dissertation Phase-I	CO 01: Identify area of interest in the subject Nanoscience and Nanotechnology CO 02: Carry out the literature survey for their identified area of research problem CO 03:Define the objectives of the proposed research problem
Course code	Dissertation Phase-I	CO 01: Formulate the plan of the research outcomes CO 02: Carry out and execute the experimental research objectives CO 03: Collection and processing of the experimental data
M. Sc. Part-II semester-X (CP-15 & 16)		
Course code	Dissertation Phase-II	CO 01: Investigate and analyse the identified data CO 02: Evaluation of the analyzed experimental data
Course code	Dissertation Phase-II	CO 01: Summarize and conclude the outcomes of the research problem CCO 02: Create manuscript from the outcomes of the research problem as per the SCI index journals. CO 03: Communication of scientific data by authorization of research articles / patents