M. Sc. Nanoscience and Technology

Syllabus

2025 – 26

University Department

Programme Code
NSTA

(A State University, Accredited with A^{++} Grade by NAAC,
Ranked 8th Among State Public Universities by MoE-NIRF)

Program Educational Objectives (PEOs)	
The M.Sc. Nanoscience and Technology program aims to equip graduates with the knowledge, skills, and attributes necessary for successful careers and advanced studies. Within five to seven years of graduation, alumni are expected to:	
PEO1	Excel in academics, research, and innovation across diverse domains of Nanoscience and Nanotechnology through advanced postgraduate training.
PEO2	Possess a strong interdisciplinary foundation in core sciences—Physics, Chemistry, and Biology integrated with principles of Nanoscience and Nanotechnology.
PEO3	Demonstrate comprehensive knowledge and technical expertise in the synthesis, fabrication, and characterization of novel nanomaterials for varied applications.
PEO4	Apply theoretical understanding and practical skills to analyze, design, and develop innovative solutions for real-world scientific and technological challenges.
PEO5	Uphold professional ethics, exhibit effective communication and teamwork, and engage in interdisciplinary approaches to address societal needs in areas such as energy, environment, and healthcare.
PEO6	Thrive in an academic and professional culture that promotes excellence, leadership, ethical conduct, and a commitment to lifelong learning.
PEO7	Collaborate across disciplines in academia, industry, and society, and actively contribute to scientific progress and the economic development of the nation.

Program Specific Outcomes (PSOs)	
Upon successful completion of the M.Sc. Nanoscience and Technology program, graduates will be able to:	
PSO1	Apply fundamental principles of Physics, Chemistry, and Engineering to understand and interpret phenomena at the nanoscale.
PSO2	Utilize mathematical modeling and analytical techniques to describe, simulate, and analyze nanosystems.
PSO3	Employ quantum mechanical concepts to explain the behavior of particles and processes at the nanometric scale.
PSO4	Integrate interdisciplinary knowledge and computational tools to model and understand complex natural and engineered nanosystems.
PSO5	Analyze nanoscale systems within the framework of quantum mechanics to explore their physical, chemical, and electronic properties.
PSO6	Gain specialized knowledge across various domains of nanotechnology, including materials science, nanoelectronics, nanomedicine, and energy nanomaterials.
PSO7	Demonstrate proficiency in advanced experimental and theoretical methodologies for the characterization and analysis of nanomaterials and nanodevices.
PSO8	Engage in research and continuous learning to stay current with advancements in nanoscience and adapt to evolving scientific and technological landscapes.
PSO9	Exhibit adaptive thinking and a commitment to sustainability by considering the environmental and societal impacts of nanotechnology.
PSO10	Demonstrate a clear understanding of professional ethics, responsibilities, and the importance of integrity in scientific research and technological development.

Program Outcomes (POs)	
Upon successful completion of the M.Sc. Nanoscience and Technology program, graduates will be able to:	
PO1	Demonstrate comprehensive knowledge in Physics, Chemistry, Biotechnology, and the fundamentals of nanoscale science and technology, with an emphasis on their multifunctional applications.
PO2	Synthesize and characterize a wide range of materials, particularly nanomaterials, using advanced techniques and instrumentation.
PO3	Apply principles of lithography and nanofabrication for designing and developing nanoscale devices and structures.
PO4	Exhibit expertise in the processing and application of nanomaterials, including MEMS and Bio-MEMS, tailored to specific requirements.
PO5	Work effectively on multidisciplinary tasks integrating material science, physics, chemistry, and nanobiotechnology, particularly in laboratory and research environments.
PO6	Operate and apply synthesis, processing, and imaging tools to investigate, analyze, and interpret nanostructured materials and systems.
PO7	Apply domain-specific knowledge to address socially relevant challenges in areas such as energy, environment, and healthcare through specialized electives and project work.
PO8	Evaluate the societal and environmental impacts of nanomaterials, with an understanding of their implications for health, safety, and ecosystems.
PO9	Independently plan, design, and execute innovative research projects and product development activities, fostering creativity and entrepreneurship.
PO10	Cultivate a lifelong learning attitude with the confidence and ability for continuous self-education and professional development.

BHARATHIAR UNIVERSITY:: COIMBATORE 641 046
M. Sc. Nanoscience and Technology Curriculum (University Department)
(For the students admitted during the academic year 2025 – 26 onwards)

Course Code	Title of the Course		Credits	Hours		Maximum Marks		
				Theory	Practical	CIA	ESE	Total
FIRST SEMESTER								
13A	Core-1	Physics of Nanomaterials	4	4	-	25	75	100
13B	Core-2	Chemistry of Nanomaterials	4	4	-	25	75	100
13C	Core-3	Biology for Nanotehnology	4	4	-	25	75	100
13D	Core-4	Properties of Materials	4	4	-	25	75	100
1EA	E1ective-1	Computational Methods	4	4	-	25	75	100
1EB		Electronic Devices						
13P	Practical-1	Practical-I	4	-	6	25	75	100
1GS132	Supportive	Introduction to Nanoscience and Technology	2	2	-	12	38	50
1VA*	Val. Added	Value Added Course -1	4	2	-	100	-	100
		Total	26	22	6			650
SECOND SEMESTER								
23A	Core-5	Synthesis of Nanomaterials	4	4	-	25	75	100
23B	Core-6	Characterization of Nanomaterials	4	4	-	25	75	100
23C	Core-7	Micro and Nanofabrications	4	4	-	25	75	100
23D	Core-8	Genetics and Nanobiotechnology	4	4	-	25	75	100
2EA	E1ective-2	Nanoelectronics and Nanophotonics	4	4	-	25	75	100
2EB		Nanomagnetic Materials and Devices						
23P	Practical-2	Practical-II	4	-	6	25	75	100
2GS134	Supportive	Applications of Nanotechnology	2	2	-	12	38	50
2JA*	Cert. Cour.	Certificate Course – 1	4	2	-	100	-	100
		Total	26	22	6			650
THIRD SEMESTER								
33A	Core-9	Nanotechnology in Health Science	4	4	-	25	75	100
33B	Core-10	Nanotechnology in Energy Conversion and Storage Devices	4	4	-	25	75	100
33C	Core-11	Nanosensors and IoT Based Sensors	4	4	-	25	75	100
33D	Core-12	Advances in Nanobiotechnology	4	4	-	25	75	100
3EA	E1ective-3	Environmental Sustainability of Nanomaterials	4	4	-	25	75	100
3EB		Societal Impacts of Nanotechnology						
37V	Mini Project	Summer Internship	2	-	-	50	--	50
33P	Practical-2	Practical-III	4		6	25	75	100
1GS132	Supportive	Introduction to Nanoscience and Technology	2	2	-	12	38	50
3VA*	Val. Added	Value Added Course -2	4	2	-	100	-	100
		Total	28	22	6			700
FOURTH SEMESTER								
43A	Core-13	IPR, Biosafety and Research Ethics	2	-	-	12	38	50
47V	Project	Project and Viva-Voce	8	-	-	50	150	200
4NS*	Swayam	Professional Certification Course	2	-		-	-	-
4JA*	Cert. Cour.	Certificate Course – 2	4	2	-	100	-	100
		Total	10					250
		Grand Total	90					2250

***Co-Scholastic Courses**

For the purpose of computing the Cumulative Grade Point Average (CGPA) and determining the final ranking, only the credits earned under *Scholastic Courses* shall be taken into account. Nevertheless, the completion of all prescribed *Co-Scholastic Courses* is **mandatory** for the award of the degree. Non-compliance with this requirement shall render the candidate ineligible for the conferment of the degree, irrespective of scholastic performance.

First Semester

Course code	13A	PHYSICS OF NANOMATERIALS	L	T	P	C
Core			4	0	0	4
Pre-requisite		Basic knowledge of general physics and mathematics.	Syllabus Version		2025 - 2026	

Course Objectives:

The primary objectives of this course are to:

1. Understand the fundamental physical principles that govern the behavior of materials at the nanoscale.
2. Comprehend the foundational concepts of quantum mechanics applicable to small and confined systems.
3. Bridge macroscopic thermodynamics and microscopic statistical mechanics using appropriate mathematical tools.
4. Develop a foundational understanding of the structure–property–processing–performance relationships in materials.

Expected Course Outcomes:

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

1	Explain the physical principles underlying nanoscale systems.	K2
2	Apply quantum mechanical concepts to analyze multidimensional nanosystems.	K3
3	Interpret the principles of statistical mechanics, thermodynamics, and chemical kinetics.	K2
4	Analyze and evaluate crystal structures and transformations at the nanoscale.	K2,K5
5	Demonstrate a comprehensive understanding of the fundamental principles in materials science.	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Quantum Mechanics - I	12 hours

Limitations of classical theory - classical and quantum theory of specific heat of solids - wave and particle - Uncertainty principle - Time dependent Schrodinger equation - Time independent Schrodinger equation -Dirac's Notation - Equations of Motion – Schrodinger – Heisenberg - interaction representation.

Unit:2	Quantum Mechanics - II	12 hours

Particle in a box – Infinite potential well - Finite potential well - Quantum mechanical tunnelling - Schrodinger equation for hydrogen atom – Many electron atoms – Chemical bonding – Born Oppenheimer Approximation – Molecular Orbital Theory – Valence bond method.

Unit:3	Statistical Mechanics and Chemical Kinetics	12 hours

Statistical distributions – Rayleigh Jeans law formula and Planck radiation formula for blackbody radiation – Macroscopic states – Microscopic states – Ensembles – Statistical Interpretation of thermodynamic variables – Equipartition Theorem – Chemical equilibrium – Condition for chemical equilibrium – law of mass action – Ionization formula – Dissociation of molecules.

Unit:4	Solid State Physics - I	12 hours

Crystal Structure – Classification of Crystals – Unit Cell – Bravais Lattices – Symmetry in Crystals – Crystal Directions and Crystal Planes – Packing Factor – SCC -BCC -FCC – HCP – Diamond – Crystal Structure Determination – Bragg's Law – Debye Scherrer Method – Determination of lattice parameters from the powder diffraction method – Laue Method-Bragg's

Monochromator-Bragg's Diffractometer-Reciprocal Lattice-Chemical Bonding in Solids-Point Defects-Line Defects-Problems.		
Unit:5	**Solid State Physics – II**	**12 hours**
Free electron theory of metals – Quantum theory of free electrons – Electrons in 3D potential box – Fermi Energy and Density of Free Electron States – Band Theory of Solids – Distinction between metal, semiconductor and insulator based on the band theory – Bloch's Theorem - - Kronig-Penny model for the periodic potential – Brillouin zones – Reduced E versus k curve-Problems		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study	
1	Quantum Mechanics, G. Aruldhas, Prentice Hall of India, (2010).
2	Fundamentals of Statistical Mechanics by B. B. Laud, New Age International Publishers (2020)
3	Materials Science by G Rangarajan and M S Vijaya, Mc Graw Hill Education (2014).
Book (s) for Reference	
1	A Text Book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, Tata McGraw Hill, (2010).
2	Introduction to Solid State Physics, Charles Kittel, 8th Edition, Wiley (2012).
3	Solid State Physics: Structure and Properties of Materials, A.M.Wahab, 2nd Edition, Narosa Publishing house, New Delhi, India, (2007).
4	Solid State Physics, S.O.Pillai, 4th Edition, New Age International Publishers, New Delhi, (2001).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/115/106/115106066/
2	https://nptel.ac.in/courses/122/106/122106034/
3	https://nptel.ac.in/courses/112/105/112105123/
4	https://nptel.ac.in/courses/112/108/112108148/
5	https://nptel.ac.in/courses/115/105/115105099/
6	https://nptel.ac.in/courses/115/104/115104109/

Course Designed by	**Dr N. Ponpandian**	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	M	S	L	L	S	S	S	S
CO2	S	S	M	S	S	M	M	L	S	S
CO3	S	M	M	M	M	S	L	L	L	S
CO4	S	S	M	L	M	M	L	M	M	S
CO5	S	S	S	S	S	L	M	M	L	S
S	Strong		**M**	Medium			**L**	Low		

Course code	**13B**	**CHEMISTRY OF NANOMATERIALS**	**L**	**T**	**P**	**C**
Core			**4**	**0**	**0**	**4**

Pre-requisite	Should have studied Chemistry/Allied Chemistry/Applied Chemistry as a major subject during graduate programme.	Syllabus Version	2025 - 2026

Course Objectives:

1. Understand the fundamental concepts of atomic and molecular structure.
2. Gain familiarity with essential concepts in general, inorganic, organic, and physical chemistry.
3. Establish a strong foundation in the inorganic chemistry of materials for research and development.
4. Enhance understanding of polymer structures and polymer-based composites.
5. Acquire fundamental knowledge of reaction kinetics and surface chemistry relevant to nanoscience.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Recall the fundamental structure of atoms and molecules.	K1
2	Understand the aromaticity and photochemistry of organic molecules.	K2
3	Apply d- and f-block chemistry to synthesize metal chalcogenides.	K3
4	Utilize polymer composites in various nanotechnology applications.	K3
5	Evaluate suitable organic and inorganic materials for solar energy nanomaterial design.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Chemical Bonds	12 hours

The structural theory of organic chemistry - chemical bonds - the octet rule - writing Lewis structures - exceptions to the octet rule - formula charge – resonance - energy changes - quantum mechanics - atomic and molecular orbitals - The structure of methane sp^3 - The structure of borane sp^2 - The structure of beryllium hydride sp hybridization - Molecular geometry: valence shell electron pair repulsion (VSEPR) theory - Polar covalent - polar and non polar molecules - Representations of organic compounds structural formulas.

Unit:2	Chemical Kinetics	12 hours

Absorption and Adsorption: Mechanism and types - Freundlich and Langmuir adsorption isotherms - multilayer adsorption and BET isotherm (no derivation required) and Applications, factors affecting adsorption of gases on solids and liquids.

Catalysis: Homogenous and heterogenous (Single reactant) - activity and selectivity - enzyme catalysis.

Colloids: Classification, preparation and purification - Colloidal state distinction between true solutions - colloids and suspension = lyophilic - lyophobic multi-molecular - macromolecular and associated colloids - properties and application of colloids - Brownian movement - Coagulation and Schultz-Hardy rule - Zeta potential and Stern double layer (qualitative idea) - Tyndall effect-, and Micelle formation.

Emulsion: Types and properties of emulsions-Emulsifier / Emulsifying agent- Theory of Emulsification-Applications and Uses of Emulsion.

Unit:3	Basics of Photochemistry	12 hours

Theory of light absorption-electronic excitation-properties & energies of excited states-Jablonski diagram-photo physical processes-fluorescence and phosphorescene-excimers

and exciplexes-intersystem crossing-energy transfer-geometry of excited states-quantum efficiency.Photochemical reactions of ketones – Norrish Type I, Norrish Type II – Paterno – Buchi reaction, Pericyclic Reactions – Characteristics – Electrocyclic reactions of 1, 3-dienes and 1, 3, 5-trienes.[2+2] and [4+2]cycloadditions. Sigmatropic reactions – [1, 3], [1, 5] and [3, 3] Sigmatropic shifts.

Unit:4	**Transition and Inner Transition Elements**	**12 hours**

Definition and electronic configurations of transition element - General characteristics of transition elements - comparison of first transition series with second and third series elements. Position of lanthanides and actinides in the periodic tables - general characteristics of both series and their comparisons. Basic concepts of coordination compounds- ligands (mono, di, and poly dentate ligand) - chelation - coordination numbers and Nomenclature of coordination compounds. Nature of metal ligand bonding in complex- study by valence bond theory and crystal field theory.

Unit:5	**Chemistry of Polymers**	**12 hours**

Introduction and review of Polymer - Properties of polymers - Polymer additives- plasticizers- fillers and reinforcement- Polymer blends- toughen plastics and phase separated blends - Polymer composites - mechanical properties - Introduction to polymer nanocomposites - Basic materials for polymer nanocomposite - Characterization of polymer nanocomposites - Properties of polymer nanocomposites - Thermoplastic nanocomposites - Thermoset Nanocomposites.

Unit:6	**Contemporary Issues**	**2 hours**

Expert lectures, online seminars – webinars

	Total Lecture hours	**62 hours**

Book (s) for Study

1	Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder, 12th Edition, John Wiley & Sons, New York, 2017.
2	Selected Topics in Inorganic Chemistry, Malik, Wahid U, Tuli G.D, Madan R.D. S. Chand Limited, 2009.
3	Fundamentals of Molecular Spectroscopy, C. N. Banwell, 5thEdition, McGraw Hill Education; 2019.
4	Polymer Science, V.R.Gowariker, N.V. Viswanathan, and Jayadev Sreedhar, New Age International Publishers, 2015.
5	Physical Chemistry, Peter Atkins, Julio de Paula, OUP Oxford, 2010.

Book (s) for Reference

1	Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Michael B. Smith, March's 8th Edition, Wiley, 2019.
2	Advanced Inorganic chemistry, F. A. Cotton, G. Wilkinson, C. A. Murilo, M. Bochmann, 6th Edition, Wiley, 2016.
3	Polymer Matrix Composites and Technology, Ru-Min Wang, Shui-Rong Zheng Yujun Zheng, 1st Edition, Woodhead Publishing, 2011.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.youtube.com/watch?v=p_BMWRaL62w
2	https://nptel.ac.in/courses/104/103/104103071/

3	http://nptel.iitm.ac.in
4	https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-cy03/

Course Designed By	**Dr P. Sakthivel**	e-mail	sakthivel.p@buc.edu.in

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	L	M	S	M	M	L	S	M
CO2	S	S	L	M	S	L	M	L	S	S
CO3	S	S	L	S	M	L	M	L	M	M
CO4	M	S	S	S	S	M	M	M	M	M
CO5	S	S	L	S	S	M	S	M	M	S
S	Strong		**M**	Medium		**L**	Low			

Course code	13C	BIOLOGY FOR NANOTECHNOLOGY	L	T	P	C
Core			4	0	0	4
Prerequisite		Basic knowledge on Biology or Life Sciences	Syllabus Version		2025 - 2026	

Course Objectives:

1. Explore the fundamental cell science and its growth with respect to prokaryotes and eukaryotes.
2. Know the basic biomolecules and its role in energy generation process.
3. Decipher knowledge on natural defense mechanisms and the techniques involved.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Remember the elemental concepts behind the cell structure and function	K1
2	Understand the naturally existing bio nanostructures and its assembling process	K2
3	Analyze the ATP generation process via different metabolic pathways	K4
4	Understand the principles of immune mechanisms to combat with non-self-components in the process of self-protection	K2
5	Analyze the interactions of antigen and antibody by immuno techniques	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Basics of Biology	12 hours

Structure and function of cells and organelles in Prokaryotes and Eukaryotes. – Nucleus - chromosome organization, structure and function of genetic material, Ribosomes, Endoplasmic reticulum, Golgi apparatus, Mitochondria, Lysosome and the Plasma membrane. Cell division and Cell Cycle - Mitosis - Meiosis.

Unit:2	Nanostructures in Biological Systems	12 hours

Structure, organization and functions of biomolecules; Carbohydrates – monosaccharides, oligosaccharides and polysaccharides, Proteins – amino acids and its classification, Lipids and Fatty acids – (saturated & unsaturated) and Nucleic acids – structure of DNA and RNA and its types.

Unit:3	Energy Metabolism	12 hours

Energy Metabolism - aerobic respiration and anaerobic respiration - Glycolysis (EMP Pathway), Tricarboxylic acid cycle (TCA), Electron Transport Chain, Substrate level phosphorylation and oxidative phosphorylation - ATP generation, Gluconeogenesis.

Unit:4	Immunology	12 hours

History of immunology, Innate and acquired immunity, Hematopoiesis, Cells and organs of the immune system. B and T- cell activation. Phagocytosis – Oxygen dependent and Oxygen independent killing. Antigen -Properties of antigen. Antibody- structure and types. Hybridoma Technology.

Unit:5	Immunological Reactions	12 hours

Antigen – Antibody Interactions, Complement Pathways – Classical and Alternate Pathways. Immuno-hematology, Blood group, Rh - incompatibilities. Immuno techniques – ELISA, RIA

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars– webinars Case study: Learn the process of Covid 19 vaccine production and understand the process cum mechanism of antibody production in human body against Coronavirus antigen. Report the importance of vaccination to combat the life threatening diseases.		
	Total Lecture hours	**62 hours**

Book (s) for Study	
1	A Text of Microbiology. Revised edition, Dubey RC and Maheswari DK S. Chand and Company Ltd., New Delhi, (2012)
2	Text Book of Microbiology, Ananthanarayan & Paniker's. 9th Edition, Universities Press, (2013).
3	Microbiology, Pelczar TR M J Chan ECS and Kreig N R Tata McGraw-Hill INC., New York, (2006).

Book (s) for Reference	
1	Microbiology, Prescott L M, J P Harley and D A Klein, Sixth edition, International edition, McGraw Hill, (2005).
2	Principles of Biochemistry (IE), Lehninger, David L.Nelson7th Edition, (2017).
3	Kuby Immunology - Richard A Goldsby, Thomas J Kindt. Barbara A Osborne, Fourth edition, W H Freeman and company, New York, (2000).
4	Immunology and Immuno technology, Chakravarthy A R, 1st Edition, Oxford University Press, India. ISBN: 9780195676884, (2006).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.elsevier.com/books/bacterial-physiology-and-metabolism/sokatch/978-1-4832-3137-2
2	https://www.frontiersin.org/journals/microbiology/sections/microbial-physiology-and-metabolism
3	https://www.ncbi.nlm.nih.gov/books/NBK10779/

Course Designed By	**Dr. P. Premasudha**	e-mail	premasudha@buc.edu.in

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	M	S	S	L	S	M	S
CO2	S	S	M	M	S	S	M	S	S	S
CO3	M	L	L	L	M	M	S	S	M	S
CO4	M	M	L	M	S	S	S	S	S	S
CO5	S	S	M	M	S	S	S	S	S	S

S	Strong		**M**	Medium		**L**	Low

Course code	**13D**	**PROPERTIES OF MATERIALS**	**L**	**T**	**P**	**C**
Core			**4**	**0**	**0**	**4**

Pre-requisite	Fundamental knowledge in physics	Syllabus Version	2025 -2026

Course Objectives:

1. Remember the concepts of atomic bonding, crystal structures, and crystalline nature as related to processing and performance of Chemical materials.
2. Understand the concepts of Imperfection of Crystals between structure-processing-properties for selection of existing materials and development of materials in the structures, and defects.
3. To know about the carrier concentrations in semiconductors, Fermi level concepts, conductivity and mobility concepts of semiconductors, Hall Effect nature - Hall coefficients for intrinsic and extrinsic semiconductors and Hall effect in Semiconductor materials
4. Understand the concepts of Mechanical and Optical properties for given material systems.
5. Understand the concepts of Magnetic properties for given material systems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	The student will demonstrate a basic remembering of the bonding, structures and nature of the materials.	K1
2	The student will demonstrate an understanding of the properties of materials and defects nature of the materials.	K2,K4
3	The student will demonstrate an understanding of approaches to concepts and mechanism of Materials..	K2,K3
4	The student will demonstrate an understanding of mechanical and optical properties of materials	K2,K4
5	The student will demonstrate an understanding of magnetic properties of materials.	K2,K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Structure of Materials	12 hours

Atomic bonding in solids-binding energy – interatomic spacing – variation in bonding characteristics – Single crystals – polycrystals– Non crystalline solids - Structure models for amorphous materials

Unit:2	Crystal Imperfections	12 hours

Imperfection in solids – Point and line defects-Frenkel defect –Schottky defect-Burger vectors-Vacancies – Interstitials – Dislocations - Generation of dislocation -Geometry of dislocation – Schmid´s law – Surface imperfection – Importance of defects – grain size distribution.

Unit:3	Band Models of Semiconductors	12 hours

Carrier concentrations in intrinsic, extrinsic semiconductors – organic semiconductors – Fermi level – variation of conductivity, mobility with temperature – law of mass action – Hall effect – Hall coefficients for intrinsic and extrinsic semiconductors – Hall effect devices. Application of diffusion in sintering, doping of semiconductors and surface hardening of metals – influence of size on band gap energy.

Unit:4	Mechanical, Optical and Thermal Properties	12 hours

Stress – Strain relation- Elastic and plastic deformation-Work hardening – Recrystallization and grain growth - Lattice vibrations, vibrations of simple lattice- phonons, Heat capacity, Thermal expansion -

Thermal conductivity- Optical properties – Light interaction with solids – Atomic, electronic interaction, applications of optical phenomena – refraction, reflection, absorption, transmission, luminescence.		
Unit:5	**Magnetic Properties**	**12 hours**
Dia and Para-magnetism–ferro, ferri and antiferromagnetism– magnetic hysteresis - Weiss molecular field theory -, Heisenberg's theory – magnetic anisotropy – domain theory - Exchange length – nanomagnetism – superparamagnetism - Electrical conduction in ionic ceramics and in polymers - Dielectric Behaviour – Ferroelectricity – Piezoelectricity.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study	
1	Materials Science and Engineering: An Introduction, W. D. Callister, John Wiley & Sons, (2007).
2	Functional Materials: A Chemist's Perspective, K. Vijayamohanan Pillai and Meera Parthasarathi, Orient Blackswan, (2013).
3	Introduction to Solid State Physics, C. Kittel, Wiley Eastern Ltd, (2005).
4	Materials Science and Engineering: A First Course, V. Raghavan, Prentice Hall, (2006).
Book (s) for Reference	
1	Solid State Physics, A.J. Dekker, Macmillan & Co, (2000).
2	Physics of Semiconductor Devices, Michael Shur, Prentice Hall of India, (1995).
3	Introduction to Nanotechnology, Charles P Poole Jr., and Frank J. Ownes, John Wiley Sons, Inc., (2003).
4	"Encyclopedia of Nanoscience &Nanotechnology", H. S. Nalwa (Ed.), American Scientific Publishers, California, (2004).
5	"Introduction to Solid State Physics", C. Kittel, Wiley Eastern Ltd., (2005).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/113/104/113104076/

Course Designed By	**Dr C. Viswanathan**	e-mail	viswanathan@buc.edu.in

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	L	L	M	L	L	L	L	S
CO2	S	S	M	M	M	L	L	L	M	S
CO3	S	S	M	M	S	L	L	L	S	S
CO4	S	S	S	M	M	L	M	M	M	M
CO5	S	S	S	M	M	L	M	M	M	M

S	Strong		**M**	Medium		**L**	Low

Course code	1EA	COMPUTATIONAL METHODS	L	T	P	C
Elective			4	0	0	4
Pre-requisite		Basic knowledge in Mathematics and Computer programing.	Syllabus Version		2025 -2026	

Course Objectives:

1. To learn about data processing and analysis
2. To gain knowledge on Numerical methods and scientific computing.
3. To understand the Python programming for computation and IOT applications

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Organize, Interpret and analyze data	K4
2	Understand the basic concepts involved in molecular dynamics simulation	K2
3	Understand the basics of data analysis.	K2
4	Have a knowledge in computational quantum chemistry	K3
5	Use Python programming for AI, Machine Learning and IOT applications	K3

K1– Remember; **K2**–Undestand; **K3**– Apply; **K4**– Analyze; **K5**– Evaluate; **K6**– Create

Unit:1	Biostatistics	12 hours

Definitions – Error – accuracy – precision –bias – Mean – standard deviation – relative standard deviation – coefficient of variation – confident limit of a measurement – F-test for precision - t-tests for bias — Analysis of variance (ANOVA).

Unit:2	Root Finding	12 hours

Bisection method, Regula-Falsi method, Iteration method and Newton-Raphson method

Unit:3	Numerical Interpolation and Differentiation	12 hours

Newton's forward, backward & general formula for interpolation, Newton's divided difference formula, Lagrange formula (SB).

Unit:4	Quantum Computation	12 hours

Computational quantum chemistry – Hartree-Fock method, Electron correlation, Introduction to density functional theory method, Basis set, Cartesian coordinates and internal coordinates, Geometry optimization, vibrational frequency calculation, potential energy surface, ionisation energy, electron affinity, stabilisation energy, Interaction energy and BSSE correction Frontier Molecular Orbitals (HOMO, LUMO), atomic charges,

Unit:5	Python	12 hours

Basis of programming, variables and data types, strings, manipulating data, operators, control statements: if, if-else, nested if-else, loops (for, while); nested loops, break and continue statements, file handling and directories, input and output statements, reading and writing of data in a file, opening and closing a file, Defining and calling a function , types of functions, function arguments, python modules, importing module, commonly used functions and modules, writing and executing python program for few simple problems.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars– webinars

	Total Lecture hours	**62 hours**
Book (s) for Study		
1	Elementary statistical methods, S.P. Gupta, Sultan Chand and sons publishers,(2014).	
2	Numerical methods in science and engineering, M.K. Venkataraman, The National Publishing Company –Madras,(1999).	
3	Numerical methods with programs in 'C', T. Veerarajan, T. Ramachandran, Tata McGraw Hill, New Delhi,(2006).	
4	Numerical Methods, E. Balagurusamy, Tata McGraw Hill Education, 1999.	
5	Mark Lutz, "Learning Python", O'Reilly Media, 5th Edition, (2016).	
Book (s) for Reference		
1	Python Programming: An Introduction to Computer Science, John M. Zelle	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	https://onlinecourses.nptel.ac.in/noc19_ee41/preview	
2	https://nptel.ac.in/courses/108/106/108106165/	
3	https://nptel.ac.in/courses/115/107/115107122/	
4	https://nptel.ac.in/courses/106/105/106105166/	
Course Designed By	**Dr R. T. Rajendrakumar**	e-mail rtrkumar@buc.edu.in

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	S	M	S	M	M	S	S
CO2	M	S	S	S	S	M	L	M	M	S
CO3	S	L	M	M	M	L	L	L	S	S
CO4	M	M	S	M	L	M	M	M	S	S
CO5	S	M	M	L	L	L	L	L	M	S
S	Strong		**M**	Medium		**L**	Low			

Course code	1EB	ELECTRONIC DEVICES	L	T	P	C
Elective			4	0	0	4
Pre-requisite		Fundamental knowledge in physics	Syllabus Version		2025 -2026	

Course Objectives:

1. To understand the fundamentals of number systems, digital logic levels, and the functionality of basic digital components.
2. To explain the operation and applications of digital electronic circuits.
3. To design, construct, and analyze various digital electronic circuits.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain the concepts of semiconductor physics.	K4
2	Describe the fundamental concepts and techniques in digital electronics.	K2
3	Apply the basic concepts to understand advanced electronic devices.	K3
4	Demonstrate knowledge in the fabrication of diodes and LEDs.	K3
5	Apply knowledge to develop nano- and molecular-scale electronic devices.	K4

K1– Remember; **K2**–Undestand; **K3**– Apply; **K4**– Analyze; **K5**– Evaluate; **K6**– Create

Unit:1	Semiconductor Physics	12 hours

Electrons and Holes in an Intrinsic Semiconductor – Donor and Acceptor Impurities – Charge Densities in a Semiconductor – The Hall Effect – Conducting Modulation – Generation and Recombination of Charges – Diffusion - - Continuity Equation – Injected Minority Carrier Charge – The Potential Variation within a Graded Semiconductor – Carrier Concentrations in an Intrinsic Semiconductor – Fermi Level in a Semiconductor having Impurities – Band Structure of Open Circuit p-n Junction.

Unit:2	Operational Amplifiers	12 hours

The ideal Op-Amp-inverting, non-inverting and differential amplifiers-CMRR; Op-Amp IC building blocks-emitter coupled differential amplifier, active load, level shifting and output stage; Op-Amp characteristics-open-loop input output characteristics, frequency response and slew rate; Op-Amp applications-adder, subtractor, integrator, differentiator, comparator, voltage-to-current converter, current-to-voltage converter and logarithmic amplifier.

Unit:3	Basic Devices	12 hours

Bipolar Junction Transistor (BJT) – Field Effect Transistor (FET) - Junction Field Effect Transistor (JFET), Metal Oxide Semiconductor Field Effect Transistor (MOSFET) and Metal Semiconductor Junction Field Effect Transistor (MESFET): Structure, Working, I-V Characteristic Studies and its Applications.

Unit:4	Advanced Devices	12 hours

Transfer Electron devices (Gunn Diode) – Principle, Working, I-V Characteristic Studies and Applications - PIN Diode: Structure, Working, - PIN Diode Parameters - PIN Diode as Switches - PIN Diode as Limiters - Photo Detectors – Photo Diode - Light Emitting Diode (LED) – Principle, Construction, Working and Characteristics – Laser - Absorption and Emission of Radiation – Population Inversion – Semiconductor and Diode Lasers.

Unit:5	Digital Principles	12 hours

Master Slave, J.K, Edge Triggered JK and D-Type Flip Flops – Set up, Hold and Propagation Delay Times - Shift Registers – Counters – Ring Counter – Up Down Counter – Synchronous Counters.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars– webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study	
1	Integrated Electronics – Jacob Millman and C. Hal Kias, Tat McGraw Hill Publishing Co. (1971).
2	Basic Electronics (Solid State), B.L. Theraja, S. CHAND (2006).
3	Microwaves, M.L. Sisodia, V.L. Gupta, New Age International (2001).
4	Semiconductor Devices, Kanaan Kano, Prentice Hall of India Pvt. Ltd. (1997)
5	Modern Physics, R. Murugeshan, Ninth Edition (2003).
6	Digital Computer Fundamentals, Thomas C. Bartee, Tata Mc Graw Hill (2011)
7	Optical Electronics, Ajoy Ghatak and K. Thyagarajan, Cambridge University Press (1998)
8	Digital Circuits and Microprocessors, Herbert Taub, McGraw Hill (1982).
9	Text Book of Electronics, S. Chattopadhyay, New Central Book Agency Pvt. Ltd., Kolkata, 2006
Book (s) for Reference	
1	Physics of Semiconductor Devices, S. M. Sze and Kwok K. Ng, Wiley Interscience, 3rd Edition (2007).
2	Introduction to Semiconductor Devices, M.S. Tyagi, John Wiley &Sons (2003).
3	Measurement Instrumentation and Experimental Design in Physics and Engineering, M. Saver and A. Man Singh, Prentice Hall, India (2000).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/108/108/108108122/
2	https://nptel.ac.in/courses/108/108/108108111/
3	https://nptel.ac.in/courses/108/106/108106069/
4	https://nptel.ac.in/courses/108/105/108105132/

Course Designed By	**Dr N. Ponpandian**	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	L	L	M	L	L	L	L	S
CO2	S	S	M	M	M	L	L	L	M	S
CO3	S	S	M	M	S	L	L	L	S	S
CO4	S	S	S	M	M	L	M	M	M	M
CO5	S	S	S	M	M	L	M	M	M	M

S	Strong		**M**	Medium		**L**	Low

Course code	13P	PRACTICAL – I	L	T	P	C
Core			0	0	4	4
Pre-requisite		Basic knowledge and understanding in physics, chemistry and biology.	Syllabus Version		2025 - 2026	

Course Objectives:

1. To experimentally demonstrate the concepts of Physics, Chemistry, and Biology relevant to nanoscience.
2. To familiarize students with fundamental topics in Physics, Chemistry, and Biology for understanding nanoscience.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Apply experimental methods to correlate practical observations with theoretical concepts.	K4
2	Demonstrate the correct usage of various measurement tools and techniques.	K2
3	Apply analytical techniques and graphical methods to interpret experimental data.	K3
4	Execute various standard procedures and techniques for conducting experiments..	K4
5	Develop effective communication skills to discuss and explain the basic principles of scientific concepts in group settings.	K4

K1– Remember; **K2**–Understand; **K3**– Apply; **K4**– Analyze; **K5**– Evaluate; **K6**– Create

Practical

1	Study the forward and reverse characteristics of a Zener diode
2	Colorimetric titration (acid base, color compound by instrument methods)
3	Pure culture Techniques (i) Spread Plate (ii) Pour Plate (iii) Streak Plate (iv) Serial Dilution
4	Construction of adder, subtractor, differentiator and integrator circuits using the given OP – Amp.
5	Complexometric titration by using EDTA
6	Bacterial Growth Curve and Generation Time
7	Construction of a single FET amplifier with Common Source configuration
8	Potentiometric titration of acid-base
9	Morphology of (i) Bacteria – Gram Staining and (ii) Fungi - Lacto Phenol Cotton Blue Mount
10	DC electrical conductivity and temperature coefficient of resistance of a semiconductor thin film using four point probe
11	Synthesis p-Bromoacetanilide from Acetanilide.
12	Estimation of Carbohydrates
13	Determination of charge type and carrier concentration in a given nanofilms using hall method
14	Preparation of tribromoaniline from Aniline
15	Blood Grouping and Rh Compatibility

Course Designed By | N. Ponpandian | e-mail | ponnpandian@buc.edu.in

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	M	L	S	S	M	S	M	S
CO2	S	M	M	L	S	M	S	L	M	S
CO3	S	M	M	L	S	S	S	M	M	S
CO4	S	M	M	L	S	M	M	S	M	S
CO5	S	M	M	L	S	S	M	M	M	S
S	Strong			**M**	Medium			**L**	Low	

Second Semester

Course code	23A	SYNTHESIS OF NANOMATERIALS	L	T	P	C
Core			4	0	0	4
Pre-requisite		Basic knowledge in science (Physics, Chemistry and Biology)	**Syllabus Version**		**2025 - 2026**	

Course Objectives:

1. To learn the top-down and bottom-up approaches for preparing nanomaterials.
2. o understand the physical, chemical, and biological methods of nanomaterial synthesis.
3. To control morphology and functional properties by optimizing preparation parameters.
4. To apply fundamental synthesis knowledge for developing functional and smart materials.
5. To understand lithographic processes for the fabrication of nanodevices.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Synthesize nanomaterials using physical, chemical, and biological approaches.	K2
2	Modify and control the size and shape of nanomaterials for diverse applications.	K4
3	Functionalize nanoparticles for specific applications.	K5
4	Develop nanocomposites with tailored functional properties.	K5
5	Fabricate device structures using lithographic techniques.	K6

K1– Remember; K2– Understand; K3– Apply; K4– Analyze; K5– Evaluate; K6– Create

Unit:1	**Chemical Methods**	12 hours

Sol – gel process– Self-assembly process – Electrodeposition – Spray pyrolysis– Flame pyrolysis– Metal nanocrystals by reduction– Solvothermal synthesis– Photochemical synthesis– Sonochemical Synthesis–Reverse micelles and microemulsions– Combustion method–Template process– Chemical vapor deposition(CVD)–Metal organic chemical vapor deposition(MOCVD).

Unit:2	**Physical Methods**	12 hours

Ball milling – Inert gas condensation technique(IGCT)–Thermal evaporation–Pulsed laser deposition(PLD)–DC/RF magnetron sputtering – Molecular beam epitaxy (MBE)–Melt spinning process –IC Fabrication process– Microlithography– Etching – Wet cleaning– CMP–Backend process – Atomic layer deposition (ALD).

Unit:3	**Biological Synthesis**	12 hours

Introduction-Natural and Bio Inspired nanocomposite materials – Biologically synthesized nanoparticles - Plant, Fungi, algae and Microbial Synthesis. Mechanisms and Factors affecting synthesis of Green Nanoparticles. Surface Functionalization, Capping agents and biological applications of Green Synthesis - (Super Absorbent Polymers, Coatings, Aerosols, Zeolites, NanoClays, Nano Emulsion, QD). Biofunctionalization of nanoparticles, Biomineralization - Magnetic nanoparticles and Magnetosome, Protein and DNA Nanostructures – Templating and Self-assembly.

Unit:4	**Surface Functionalization of Nanomaterials**	12 hours

Conjugation Chemistry Principles - Amine Reactions - Thiol Reactions - Hydroxyl Reactions - Carboxylic Acid Reactions - Aldehydes and Ketones Reactions - Alkenes and Alkynes - Photochemical Reactions - Biomolecules Conjugation Onto Self-Assembled Monolayers via Covalent Binding - Biomolecules Conjugation on Self - Assembled Monolayers via Affinity Binding - Challenges in (Bio) conjugation.

Unit:5	**Carbon Based Nanomaterials**	12 hours

Synthesis of one-, Two-, Three-, and Zero- dimension Nanostructure and A case study – Carbon nanostructure tuning the size and shape to enhance the functional properties for their potential Applications.		
Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	62 hours

Book (s) for Study	
1	Advances in the Liquid-phase synthesis of inorganic nanoparticles, Brain L. Cushing, Vladimir L. Kolesnichenko, Charles J. O'Connor, Chem Rev. 104 (2004) 3893-3946.
2	Nanocrystals: Synthesis, Properties and Applications, C. N. R. Rao, P. J. Thomas and G. U. Kulkarni, Springer, (2007).
3	Nanotechnology – Enabled Sensors, Kourosh Kalantar – zadeh and Benjamin Fry, Springer, (2008).
4	Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Guozhong Gao, Imperial College Press, (2004).
5	Nanochemistry: A Chemical Approach to Nanomaterials–Royal Society of Chemistry, Cambridge, UK, (2005).

Book (s) for Reference	
1	Nanocomposite science and technology, Pulickel M. Ajayan, Linda S. Schadler, Paul V. Braun, Wiley – VCH Verlag, Weiheim, (2003).
2	Encyclopedia of Materials Characterization, C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Butterworth - Heinemann Publishers, (1992).
3	Hand book of Microscopy for Nanotechnology, Ed. By Nan Yao and Zhong Lin Wang, Kluwer Academic Press, (2005).
4	Nanochemistry, G.B. Sergeev, Elsevier, (2006).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/118/102/118102003/
2	https://nptel.ac.in/courses/118/107/118107015/
3	https://nptel.ac.in/content/syllabus_pdf/118102003.pdf

Course Designed By	Dr N. Ponpandian	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	M	S	S	S
CO2	S	S	M	L	S	S	M	S	S	S
CO3	S	S	M	M	S	M	L	M	S	S
CO4	S	S	S	S	S	S	M	S	S	S
CO5	S	S	S	S	S	S	M	M	S	S

S	Strong		M	Medium		L	Low

Course code	23B	**CHARACTERIZATION OF NANO MATERIALS**	L	T	P	C
Core			4	0	0	4
Pre-requisite		Basic knowledge in science (Physics, Chemistry, and Biology)	**Syllabus Version**		**2025 - 2026**	

Course Objectives:

1. To enable students to understand the fundamental principles and concepts of material characterization.
2. To apply characterization techniques for analyzing the structural, optical, mechanical, chemical, thermal, magnetic, and electrical properties of materials.
3. To analyze and apply characterization data for designing new materials with multifunctional properties.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain the fundamental concepts and techniques used in material characterization.	K2
2	Apply structural and morphological characterization techniques to confirm the phases and surface structures of materials.	K3
3	nalyze the functional properties of materials, including electrical, magnetic, mechanical, optical, and thermal characteristics.	K4
4	Employ nuclear spectroscopic techniques to identify the chemical environment of materials.	K5
5	Utilize surface characterization techniques to determine the composition and stoichiometry of materials.	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Structural Characterization**	12 hours

Powder X-ray diffractometer - Synchrotron radiation – FTIR spectrometer - Raman Spectrometer –— Stylus profilometer.

Unit:2	**Microscopic and Surface Analysis**	12 hours

Electron microscopes: scanning electron microscope (SEM) – transmission electron microscope (TEM); Scanning Probe Microscopy: atomic force microscope (AFM) – scanning tunnelling microscope(STM); Laser confocal microscope – Brunauer – Emmer – Teller Surface area analysis.

Unit:3	**Spectroscopy**	12 hours

X-ray photoelectron spectroscopy (XPS) – EDAX and WDA - Mass Spectrscopy – Secondary Ion Mass Spectroscopy (SIMS) –ICPMS - Nuclear magnetic resonance (NMR) – Electron spin resonance (ESR).

Unit:4	**Electrical, Mechanical and Magnetic Properties**	12 hours

Impedance Spectroscopy – Electro analytical Techniques: Potentiometry – Cyclic Voltammetry - Physical Property Measurement System (PPMS) –Nanoindentation – Vibrating sample magnetometer.

Unit:5	**Thermal and Optical Properties**	12 hours
Differential scanning calorimeter (DSC) – Thermogravimetric/Diffferential thermal analyzer (TG/DTA) – UV – Visible spectrophotometer – Spectroflourometer – Contact angle measurement. Dynamic Light Scattering (DLS)		
Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	62 hours

Book (s) for Study	
1	Encyclopedia of Materials Characterization, C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Butterworth-Heinemann Publishers, (1992).
2	Handbook of Microscopy for Nanotechnology, Ed. By Nan Yao and Zhong Lin Wang, Kluwer Academic Press, (2005).
3	Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Guozhong Gao, Imperial College Press, (2004).
4	Nanotechnology - Enabled Sensors, Kourosh Kalantar-zadeh and Benjamin Fry, Springer (2008).
5	Nanochemistry, G. B. Sergeev, Elsevier, (2006).
Book (s) for Reference	
1	Nanotechnology: Basic Science and Emerging Technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press, (2005)
2	Nanocomposite Science and Technology, Pulickel M.Ajayan, Linda S.Schadler, Paul V. Braun, Wiley-VCH Verlag, Weinheim, (2003).
3	Introduction to Nanoscience, S. M. Lindsay, 1st Edition, Oxford University Press, (2010).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/118/104/118104008/
2	https://nptel.ac.in/courses/113/107/113107081/
3	https://www.classcentral.com/course/swayam-structural-analysis-of-nanomaterials-14310

Course Designed By	Dr N. Ponpandian	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	S	S	S	S	S	S
CO2	M	S	S	M	S	S	S	S	S	S
CO3	M	S	S	L	S	S	M	S	M	S
CO4	M	S	S	M	S	S	M	S	M	S
CO5	M	S	S	M	S	S	M	S	S	S
S	Strong		M	Medium		L	Low			

Course Code	23C	MICRO AND NANOFABRICATIONS	L	T	P	C
Core			4	0	0	4
Pre-requisite		Basic understanding in Materials Science	Syllabus Version		2025 - 2026	

Course Objectives:

1. To understand clean room standards and their role in process integration.
2. To learn various techniques involved in nanostructuring for MEMS/NEMS fabrication.
3. To understand the process of nanomanipulation and its analysis using various imaging techniques.
4. To explore the fundamentals, applications, and future challenges of MEMS design.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain clean room standards and their relevance to process integration.	K2
2	Demonstrate an understanding of nanostructuring using various lithographic techniques	K2,K6
3	Apply imaging and inspection techniques to analyze nanostructured materials using conventional and advanced methods.	K2,K4
4	Analyze MEMS techniques, applications, and future challenges.	K4,K5
5	Analyze NEMS techniques, applications, and future challenges.	K4,K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Clean Room and Process Integration	12 hours

Clean Rooms: Cleanroom Standards – Clean room sub-systems – Environment Safety and Health Aspects – Oxidation - Ion Implantation - Etching- Diffusion Process Integration: Junction and Oxide Isolation – LOCOS methods – Trench Isolation – Semi Insulating Substrates -Schottky contacts Implanted Ohmic Contacts – Alloyed Contacts – Multi level Metallization.

Unit:2	Nanostructuring By Physical Techniques	12 hours

Introduction–Lithography–Photolithography – Phase-shifting photolithography – Electron beam lithography-X – ray lithography – Focused ion beam (FIB) lithography – Neutral atomic beam lithography – Nanomanipulation and nanolithography– Soft Lithography– Assembly of Nanoparticles and nanowires - Other methods for microfabrication.

Unit:3	Nanomanipulation and Processing	12 hours

Scanning tunneling microscopy (STM) – Atomic force microscopy (AFM) – Near-field scanning optical microscopy (NSOM) – Advanced Techniques: Embossing and surface passivation, Dimensional Subtraction and Addition, Multistep Processing, of –Micro contact printing– Molding – implications and applications of the conventional and advanced techniques.

Unit:4	MEMS Techniques and Application	12 hours

MEMS materials-MEMS challenges - scaling - scaling in geometry, rigid body dynamics, electrostatic forces, electromagnetic forces, electricity, fluid mechanics, heat transfer. Need for MEMS-MEMS features-MEMS design limits and safety factors - MEMS future and applications, microsystems and microelectronics-Recent trends in MEMS – MEMS Sensor.

Unit:5	NEMS Techniques and Applications	12 hours

Introduction to NEMS and its architecture - carbon nanotube electronics - modeling - analysis and simulation - simulation of Actuators, FET, Pressure transducer - applications and future challenges - Molecular and Nanostructured Dynamics – Molecular Wires and Molecular Circuits		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study

1	Nanostructures & Nanomaterials Synthesis, Properties Applications, Guozhong Cao, World Scientific Publishing Private Ltd., (2004).
2	Nanofabrication, Principles, Capabilities and Limits, Zheng Cui, Springer Science business media, (2008).
3	MEMS and NEMS systems, Devices and Structures‖, Syergey Edward Lyshevski, CRC Press, New York, (2002).
4	MEMS and Microsystems Design and Manufacture, Tai Ran Hsu, Tata Mcraw Hill, (2002).
5	Micro Electro Mechanical System Design, James J Allen, CRC Press-Taylor & Francis‖, New York, (2005).
6	Micro and Smart Systems‖, Ananthasuresh G. K, Vinoy. K.J, Gopalakrishnan.S, Wiley India Pvt Ltd, New Delhi, (2012).

Book (s) for Reference

1	Foundations of MEMS, Chang Liu, Pearson education India limited, (2006).
2	MEMS, Mahalik N P, Tata McGraw-Hill Education, (2008).
3	Marc. J, Madou, "Fundamentals of Microfabrication: The Science of Miniaturization", CRC Press, (2002).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/117/105/117105082/
2	http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.111.3275&rep=rep1&type=pdf

Course Designed By	**Dr C. Viswanathan**	e-mail	viswanathan@buc.edu.in

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	L	M	S	S	L	L	L	M
CO2	S	S	S	S	S	M	M	L	S	S
CO3	S	S	S	M	S	S	M	L	S	S
CO4	S	S	M	S	M	L	S	S	S	S
CO5	S	S	M	S	M	L	S	S	S	S

S	Strong		**M**	Medium		**L**	Low

Course code	23D	GENETICS AND NANOBIOTECHNOLOGY	L	T	P	C
Core			4	0	0	4
Prerequisite		Basic knowledge on Biology and Nanotechnology	Syllabus Version		2025 -2026	

Course Objectives:

1. To study the central concepts of molecular biology.
2. To understand the interactions of nanoparticles with cell membranes.
3. To learn techniques for probing nanoparticles inside cells.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Recall the central dogma of cell survival.	K2
2	Explain the process of transcription and its enzymology.	K2
3	Describe the concept of the triplet codon and its genetic significance in determining protein structure.	K2
4	Analyze the process of nanoparticle internalization within cellular structures.	K4
5	Evaluate the interactions of nanoparticles with various cellular components.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit:1	Molecular Biology	12 hours

Chromosomes and its structure, structure and types of DNA – Double helix, nucleotides, DNA replication, semiconservative replication, DNA polymerase, replication process, mutagenesis and types of mutagenesis, difference between mutation and mutagenesis, mutagenesis techniques. DNA repair – base excision repair, nucleotide excision repair, mismatched repair.

Unit:2	Transcription	12 hours

RNA – Definition, structure of r-RNA, t-RNA and m-RNA. Initiation of transcription in prokaryotes, prokaryotic RNA polymerase, prokaryotic promoters, elongation, and termination in prokaryotes, prokaryotic termination signals. Reverse transcription.

Unit:3	Translation	12 hours

Protein synthesis (Translation) - Basic mechanism of Protein synthesis: Initiation, elongation, termination, Protein Targeting, Folding, and Modification process - Gene expression: Prokaryotic and Eukaryotic gene expression, Regulation of gene expression - genetic code, ribosome structure, DNA repairing of Genetic code.

Unit:4	Cell Membrane Interactions and Intracellular Trafficking of Nanoparticles in Cell	12 hours

Phagocytosis, Clathrin-mediated endocytosis (CME), Caveolae-dependent endocytosis, Clathrin /caveolae independent endocytosis, Macropinocytosis. Cell organelles like Endoplasmic reticulum, Golgi bodies and lysosomes.

Unit:5	Probing Cellular Interactions of Nanoparticles	12 hours

Confocal laser scanning microscopy, Flow cytometry, ICP-MS, Western blotting, PCR and RT – PCR		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study	
1	Molecular cell biology, Darnell, Lodish, Baltimore, Scientific American Books, Inc., (1994).
2	Microbial Genetics, Freifelder, D., 2nd Ed. Narosa Publishing House, New Delhi, (2006).
3	Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata McGraw Hill, (2003).
Book (s) for Reference	
1	Microbiology, Prescott L M, J P Harley and D A Klein, 6th edition, International edition, McGraw Hill, (2005).
2	Microbial Genetics, Maloy, S.R., Cronan, J.E. Jr. and Freifelider, D. 2ndEd. Jones and Bartlett Publishers, (1994).
3	Molecular cell biology, Darnell, Lodish, Baltimore, Scientific American Books, Inc., (1994).
4	Pricinciples of Gene Manipulation, Primrose. S.B., Twyman R.M., Old. R.W. Blackwell Science Limited, (2001).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://dx.doi.org/10.3762%2Fbjnano.11.25
2	https://www.ncbi.nlm.nih.gov/books/NBK10779/
3	https://nptel.ac.in/courses/102/107/102107058/
4	https://nptel.ac.in/courses/118/106/118106019/

Course Designed By	**Dr P. Premasudha**	e-mail	premasudha@buc.edu.in

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	L	M	L	S	S	L	S	S	S
CO2	M	S	L	M	M	M	M	L	S	S
CO3	S	S	L	L	M	S	S	S	S	S
CO4	S	M	M	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S	Strong		**M**	Medium		**L**	Low

Course code	2EA	NANOELECTRONICS AND NANOPHOTONICS	L	T	P	C
Elective			4	0	0	4
Pre-requisite		Basic Physics Concepts	Syllabus Version		2025 -2026	

Course Objectives:

The main objectives of this course are to:

1. Provide advanced-level knowledge in nano-microelectronics process engineering, addressing the rapid growth of the integrated circuit (IC) industry and the need for expertise in state-of-the-art nanoelectronics and design.
2. Develop an in-depth understanding of device electronics for integrated circuits, forming a foundation for device fabrication and applications in sensor technology, optoelectronics, communication, and nanotechnology.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Analyze the conceptual foundations underlying the operation of nanoelectronic devices.	K4
2	Explain diverse electronic device fabrication techniques.	K2
3	Engage in scientific interactions with industry professionals within and beyond the classroom setting.	K6
4	Interact scientifically with industry both within and outside of a classroom setting.	K6
5	Demonstrate a commitment to continuing education and professional development.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit:1	Basics of Nanoelectronics	12 hours

Physical Fundamentals: Electromagnetic fields and photons – Quantization of action - Charge and flux – Electrons behaving as waves (Schrodinger equation) – Electrons in potential wells – Photons interacting with electrons in solids – Diffusion process - Quantum Computers.

Unit:2	Quantum Electronics	12 hours

Quantum electronic devices - From classical to quantum physics -Upcoming electronic devices – Electrons in mesoscopic structure – Short channel MOS transistor – Split gate transistor – Electron wave transistor – Electron spin transistor – Quantum cellular automate (QCA) – Quantum dot array – Principles of single electron transistor (SET) – SET circuit design – comparison between FET and SET circuit design.

Unit:3	Nanoelectronic Devices and Applications	12 hours

Nanoelectronics with tunneling devices - Super conducting devices – Tunneling element technology - RTD – Circuit design based RTD –Defect tolerant circuits, Molecular electronics - Elementary circuits – Flux quantum devices – Applications of super conducting devices.

Memory devices and sensors – Nano ferroelectrics - ferroelectric random access memories – introduction – Fe RAM circuit design – ferroelectric thin film properties and integration — surface and bulk acoustic devices – gas-sensitive FETs – resistive semiconductor gas sensors – electronic noses – identification of hazardous solvents and gases – semiconductor sensor array.

Unit:4	Nanophotonics	12 hours

Electromagnetic properties of nanostructures – Wavelength and dispersion laws – Density of states– Maxwell and Helmholtz equations – **Photonic Crystals – Definition and types of photonic crystals -** Photonic band-structure and photonic band gap - Propagation of light in periodic media – Brillouin zones - Band structure in periodic media – 1D case. **Fabrication of photonic crystals -** Photonic crystals by self-assembly - Photonic crystals by microfabrication - Photonic crystals with tunable properties.		
Unit:5	**Biophotonics**	**12 hours**
Interaction of Light with cells and tissues - Nature of optical interactions (optical loss and optical transparency) - Optical properties of a tissue (Double integrating sphere experiment) – Light-induced processes in tissues – Autofluorescence, photochemical processes, thermal effects, photoablation, plasma induced ablation and photo disruption. Bioimaging –Biosensing – Up-conversion nanoparticles. Bioderived materials (Baceriorhodopsin, Green fluorescent protein, DNA, Bio-objects and bio-colloids) – Bioinspired materials – Biotemplates (Bacteria and Viruses as templates).		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study	
1	Nanoelectronics and Nanosystems: from Transistors to Molecular Devices. K.Goser, P. Glosekotter, J. Dienstuhl, Springer, (2004).
2	Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices (2^{nd} edition), Rainer Waser (Ed.), Wiley-VCH Verlag, Weiheim (2005).
3	Introduction to Nanophotonics, Sergey V. Gaponenko, Cambridge University Press, New York, ISBN-13 978-0-521-76375-2 (2010).
4	Photonic crystals: Physics and Technology, (Eds.) C. Sibilia, T. M. Benson, M. Marciniak, T. Szoplik, (ISBN: 978-88-470-0843-4) (2008).
5	Introduction to Biophotonics, Paras N. Prasad, (John Wiley and Sons, New Jersey), ISBN: 0-471-28770-9 (2003).
Book (s) for Reference	
1	Nano and Molecular Electronics Handbook, Edited by Sergey Edward Lyshevski, CRC Press, (2007).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/117/108/117108047/
2	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-701-introduction-to-nanoelectronics-spring-2010/readings/MIT6_701S10_notes.pdf
3	https://nptel.ac.in/courses/118/106/118106021/

Course Designed By:	**Dr. N. Ponpandian**	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	S	M	M	S	S	S
CO2	S	M	S	S	M	M	M	S	S	S
CO3	S	M	S	M	S	S	S	S	S	S
CO4	S	L	M	S	S	S	S	S	S	S
CO5	S	M	S	M	M	S	S	S	S	S
S	Strong			**M**	Medium			**L**	Low	

Course code	2EB	NANOMAGNETIC MATERIALS AND DEVICES	L	T	P	C
Elective			4	0	0	4
Pre-requisite		Basic understanding in Physics.	Syllabus Version		2025 -2026	

Course Objectives:

The main objectives of this course are to:

1. Understand the basic magnetic parameters and the significance of structure–property relationships in determining their absolute values.
2. Understand magneto-transport phenomena in nanoscale systems.
3. Gain knowledge of the fundamental mechanisms for tuning magnetic properties.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Analyze the concepts of magnetism at both micro- and nanoscale levels.	K4
2	Explain the principles of nanomagnetism and the advanced tools used for its study.	K2
3	Utilize various imaging techniques to investigate magnetic behaviors.	K6
4	Identify suitable applications of magnetic materials based on their functional properties.	K6
5	Apply knowledge of nanomagnetism in developing applications for data storage and biomedicine.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit:1	Fundamental s of Magnetism	12 hours

Magnetic fundamentals –Antiferromagnetic materials – Domains and the magnetization process– Coercivity of fine particles – Super paramagnetism in fine particles – Exchange anisotropy - Induced anisotropy in thin films – Electron transport in magnetic multi-layers – Spin polarized electron tunneling – Interlayer exchange coupling – Spin relaxation in magnetic metallic layers and multi-layers - Nonequilibrium spin dynamics in laterally defined magnetic structures.

Unit:2	Nanomagnetism	12 hours

Two-spin channel model - Two terminal spin electronics – Three terminal spin electronics - Spin tunneling - Study of ferromagnetic and antiferromagnet interfaces – Photoemission Electron Microscopy - X-ray Absorption Spectroscopy - X-ray Magnetic Linear Dichroism (XMLD) - X-ray Magnetic Circular Dichroism (XMCD) - Temperature dependence of X-ray Magnetic Dichroism

Unit:3	Fabrication and Imaging	12 hours

Molecular nanomagnets – Mesoscopic magnetism - Particulate nanomagnets – Geometrical nanomagnets – Fabrication techniques scaling – Characterization using various techniques – Imaging magnetic microspectroscopy – Optical Imaging – Lorentz Microscopy – Electron Holography of Magnetic Nanostructures –Magnetic Force Microscopy.

Unit:4	Magnetic Data Storage and Recording	12 hours

Magnetic data storage – Disk formatting – Partitioning – Hard disk features – Hard disk data transfer modes – Programmed I/O – Direct memory access – Ultra DMA – Data addressing – Standard CHS addressing – Extended CHS addressing – Logical Block Addressing – Magnetic recording- Principles of magnetic recording - Magnetic digital recording - Perpendicular recording - Magneto-Optic recording - Magnetic media – Kerr effect – Faraday effect.

Unit:5	**Magnetic Structures and Application**	**12 hours**
Magnetic sensors and Giant Magnetoresistance - Optically transparent materials - Soft ferrites- Nanocomposite magnets - Magnetic refrigerant – Ferro/biofluids– Biomedical applications of magnetic nanoparticles - Diagnostic applications - Therapeutic applications - Physiological aspects - Toxic effects.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study	
1	Hans .P.O, and Hopster. H, "Magnetic Microscopy of Nanostructures", Springer, 2004.
2	Bland. J.A.C, and B. Heinrich. B, "Ultra thin Magnetic Structures III – Fundamentals of Nanomagnetism", Springer, 2004.
3	Nicola. A.S, "Magnetic Materials: Fundamentals and Device Applications", Cambridge University Press, 2003.
Book (s) for Reference	
1	J. M. D. Coey, Magnetism and Magnetic Materials, Pearson Education, 2010.
2	B. D. Cullity, C. D. Graham, Introduction to Magnetic Materials, John Wiley & Sons, Inc, 2009.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.youtube.com/watch?v=QQZ6EGf0Ju8
2	https://nptel.ac.in/courses/115/106/115106061/
3	https://nptel.ac.in/courses/115/103/115103038/

Course Designed By:	**Dr. N. Ponpandian**	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	S	M	M	S	S	S
CO2	S	M	S	S	M	M	M	S	S	S
CO3	S	M	S	M	S	S	S	S	S	S
CO4	S	L	M	S	S	S	S	S	S	S
CO5	S	M	S	M	M	S	S	S	S	S

S	Strong		**M**	Medium		**L**	Low

Course code	23P	PRACTICAL – II – SYNTHESIS AND CHARACTERZATION OF NANAMATERIALS	L	T	P	C
Core			0	0	4	4
Pre-requisite		Basic knowledge and understanding in Nanoscience.	Syllabus Version		2025 -2026	

Course Objectives:

The main objectives of this course are to:

1. Understand the concept of "nano" in relation to materials, comparing their size to bulk materials, atoms, and molecules.
2. Learn the specific physicochemical properties of nanomaterials and their related applications.
3. Acquire knowledge of basic physical techniques and chemical synthesis methods for the preparation of nanomaterials.
4. Learn fundamental procedures for surface functionalization and coating of nanomaterials.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Analyze the concept of nanomaterials in comparison to bulk materials, atoms, and molecules.	K4
2	Explain the physical and chemical procedures for the fabrication and synthesis of nanomaterials.	K2
3	Apply characterization methods for nanomaterials, considering size-related limitations and interpreting results.	K3
4	Apply basic surface functionalization and coating procedures for nanomaterials.	K3
5	Explain interparticle interactions and the assembly of nanoparticles into complex structures and materials.	K2

K1– Remember; **K2**–Understand; **K3**– Apply; **K4**– Analyze; **K5**– Evaluate; **K6**– Create

Practical

1	Synthesis of Au/Ag nanoparticles using co-precipitation method,
2	Synthesis of CdS nanoparticle using hydrothermal process.
3	Synthesis of ZnO nanoparticles using sputtering process.
4	Synthesis of TiO_2 nanoparticles using sol-gel process.
5	Synthesis of Fe_2O_3nanofibres using electrospinning
6	Preparation of WO_3 nanostructures using microwave synthesis.
7	To optimize the concentration of nanoparticles dispersed solution using UV-vis spectroscopy.
8	Fabrication of porous alumina or anodized alumina template.
9	To find the optical band gap of the given semiconducting materials by measuring UV-Visible transmission spectrum.
10	To find the average grain/crystallite size, unit cell parameters, microstrain by recording the X-ray diffraction pattern of the given sample.
11	Isolation of chromosomal DNA from microbes
12	Fractionation and Size Determination of nucleic acids and proteins – (i) Agarose Gel Electrophoresis and (ii) SDS – PAGE Electrophoresis
13	Estimation of Protein – Bardford Method
14	Separation Techniques: Chromatography (i) TLC and (ii) Column
15	Antibiotic Susceptibility Test - Kirby Bauer Technique

Course Designed By	N. Ponpandian	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	S	S	S	S	S	S
CO2	S	S	L	L	S	S	S	S	S	S
CO3	S	S	S	M	S	M	S	S	S	S
CO4	S	S	S	S	S	L	S	S	S	S
CO5	S	S	S	S	S	M	S	S	S	S
S	Strong			**M**	Medium			**L**	Low	

Third Semester

Course Code	33A	NANOTECHNOLOGY IN HEALTH SCIENCE	L	T	P	C
Core			4	0	0	4
Pre-requisite		This course requires a basic knowledge of Material Physics, Chemistry, and Biotechnology to understand the diverse nature of nanomaterials and their applications.	Syllabus Version		2025 -2026	

Course Objectives:

1. To provide an overview of the distinctive features of nanotechnology and their applications in health science and technology through discussions, presentations, and group projects.
2. To help students from different disciplines understand the interdisciplinary nature of nanoscience in health applications.
3. To impart knowledge of recent developments in nanotechnology for diagnostics, therapeutics, and regenerative medicine.

Expected Course Outcomes:

On completion of the course the student should able to:

1	Explain the fundamental concepts of nanotechnology and their applications in health science.	K3
2	Illustrate the structure, properties, and functions of nanomaterials used in health care.	K3
3	Analyze the design strategies and nanoscale phenomena relevant to nanomedicine.	K4
4	Evaluate approaches in drug development and explain their molecular mechanisms of action.	K5
5	Design and justify nano-carriers for targeted drug and gene delivery applications.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Basics of Biomaterial Science	12 hours

Introduction of biomaterials science-Definition and classification of biomaterials-metals, ceramics, polymers and nanocomposites-Properties of biomaterials (Physical-Chemical-Biological-Mechanical-Electrochemical properties) - Nano-scale phenomena in biomaterials-Smart gels and their properties.

Unit:2	Materials for Bone and Dentistry	12 hours

Materials in Orthopedics: Structure and composition of bone- Conventional materials for orthopedics-Orthopedic nanomaterials-Biological properties of bone grafts-Alloplastic materials-Bone stabilizers-Artificial implant devices-Implant failure.

Dental materials: Dental anatomy-Characteristics of oral environment - Classification of dental restorative materials - Bonding agents-Principles of adhesion-Resins-Dental ceramics-Cements-Glass ionomers-Dental implant devices.

Unit:3	Nanobiomaterials and Tissue Engineering	12 hours

Principles of tissue engineering-Hard and soft tissue engineering-Nanobiomaterials for artificial cells-Scaffolds for tissue engineering-Materials-Fabrication techniques-Synthetic matrices for bladder reconstruction; Nanoparticles-Magnetic nano beats-Artificial skin; Composite grafts-Skin substitutes-Construction of small blood vessel; Production of retrovirus-Collagen gel scaffolds-Silicone materials; Breast and genital implants.

Unit:4	Basics of Nanomedicines	12 hours

Concept of nanomedicines-Rationale for designing of nanomedicines-Nano-structures in nanomedicines-transport of nanoparticles across the biological barriers, parameters affecting binding and uptake of nanoparticles-size, shape, surface charge, protein corona, surface modification-Clinical translation of nanomedicines: Preclinical and clinical considerations of nanomedicines-Regulation of nanomedicines.

Unit:5	Regenerative Medicine	12 hours

Introduction to regenerative medicine-Methods of cell based therapy-Stem cells-Molecular and cellular based of organ development-Therapeutic uses of stem cells-Molecular bases of disease-Bio-artificial organs; Artificial pancreas-Lever-Ear-Heart-Ethics-Current issues in patent law-From concept to market (Regenerative products).		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**62 hours**

Book(s) for Study	
1	Biomaterial science an introduction to materials in medicine, Buddy D. Ratner, Allans S. Hoffman, Frederick J. Schoen, Jack E. Lemons, **2004, ISBN: 0-12-582463-7.**
2	Biomechanics and Biomaterials in Orthopedics, Dominique G. Poitout, 2nd edition, Springer, **2004, ISBN: 978-1-84882-663-2.**
3	Advanced Dental Biomaterials, Zohaib Khurshid Shariq Najeeb Muhammad Sohail Zafar Farshid Sefat, 1st edition, 2019, **ISBN: 9780081024768.**
4	Nanobiomaterials in Hard Tissue Engineering, Alexandru Mihai Grumezescu, Volume 4, **2016, ISBN: 9780323428620.**
5	Stem Cells & Regenerative Medicine, Audet, Julie, Stanford, William L, Springer Publications, **2009, ISBN: 978-1-59745-060-7.**
6	Tissue engineering, second edition, Hansjorg Hauser, |Martin Fussenegger, **2007**, **ISBN: 978-81-8489-248-2**
7	Principles of Regenerative Medicine, Anthony Atala, Robert Lanza, Tony Mikos, Robert Nerem, 3rd edition, **2018**, **ISBN: 9780128098806.**
Book (s) for Reference	
1	Biomaterials, Sujata V. Bhat, Alpha Science International, **2005, ISBN: 1842652079**.
2	Materials for Biomedical Engineering: Nanobiomaterials in Tissue Engineering Kindle, Alina Maria Holban, Alexandru Grumezescu, 1st edition, **2019, ISBN: 0128169095.**
3	Basic Dental Materials, Manappallil John, 4th edition, **2016, ISBN: 10-9789352500482.**
4	Nanobiomaterials in Soft Tissue Engineering, Alexandru Mihai Grumezescu, Volume 4, **2016, 978-0-323-42865-1.**
5	The Clinical Nanomedicine Handbook, By Sara Brenner, CRC Press, **2017, ISBN: 1439834792**.
6	Foundation of Regenerative Medicine, Anthony Atala, 1rd edition, **2009, ISBN: 9780123785626.**
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://ocw.mit.edu
2	https://chalmers.instructure.com
3	https://www.mooc-list.com
4	https://www.classcentral.com

Course Designed By	**Dr A.M. Ballamuragan**	e-mail	balamurugan@buc.edu.in

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	S	L	S	S	M	L	S	S	M
CO2	S	S	M	S	S	S	M	S	S	M
CO3	S	S	M	M	S	M	S	S	M	S
CO4	S	S	L	S	M	S	S	S	M	L
CO5	S	M	M	M	S	S	S	S	S	M
S	Strong			**M**	Medium			**L**	Low	

Course code	33B	NANOTECHNOLOGY FOR ENERGY CONVERSION AND STORAGE DEVICES	L	T	P	C
Core			4	0	0	4
Pre-requisite		Physics / Chemistry / Nanoscience / Allied Chemistry / Applied Chemistry as a major subject during graduate programme..	Syllabus Version		2025 -2026	

Course Objectives:

1. To provide foundational knowledge on the concepts of electrochemistry and energy systems.
2. To understand the principles of energy conversion systems with focus on nanostructured materials.
3. To explore various energy storage methods including batteries and capacitors.
4. To introduce applications of semiconducting and nanostructured materials in energy devices.
5. To evaluate the challenges, recent developments, and future trends in nanotechnology-enabled energy systems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Recall and describe the basic concepts of electrochemistry and energy conversion systems.	K1
2	Apply the working principles of different types of fuel cells and identify suitable nanomaterials.	K3
3	Explain and analyze the functioning of photovoltaic cells and evaluate different types of solar cells.	K2
4	Examine and assess the design, materials, and performance of battery systems for energy storage.	K4
5	Design and propose nanostructured materials for supercapacitors and green energy devices.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit:1	Fundamental Concepts in Electrochemistry	12 hours

Electrochemical Cell - Faraday's laws - Electrode Potentials - Thermodynamics of electrochemical cells - Polarization losses in electrochemical cells - Electrode process and kinetics, Electrical double layer - Photoelectrochemical cell - thermoelectric effect.

Unit:2	Energy Conversion Systems	12 hours

Issues and Challenges of functional Nanostructured Materials for electrochemical Energy - Conversion Systems - Fuel Cells - Principles and nanomaterials design for; Proton exchange membrane fuel cells (PEMFC) - Direct methanol fuel cells (DMFC) - Solid-oxide fuel cells (SOFC) - Current status and future trends.

Unit:3	Photovoltaic Systems	12 hours

Principles of photovoltaic energy conversion (PV) - Types of photovoltaic Cells - Physics of photovoltaic cells - Organic photovoltaic cell cells - thin-film Dye-Sensitized Solar Cells - Quantum dot (QD) - Sensitized Solar Cells (QD-SSC) - Organic-Inorganic Hybrid Bulk Heterojunction (BHJ-SC) Solar cells - Current status and future trends.

Unit:4	Energy Storage System - Batteries	12 hours

Energy Storage Devices - Primary and Secondary Batteries (Lithium-ion Batteries) - Cathode and anode materials - Nanostructured Carbon-based materials – Nano - Oxides - Novel hybrid electrode materials - Current status and future trends.

Unit:5	**Electrochemical Capacitors**	**12 hours**
Capacitor - Electrochemical supercapacitors - electrical double layer model - Principles and materials design - Nanostructured Carbon-based materials - Redox capacitor Nano oxides - Conducting polymers based materials- Current status and future trends.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars– webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study

1	Allen J.Bard and Larry R Electrochemical methods: Fundamentals and Applications, Faulkner, 2nd Edition John Wiley & Sons. Inc, (2004).
2	D. Linden. Thomas B. Reddy, Handbook of Batteries, 3rd Edition, McGraw-Hill, New York, (2002).
3	B.E. Conway, Electrochemical supercapacitors: Scientific Fundamentals and Technological Applications, Kluwer Academic Plenum publisher, New York, (1999).
4	C. Brabec, V. Dyakonov, U. Scherf, Organic Photovoltaics: Materials, Device Physics, and Manufacturing Technology, 2nd Edition, Wiley VCH, (2014).
5	J. Larmine and A. Dicks, Fuel Cell System Explained, John Wiley, New York, (2000).

Book (s) for Reference

1	Science and Technology of Lithium Batteries-Materials Aspects: An Overview, A. Manthiram, Kulwer Academic Publisher, (2000).
2	M. S. Whittingham, A. J. Jacobson, Intercalation Chemistry, Academic Press, New York, (1982).
3	M. Wakihara, O. Yamamoto, (Eds.) Lithium Ion Batteries: Fundamentals and Performance, Wiley –VCH, Weinheim, (1998).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ch26/
2	https://nptel.ac.in/courses/112/107/112107283/
3	https://nptel.ac.in/courses/102/107/102107058/

Course Designed By	**Dr P. Sakthivel**	e-mail	sakthivel.p@buc.edu.in

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	L	S	L	S	S
CO2	S	M	M	L	L	M	S	M	S	S
CO3	S	L	M	L	S	M	S	M	S	S
CO4	S	M	L	S	L	M	S	L	S	S
CO5	S	M	M	S	S	M	S	S	S	S

S	Strong		**M**	Medium		**L**	Low

Course code	33C	NANOSENSORS AND IoT BASED SENSORS	L	T	P	C
Core			4	0	0	4
Pre-requisite		Basic knowledge of nanomaterials, sensors, and internet concepts.	Syllabus Version		2025 - 2026	

Course Objectives:

1. Explain the fundamental principles, parameters, and characteristics of nanosensors.
2. Provide insights into the fabrication, components, and working mechanisms of physio-, chemo-, and bio-nanosensors.
3. Enable students to select and apply appropriate nanosensors for diverse real-world applications.
4. Analyze and evaluate the performance metrics and figures of merit of nanosensors.
5. Integrate nanosensors with Internet of Things (IoT) technologies to develop innovative sensing systems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain the fundamental components, principles, and performance characteristics of nanosensors.	K2
2	Apply nanostructured materials and fabrication techniques for designing nanosensors suitable for specific applications.	K3
3	Analyze and interpret the performance parameters and figures of merit of various nanosensors.	K4
4	Design and develop IoT-enabled nanosensor systems for real-time and remote applications.	K6
5	Evaluate and improve sensor performance by modifying material and functional properties.	

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit:1	Sensor Principles	12 hours

Active and passive sensors - static characteristic - accuracy, error, precision, resolution, sensitivity, selectivity, noise, drift, detection limit - reproducibility, hysteresis, stability, response time, recovery time, dynamic range - dynamic characteristics.

Photoelectric effect - photo dielectric effect - photoluminescence effect - electroluminescence effect - chemiluminescence effect - Barkhausen effect - Hal effect - Ettinshausen effect - thermoelectric effect - peizoresistive effect – piezoelectric effect - pyroelectric effect -Magneto-mechanical effect (magnetostriction) - Magneto resistive effect.

Unit:2	Physical Sensors	12 hours

Mass sensor- Nanogram Mass Sensing by Quartz Crystal Microbalance - Displacement sensor- Electron Tunneling Displacement Nanosensors; Magnetomotive Displacement Nanosensor - Piezoresistive and Piezoelectric Displacement Nanosensors,- Force sensor - Femtonewton Force Sensors- Pressure sensor - Membrane-Based CNT Electromechanical Pressure Sensor – Accelerometer – Tunnel effect accelerometer- Silicon Nanowire Accelerometer – Flow sensor - CNT Flow Sensor for Ionic Solutions – Temperature sensor – CNT based Resistive Low-Temperature Nanosensor- Silicon Nanowire Temperature Nanosensors – Light sensor – CNT/Polymer Nanocomposite as Conductivity Response Infrared Nanosensor - Zinc Oxide Nanorods based Resistive UV Nanosensors.

Unit:3	Chemosensors	12 hours

Gas Sensing with Nanostructured Thin Film, Adsorption on Surfaces, Conductometric transducers Suitable for Gas Sensing, Gas Reaction on the Surface, Effect of Gas Sensitive Structures and Thin Films- Metallic Nanoparticle Based Gas Sensors - Metal Oxide Gas Sensors - Carbon Nanotube Gas Sensors - Porous Silicon-Based Gas Sensor - Organic Polymer Film–Based Gas Sensors - Nanosensor Arrays - Nanoelectronic Nose – Optochemical Nanosensors.- Nanosensors Based on Surface-Enhanced Raman Scattering (SERS) - Colloidal Surface plasmon resonance (SPR) Colorimetric Gold Nanoparticle Spectrophotometric Sensor.		
Unit:4	**Biosensors**	**12 hours**
Nanoparticle-Based Electrochemical Biosensors –DNA enabled biosensors - CNT-Based Electrochemical Biosensors - Functionalization of CNTs for Biosensor Fabrication Quantum Dot-Based Electrochemical Biosensors - Nanotube- and Nanowire-Based FET Nanobiosensors - Cantilever-Based Nanobiosensors - Optical Nanobiosensors.		
Unit:5	**IoT Based Sensors**	**12 hours**
Internet of things – Building blocks of IoT, Characteristics of IoT- Design of IoT - connectivity – mobile-satellite-Bluetooth -Wi-Fi – Wimax- IoT enabled technologies – IoT communication models -Internet of nano things - sensor network – Applications – Agriculture – Transport – Environment – Health care – wearable devices.		
Unit: 6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars– webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study	
1	Nanotechnology-Enabled Sensors, Kourosh Kalantar-zadeh, Benjamin Fry, Springer, New York, (2010).
2	Nanosensors: Physical, Chemical and Biological, Vinod Kumar Khanna, CRC,(2012).
3	Internet of Things: A hands on approach, A. Bagha, V. Madisetti, Bagha and Madisetti Publishers,(2014).
Book (s) for Reference	
1	Teik-Cheng Lim, Nanosensors: Theory and Applications in Industry, Healthcare and Defense, CRC,(2011).
2	Kevin C. Honey church, Nanosensors for Chemical and Biological Applications: Sensing with Nanotubes, Nanowires and Nanoparticles, woodhead publishing (2014).
3	Biosensor, Rajmohan Joshi, Isha Books, New Delhi, (2006).
4	Chemical sensors and Biosensors, Brain R. Eggins, John-Wiley, New York, (2002).
5	Smart Biosensor Technology, Bassi.A.S and Knopf.G.K, CRC Press, New York,(2007).
6	Sensors: Principles and Applications, Peter Hauptmann and Tim Pownall, Prentice Hall, (2003).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://onlinecourses.nptel.ac.in/noc19_ee41/preview
2	https://nptel.ac.in/courses/108/106/108106165/
3	https://nptel.ac.in/courses/115/107/115107122/
4	https://nptel.ac.in/courses/106/105/106105166/

Course Designed By	**Dr R. T. Rajendrakumar**	e-mail	rtrkumar@buc.edu.in

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	M	S	M	M	M	L	S
CO2	M	S	M	S	S	M	L	S	M	L
CO3	M	L	L	S	M	S	M	M	L	M
CO4	M	L	L	L	M	S	L	S	S	L
CO5	M	L	M	L	L	M	L	M	M	S
S	Strong			**M**	Medium			**L**	Low	

Course code	33D	ADVANCES IN NANOBIOTECHNOLOGY	L	T	P	C
Core						
Pre-requisite		Basic understanding of nanotechnology concepts and biology.	Syllabus Version		2025 -2026	

Course Objectives:

1. Explain the fundamental principles of drug delivery systems and their parameters for effective therapeutic outcomes.
2. Demonstrate the interaction of nanoparticles within biological systems, including mechanisms and toxicity assays.
3. Introduce recent advancements in nanotherapeutics and cancer therapies.
4. Analyze targeted drug delivery mechanisms through surface modifications and functionalization of nanomaterials.
5. Familiarize students with emerging tools such as 3D bio-printing and its applications in health science.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Recall and describe the fundamental principles and strategies of drug delivery systems.	K1
2	Explain the mechanisms of nanoparticle action inside cells and demonstrate relevant in vitro toxicity assays.	K2
3	Summarize and discuss recent developments in nanobiotechnology-based therapies for cancer treatment.	K2
4	Analyze the design, surface modification, and application of nanoparticles in targeted drug delivery.	K4
5	Evaluate and appraise recent advances in nanobiotechnology, including 3D bio-printing applications, and propose future research directions.	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Principles of Drug Delivery Systems	12 hours

Modes of drug delivery, Absorption distribution metabolism excretion of drugs, Classification of targeted drug delivery systems, Advanced targeted drug delivery - Controlled drug delivery, site specific drugs, Barriers for drug targeting, Prodrug and Bioconjugation, Surface Modification, Strategies for site specific drug delivery - Nano drug delivery systems - Inorganic Nanoparticles, Polymeric Nanoparticles, Lipid Nanoparticles, Solid-Lipid Nanoparticles, Nanocomposites.

Unit:2	Cellular & Molecular Toxicity evaluation of Nanoparticles	12 hours

Cell viability Assays – (LDH assay, MTT assay, Trypan blue exclusion assay), Geno-toxicology assay – (Comet assay, Micronucleus assay), In vitro toxicity assays (ROS assay, Mitochondrial potential, Apoptosis (Annexin V/PI, Caspase), Proliferation assays) cellular uptake and cell cycle analysis by flow cytometer.

Unit:3	Nanoparticles and Cancer Therapy	12 hours

Cancer and its types: Mechanisms of progression in Cancer: Cellular trafficking, Cancer invasion, Migration, Angiogensis and Metastasis, Oncogenes and Tumor suppressor genes. Chemotherapy, Radiotherapy, Immunotherapy, Small Molecular Inhibitors, Photodynamic Therapy (PDT), Photothermal Therapy (PTT), Magnetic Hyperthermia (MHT), High Intensity Focused Ultrasound (HIFU).

Unit:4	Nano Bio Analytics	12 hours
Nano Bio Interface, Luminescent Nanostructures for Bio labelling and Bio imaging - Quantum Dots- multiplexing, Up conversion Nanoparticles, Persistent Luminescence Nanoparticles, Biomolecular structure analysis – AFM, Bio SPM, Molecular Pulling, Biofunctionalized Nanoparticles for SCRS and SPR, Bio-conjugated Nanoparticles for Bio analytical applications, High Throughput Screening.		
Unit:5	**3D Bio -Printing (Three Dimensional Bio-Printing)**	**12 hours**
Introduction - History, principle and its components, Classification of 3D bio-printing techniques - Extrusion-based bio-printing, Droplet-based bio-printing, Laser-based bio-printing, Design Requirements for 3D Bio-printing- Magnetic Resonance Imaging, Computed Tomography, Computer-Aided Design Based Systems, 3D modelling software's, Bio inks for 3D bio-printing - Applications of 3D Bio-printing and future trends.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study

1	Tomar, Rajesh Singh, Nanobiotechnology: Concepts and Applications in Health, Agriculture, and Environment. Apple Academic Press, 2023.
2	Handbook of Nanomaterials for Cancer Theranostics. Conde, J. (Ed.). (2018).
3	Singh, Ajaya Kumar, and Bhawana Jain, editors. Bionanotechnology for Advanced Applications. CRC Press, 2024.

Book (s) for Reference

1	Bhowmick, Tridib Kumar, et al., editors. Nanobiotechnology: Principles and Applications. Bentham Science Publishers, 2024.
2	Zhang, Wen, et al., Advances in Nano Biotechnology. Scientific Research Publishing, 2024.
3	3D Bio-printing in Regenerative Engineering, Principles and Applications, Ali Khademhosseini, Gulden Camci-Unal, 1st edition, CRC press, (2018).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://doi.org/10.1021/acs.chemrev.7b00258
2	https://doi.org/10.5772/intechopen.71923

Course Designed By	**Dr P. Premasudha**	e-mail	premasudha@buc.edu.in

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	L	M	S	M	S	S	S
CO2	S	S	M	M	S	S	S	S	S	S
CO3	S	S	M	S	S	S	S	S	S	S
CO4	M	S	M	M	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S	Strong		**M**	Medium		**L**	Low

Course code	**3EA**		**L**	**T**	**P**	**C**

Core	ENVIRONMENTAL SUSTAINABILITY OF NANOMATERIALS	4	0	0	4
Pre-requisite	General concepts of nanomaterials and their functional properties.	**Syllabus Version**		**2025 -2026**	

Course Objectives:

The main objectives of this course are to:

1. Introduce the fundamentals of nanomaterials and their role in environmental sustainability.
2. Enhance knowledge on the application of nanomaterials in environmental remediation.
3. Provide insights into the development of nanomaterial-based green and renewable energy sources.
4. Familiarize students with advanced methods of CO_2 capture using nanotechnology.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain the beneficial effects of sustainable nanotechnology on climate change, quality of life, and natural resource management.	K3
2	Analyze the principles of catalysis (including photocatalysis) and illustrate their common applications in environmental treatment.	K4
3	Evaluate the role of nanomaterials (CNTs, nanostructured films/membranes) in water treatment technologies.	K4
4	Design strategies to improve the functional properties of photocatalysts and photoelectrocatalysts.	K5
5	Assess advanced energy conversion processes such as water splitting and CO_2 reduction using nanomaterials.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**Nanotechnology for Environmental Remediation**	**12 hours**

Types of environmental contaminants – Role of nanomaterials in remediation – Overview of functional nanomaterials: nano membranes, meshes, fibers, clays, zeolites, adsorbents, CNTs, nano catalysts, biopolymers, bimetallic iron nanoparticles, semiconductors. Applications in envi-ronmental clean-up – Overview of nanofiltration, Nano sensors, and nanotechnology-enabled treatment techniques (see Unit 3 for photocatalysis). Nano remediation methods – Thermal, phys-io-chemical, and biological approaches – Use of nanoparticles in water and industrial waste treatment – Environmental benefits and sustainability of nanomaterial use.

Unit:2	**Environmental issues in Water and Remediation**	**12 hours**

Emerging contaminants in water – Sources and occurrence of pharmaceuticals, estrogens , drugs of abuse, surfactants, and perfluorinated compounds (PFCs). Industrial pollutants – Plasticizers, corrosion inhibitors, and textile dyes. Health and ecological impacts – Comparative analysis of risks to humans and ecosystems. Conventional water treatment technologies – Adsorption: Acti-vated carbon – mechanism and limitations. Chemical oxidation: Ozonation, chlorination, chlorine dioxide – principles, applications, and by-product concerns. Membrane separation processes: Ul-trafiltration (UF), nanofiltration (NF), reverse osmosis (RO) – removal capabilities and energy considerations.

Unit:3	**Photocatalysis for Environmental Remediation**	**12 hours**

Principles and mechanisms of photocatalysis – Definition, types, key reactive species. Mechanis-tic study using TiO_2 as a model catalyst – Visible-light-responsive photocatalysts: strategies such as doping and composite formation-Factors influencing photocatalytic performance – Catalyst structure, light source parameters, and solution chemistry. Photocatalytic kinetics – Langmuir-Hinshelwood model (primary), pseudo-first-order reactions. Challenges in photocatalysis – Charge carrier recombination, catalyst stability, and recovery. Application and reactor engineer-ing – Comparison of slurry and immobilized systems; continuous-flow reactor design. Efficiency enhancement strategies – Doping,

surface modification, and cocatalyst integration. Case studies – Photocatalytic degradation of dyes and pharmaceutical contaminants		
Unit:4	**Water Splitting for Hydrogen Production**	**12 hours**
Overview of water splitting reactions – Natural and artificial photosynthesis – Fundamentals of HER and OER reactions. Water oxidation catalysts and semiconductor materials – Band gap alignment and redox potential considerations – Common photocatalysts: TiO_2, WO_3, g-C_3N_4, Fe_2O_3. Dye-sensitized and Z-scheme photocatalysts – Co-catalysts for efficiency enhancement. Electrode preparation methods – Wet and dry techniques – Electrochemical screening for catalytic activity – Stability and efficiency metrics – Assessment of long-term performance.		
Unit:5	**Nanotechnology for Carbon Dioxide Capture**	**12 hours**
CO_2 as a resource – Circulated CO_2 economy and climate relevance – Overview of CO_2 capture and separation technologies. Direct air capture using nanomaterials – Mechanisms: physisorption vs. chemisorption – Key materials: MOFs, CNTs, nano porous membranes, nanocrystals, nanoparticle ionic materials, CuO-loaded porous carbon, cellulose-based porous nanomaterials, nanocomposites. Performance evaluation: Selectivity, adsorption capacity, regeneration energy – Potential conversion of captured CO_2 into fuels or chemicals – Environmental benefits and sustainability of nano-enabled CO_2 capture methods.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study	
1	Nanomaterials for Environmental Protection, Ed. By Boris I. Kharisov, Oxana V. Kharissova, H. V. Rasikha Dias, John Wiley, 2015.
2	Nanotechnologies for Environmental Remediation : Applications and Implications, edited by Giusy Lofrano, Giovanni Libralato, Jeanette Brown, Springer, 2016.
3	Hydrogen Production by Electrolysis, Edited by AgataGodula –Jopek, Wiley – VCH, 2015.
4	Management of Contaminants of Emerging Concern (CEC) in Environment edited by Pardeep Singh, Sanchayita Rajkhowa, Chaudhery Mustansar Hussain, Elsiver 2017
5	Diallo, M., Duncan, J., Savage, N., Street, A., and Sustich, R. (Eds). "Nanotechnology Applications for Clean Water" William Andrew. 2008
Book (s) for Reference	
1	Nanomaterials for Environmental Protection, Ed. By Boris I. Kharisov, Oxana V. Kharissova, H. V. Rasikha Dias, John Wiley, 2015.
2	Nanotechnologies for Environmental Remediation : Applications and Implications, edited by Giusy Lofrano, Giovanni Libralato, Jeanette Brown, Springer, 2016.
3	Hydrogen Production by Electrolysis, Edited by AgataGodula –Jopek, Wiley – VCH, 2015.
4	Management of Contaminants of Emerging Concern (CEC) in Environment edited by Pardeep Singh, Sanchayita Rajkhowa, Chaudhery Mustansar Hussain, Elsiver 2017
5	Diallo, M., Duncan, J., Savage, N., Street, A., and Sustich, R. (Eds). "Nanotechnology Applications for Clean Water" William Andrew. 2008
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/content/storage2/courses/105108075/module9/Lecture40.pdf
2	https://nptel.ac.in/courses/118/107/118107015/

3	https://nptel.ac.in/courses/105/107/105107181/
4	https://onlinecourses.nptel.ac.in/noc20_ce31/preview
5	https://nptel.ac.in/courses/112/107/112107283/
6	https://nptel.ac.in/courses/112/107/112107283/

Course Designed By	**Dr N. Ponpandian**	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	M	L	M	S	S	S	S	S	S
CO2	S	M	L	M	S	S	S	S	S	S
CO3	S	L	M	S	S	S	S	S	S	S
CO4	S	L	M	S	S	M	S	S	S	S
CO5	M	M	L	S	S	M	S	S	S	S
S	Strong		**M**	Medium			**L**	Low		

Course code	3EB	SOCIETAL IMPACTS OF NANOTECHOLOGY	L	T	P	C
Elective			4	0	0	4
Pre-requisite		General concepts of nanomaterials and their functional properties.	Syllabus Version		2025 - 2026	

Course Objectives:

The main objectives of this course are to:

1. Provide knowledge of the economic impact of nanotechnology on industries and global markets.
2. Enable students to analyze societal and ethical implications of nanotechnology research and applications.
3. Familiarize students with laws, policies, and regulatory frameworks governing nanotechnology.
4. Evaluate commercialization strategies and societal acceptance of nanotechnology.
5. Develop a critical perspective on contemporary issues, risks, and opportunities of nanotechnology.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Apply knowledge to analyze the economic impact of nanotechnology in industrial and societal contexts.	K3
2	Examine and evaluate ethical issues and legal frameworks related to nanotechnology.	K4
3	Analyze the societal impacts and implications of nanotechnology adoption and trends.	K4
4	Evaluate potential legal risks and regulatory challenges associated with nanotechnology.	K5
5	Critically assess strategies for product scaling-up and commercialization of nanotechnology.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Protection and Regulation for Nanotechnology	12 hours

Patentability requirements-riding the patent office pony-infringement issues-nanotech patents outside the united states-copyright requirements-nanotech creation as artist works-Delegation of power of agencies-Examples of regulation of nanotechnology environmental regulations-regulation of exports-political and judicial control over agency action.

Unit:2	Liability Legal Aspects of Nanotechnology	12 hours

The applications of civil &criminal laws-civil liability, application of negligence to nanotechnology, strict liability for nanotechnology products-warranty-class actions nanotechnology business organization-criminal liability

Unit:3	Economic Impacts and Commercialization of Nanotechnology and Social Scenarios	12 hours

Introduction -Socio-Economic Impact of Nanoscale Science: Initial Results and Nano bank-Managing the Nanotechnology Revolution: Consider the Malcolm Baldrige National Quality Criteria -The Emerging Nano Economy: Key Drivers, Challenges, and Opportunities-Transcending Moore's Law with Molecular Electronics and Nanotechnology- Navigating Nanotechnology Through Society -Nanotechnology, Surveillance, and Society: Methodological Issues and Innovations for Social Research-Nanotechnology: Societal Implications: Individual Perspectives Nanotechnology and Social Trends-Five Nanotech

Unit:4	Ethics, Law and Governance	12 hours
Ethics and Law-Ethical Issues in Nanoscience and Nanotechnology: Reflections and Suggestions-Ethics and Nano: A Survey-Law in a New Frontier- An Exploration of Patent Matters Associated with Nanotechnology -The Ethics of Ethics -Negotiations over Quality of Life in the Nanotechnology Initiative. Governance-Problems of Governance of Nanotechnology -Societal Implications of Emerging Science and Technologies: A Research Agenda for Science and Technology Studies (STS)- Institutional Impacts of Government Science Initiatives - Nanotechnology for National Security.		
Unit:5	**Public Perceptions and Education**	**12 hours**
Public Perceptions-Societal Implications of Nanoscience: An Agenda for Public Interaction Research -Communicating Nanotechnological Risks- A Proposal to Advance Understanding of Nanotechnology's Social Impacts -Nanotechnology in the Media: A Preliminary Analysis-Public Engagement with Nanoscale Science and Engineering -Nanotechnology: Moving Beyond Risk-Communication Streams and Nanotechnology: The (Re)Interpretation of a New Technology-Nanotechnology: Societal Implications — Individual Perspectives-Historical Comparisons for Anticipating Public Reactions to Nanotechnology.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**62 hours**

Book (s) for Study

1	Mihail. C, Roco and William Sims Bainbridge "Nanotechnology: Societal Implications II-Individual Perspectives", Springer, 2007.
2	Geoffrey Hunt and Michael. D, Mehta "Nanotechnology: Risk, Ethics and Law", Earthscan/James & James publication, 2006.
3	Jurgen Schulte "Nanotechnology: Global Strategies, Industry Trends and Applications", John Wiley & Sons Ltd, 2005.
4	Mark. R, Weisner and Jean-Yves Bottero "Environmental Nanotechnology applications and impact of nanomaterial", The McGraw-Hill Companies, 2007.

Book (s) for Reference

1	Jurgen Schulte ―Nanotechnology: Global Strategies, Industry Trends and Applications‖, JohnWiley & Sons Ltd (2005).
2	Mark. R. Weisner and Jean-Yves Bottero ― Environmental Nanotechnology applications andimpact of nanomaterial‖, The McGraw-Hill Companies (2007).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/103/105/103105122/
2	https://nptel.ac.in/content/storage2/courses/105108075/module9/Lecture40.pdf
3	https://www.azonano.com/article.aspx?ArticleID=4992

Course Designed By	**Dr N. Ponpandian**	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	L	M	S	S	S	S	S	S

CO2	S	M	L	M	S	S	S	S	S	S
CO3	S	L	M	S	S	S	S	S	S	S
CO4	S	L	M	S	S	M	S	S	S	S
CO5	M	M	L	S	S	M	S	S	S	S
S	Strong			**M**	Medium			**L**	Low	

Course code	37V	SUMMER INTERNSHIP PROJECT	L	T	P	C
Core			0	0	2	2
Pre-requisite		Basic knowledge and understanding of physics, chemistry, biology, and fundamentals of nanoscience and technology.	Syllabus Version		2025 -2026	

Course Objectives:

1. Provide real-life organizational exposure to broaden students' perspectives on functional activities in research/industry.
2. Enable students to connect theoretical knowledge with practical applications in a professional environment.
3. Equip students with workplace skills including communication, teamwork, and problem-solving.
4. Develop professional ethics, responsibility, and networking abilities to support career/higher education prospects.
5. Foster independent learning, adaptability, and integrity in handling organizational information and practices.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Analyze professional practices through direct experience in an organizational setup.	K4
2	Relate theoretical concepts learned in classrooms to practical workplace applications.	K2
3	Apply acquired knowledge and skills in problem-solving within industrial/research environments.	K3
4	Demonstrate effective communication, teamwork, and interpersonal skills in organizational contexts.	
5	Practice time management, multitasking, and self-directed learning strategies to enhance professional competence.	

K1– Remember; **K2**–Undestand; **K3**– Apply; **K4**– Analyze; **K5**– Evaluate; **K6**– Create

The total marks for the Summer Internship Project will be 50 and it carries 2 credits. The marks will be awarded for the following aspects:

1	**Introduction:** Clear understanding of the topic/subject; understanding of the organisation/unit//field as well as review of similar studies
2	**Details about the study:** Objectives, formulation of the problem, scope, and rationale of the study.
3	**Methods/methodology adopted for the study:** Analytical, Survey, Field Work or any other method with appropriate justification and reasoning.
4	**Analysis and conclusions:** The logic of analysis, source of data, whether the conclusions are in line with the objectives, etc.
5	**Contribution and learning from the project:** Details of the contribution of the study,, the benefits to the organisation, the learning from the study for the student, etc.
6	**Acknowledgements:** References/Citations and Bibliography and help, if any,, received from other individuals/organisations.
7	**Presentation of the report, format of the report, flow of the report, style, language, *etc*.**

8	**Presentation of the report to the examiners:** Substance and treatment of the topic, style of presentation, performance in the question answer session, time management, language, etc.
9	Overall impression.
10	It also includes the report on the study tour during I and III Semesters.

Course Designed By	**Dr N. Ponpandian**	**e-mail**	**ponpandian@buc.edu.in**

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	L	S	S	S	L	S	S
CO2	S	S	L	L	S	S	M	M	M	S
CO3	S	S	M	M	S	S	M	L	S	S
CO4	S	S	L	M	S	S	L	M	M	S
CO5	S	S	L	L	S	S	M	M	M	S

S	Strong		**M**	Medium		**L**	Low

Course code	33P	PRACTICAL – III – APPLICATIONS OF NANOMATERIALS	L	T	P	C
Core			0	0	4	4
Pre-requisite		Basic knowledge and understanding of nanoscience, physics, chemistry, and biology.	Syllabus Version		2025 -2026	

Course Objectives:

1. Provide hands-on training in operating advanced instruments for analyzing the physical, chemical, and biological properties of nanomaterials.
2. Develop practical skills to design, fabricate, and evaluate application-specific nanoscale devices and systems.
3. Enhance understanding of nanomaterials' functionalization, sensing, and energy-related applications.
4. Train students in biomedical and environmental applications of nanomaterials through laboratory

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Analyze the design aspects of application-specific nanoscale devices and their working principles.	K4
2	Explain the material properties relevant to the fabrication of nanosensors.	K2
3	Apply knowledge of nanomaterial functionalization techniques to various applications..	K3
4	Evaluate electrochemical energy storage systems and biomedical applications of nanomaterials.	K5
5	Design and develop experiments using modern tools, techniques, and skills for nanomaterials-based applications.	K6

K1– Remember; **K2**–Understand; **K3**– Apply; **K4**– Analyze; **K5**– Evaluate; **K6**– Create

Practical

1	Electrochemical properties of nanoparticles using cyclic-voltammetry
2	Electrochemical sensors for the detection of pollutants in water
3	Gold nanoparticle based SERS sensing characteristics of toxic compound
4	Evaluating gas sensing parameters for a given nanosensor
5	Determination of charge storage efficiency, energy density of a given nanomaterials based supercapacitor
6	Evaluation of photocatalytic degradation efficiency of a give nanomaterial against organic dye degradation.
7	Evaluation of the surface energy of a given nanomaterial using contact angle method
8	Analyzing the figures of merit of a field effect transistor based gas sensor
9	Determine the hydrogen evolution properties of a given electro catalyst
10	Verification of Lambert Beer's law and determination of concentration of unknown solution by UV-Vis spectrophotometer.
11	Fabrication of scaffolds
12	3-D printing of scaffolds
13	Cell isolation and seeding
14	Electro chemical corrosion experiment
15	Animal Cell Culture Techniques – Primary Cell Culture, Sub Culturing

Course Designed By	Dr N. Ponpandian	e-mail	ponpandian@bu

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	M	S	S	S	S	S	S
CO2	S	S	M	S	S	S	S	S	S	S
CO3	S	S	M	M	S	S	S	S	S	S
CO4	S	S	M	L	S	S	S	S	S	S
CO5	S	S	L	M	S	S	S	S	S	S
S	Strong			**M**	Medium			**L**	Low	

Fourth Semester

Course code	43A	IPR, Biosafety and Research Ethics	L	T	P	C
Core			2	0	0	2
Pre-requisite		Basic knowledge in intellectual property rights and laboratory safety..	Syllabus Version		2025 - 2026	

Course Objectives:

The main objectives of this course are to:

1. Provide conceptual understanding of Intellectual Property Rights (IPR) and Biosafety principles.
2. Familiarize students with the process of patenting, database searches, and analytical report preparation.
3. Develop knowledge of national and international IPR laws, policies, and frameworks.
4. Enable students to analyze biosafety issues in science and technology applications.
5. Equip learners to critically evaluate risks and apply biosafety guidelines in research and industrial practices.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain the fundamental concepts, history, and classification of Intellectual Property Rights.	K2
2	Analyze and perform patent database searches, interpret results, and prepare structured reports.	K4
3	Evaluate patent drafting processes, applications, and filing procedures at national and international levels.	K5
4	Interpret national and international IPR laws, policies, and case studies related to biotechnology and genetics.	K2
5	Explain biosafety principles, levels, and guidelines, and critically evaluate GMO applications and associated risks.	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Types of IP	6 hours

Patents – Trademarks - Copyright & Related Rights - Industrial Design - Traditional knowledge - Geographical indications - Protection of new GMOs; International framework for the protection of IP - Invention in context of "prior art" - Patent databases - Searching International Databases - Country-wise patent searches (USPTO, EPO, India etc.) - Analysis and report formation.

Unit:2	Types of Patents	6 hours

Indian patent act 1970 - Recent amendments - Patent application- forms and guidelines -Fee structure -Time frames - Filing of a patent application - Precautions before patenting- disclosure/non-disclosure - Patent application- Forms and guidelines -Fee structure -Time frames - Types of patent applications -Provisional and complete specifications - PCT and convention patent applications - International patenting – Requirement -Procedures and costs - Financial assistance for patenting-introduction to existing schemes.

Unit:3	IPR Policies	6 hours

IPR policy of Government of India - Indian &international patent laws - Indian patent act 1970; recent amendments - Financial assistance for patenting-existing schemes- Role of patents in biotechnology - The patentability of microorganisms - IPR and WTO regime - consumer protection and plant genetic resources-GATT and TRIPS - Patenting gene - Issues and case studies.

Unit:4	Biosafety	6 hours
Historical background - Introduction to biological safety cabinets - Primary containment for biohazards - Biosafety levels- Biosafety levels of specific microorganisms - Recommended biosafety levels for infectious agents and infected animals - Biosafety guidelines - Government of India.		
Unit:5	**Rules in Biosafety**	**6 hours**
Definition of GMOs & LMOs - Roles of institutional biosafety committee - RCGM, GEAC - GMO applications in food and agriculture - Environmental release of GMOs - Risk analysis - Risk assessment - Risk management and communication - Overview of national regulations and relevant international agreements including Cartagena protocol.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**32 hours**

Book (s) for Study	
1	Intellectual Property Law, P. Narayanan, 3rd Edition, Eastern Law House, 2018.
2	Intellectual Property Law, Meenu Paul, Reprint, Allahabad Law Agency, 2018.
3	Biotechnology, John E. Smith, 5thEdition, Cambridge University Press, 2012.

Book (s) for Reference	
1	Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.
2	Intellectual Property Rights, Neeraj Pandey, Khusdeep Dharni, PHI Learning (P) Ltd., 2014.
3	Laboratory biosafety manual Third edition, World Health Organization, 2004.
4	Biological Safety: Principles and Practices, 5th Edition, **Volume 25, Number 1,** Dawn P. Wooley; Karen B. Byers, ASM Press, Washington, DC, USA, 2017.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/109/106/109106137/
2	https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-hs45/
3	https://nptel.ac.in/courses/109/106/109106148/
4	https://nptel.ac.in/courses/127/105/127105008/
5	https://onlinecourses.nptel.ac.in/noc20_hs18/preview

Course Designed By	**Dr N. Ponpandian**	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	L	S	M	M	S	S	S
CO2	S	M	M	M	M	L	L	S	S	S
CO3	S	S	M	L	S	S	M	S	S	M
CO4	S	S	M	L	M	M	S	S	S	S
CO5	S	S	M	M	S	S	S	S	S	S
S	Strong		**M**	Medium			**L**	Low		

Course code	47V	PROJECT AND VIVA VOCE	L	T	P	C
Core			0	0	8	8
Pre-requisite		Basic knowledge and understanding in Physics, Chemistry, Biology, and Nanoscience & Technology.	Syllabus Version		2025 -2026	

Course Objectives:

1. Enable students to independently plan and execute research-based projects.
2. Integrate knowledge from different subjects in solving real-life scientific/engineering problems.
3. Foster critical thinking, problem-solving, and innovation through hands-on research.
4. Develop personal qualities such as initiative, responsibility, teamwork, and creativity.
5. Enhance written and oral communication skills in presenting scientific work.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Formulate research problems and design appropriate methodologies to achieve project objectives.	K4
2	Demonstrate proficiency in handling laboratory/workshop equipment, characterization techniques, and data collection.	K2
3	Critically analyze, interpret, and evaluate experimental/field data to derive meaningful conclusions.	K3
4	Work independently and collaboratively, demonstrating initiative, research ethics, and problem-solving skills.	
5	Communicate scientific concepts and research findings effectively through oral presentation and technical report writing.	

K1– Remember; **K2**–Understand; **K3**– Apply; **K4**– Analyze; **K5**– Evaluate; **K6**– Create

About the Project

1	Final year projects are designed to apply acquired knowledge, intellectual abilities, and practical skills to solve real or near-real-life problems. Projects may involve investigation, design, or development of devices, or a combination of both.
2	Students, under supervision, are expected to perform literature review, formulate hypotheses, design methodologies, conduct experiments, analyze results, and draw conclusions.
3	Communication is emphasized: a. **Oral skills** through discussions, project reviews, and final viva voce. b. **Written skills** through project reports and publications.
4	Continuous monitoring will ensure effective project execution, ethical research practice, and optimum utilization of resources.
5	**Assessment Guidelines** • Project Report (75 Marks): • Aim and Objectives of Research – 10 • Methodology – 15 • Execution of Research – 20 • Data Analysis & Interpretation – 15

	• Report Writing & Organization – 10 • Conclusion & Research Outcomes – 5 **PowerPoint Presentation & Viva (25 Marks):** • Body Language & Presentation Style – 5 • Communication Skills – 5 • Content, Structure & Clarity of Presentation – 15

Course Designed By	**Dr N. Ponpandian**	e-mail	ponpandian@buc.edu.in

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	S	S	S	S	S	S
CO2	S	S	L	L	S	S	S	S	S	S
CO3	S	S	S	M	S	S	S	S	S	S
CO4	S	S	L	S	S	S	S	S	S	S
CO5	S	S	M	L	S	S	S	S	S	S
S	Strong			**M**	Medium			**L**	Low	

Supportive Courses

Course code	1GS	INTRODUCTION TO NANOSCIENCE AND TECHNOLOGY	L	T	P	C
Supportive			2	0	0	2
Pre-requisite		Studied Physics / Chemistry / Biology / Any Allied subject during graduate programme.	Syllabus Version		2025 -2026	

Course Objectives:

1. Introduce the fundamental concepts of atomic structure.
2. Familiarize students with the principles of chemical bonding.
3. Lay the foundation of nanoscience and technology.
4. Enhance understanding of nanomaterials synthesis techniques.
5. Provide basic knowledge of nanomaterials characterization methods.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Recall and explain the basic structure of atoms, molecules, and periodic properties.	K1
2	Demonstrate understanding of different types of chemical bonding and bonding theories.	K2
3	Apply fundamental chemistry concepts to synthesize nanomaterials using various techniques.	K3
4	Analyze nanomaterials using standard spectroscopic and microscopic characterization techniques.	K4
5	Evaluate the advantages and limitations of different nanomaterials and propose suitable methods for their synthesis and characterization.	

K1– Remember; **K2**–Understand; **K3**– Apply; **K4**– Analyze; **K5**– Evaluate; **K6**– Create

Unit:1	Basics of Atomic Structures	6 hours

Atoms, Molecules, Ions, Electrons & Periodic trends: Atomic models, Periodic table and electronic structures, Sizes of atoms & ions, Ionization Energy, Electron affinity and electron negativity, Trends in chemistry of groups.

Unit:2	Chemical Bonding	6 hours

Molecular structure and Bonding Theories: Atomic Bonding in solids, Types of bond: Metallic, Ionic, Covalent and Vender-Waals bond; Hybridization; Hydrogen bonding, Molecular orbital theory for simple molecules such as diatomic molecules etc.,

Unit:3	Basic Concepts of Nanoscience	6 hours

Nanoscience- Nanotechnology- Nanomaterials definitions,- Classification of carbon nanostructures- Allotropes, dimensions (one, two, three, and zero dimension), confinement- Surface to volume ratio-Energy at bulk and nano scale- Nature Nanophenomena- Size dependent variation in Physical- Chemical- Catalytic properties.

Unit:4	Synthesis of Nanomaterials	6 hours

Chemical precipitation and co-precipitation, Sol-gel synthesis, Microemulsions or reverse microemulsions, Solvothermal synthesis, Thermolysis routes, Metal nanocrystals by reduction, Microwave heating synthesis, Photochemical synthesis, Electrochemical synthesis, Sonochemical synthesis.

Unit:5	Characterization of Nanomaterials	6 hours

Optical Spectroscopy- UV-Vis Absorption Spectroscopy, Photoluminescence (PL) Spectroscopy, Fourier Transform Infrared Spectroscopy (FT-IR), Raman Spectroscopy.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**32 hours**

Book (s) for Study	
1	Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder, 12th Edition, John Wiley & Sons, New York, (2017).
2	Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, John Wiley & Sons Ltd, (2005).
3	NANO: The Essentials- Understanding Nanoscience and Nanotechnology, T. Pradeep, McGraw Hill Education (India) Private Limited, (2018).
4	Schodek, Nanomaterials, Nanotechnologies and Design M.F. Ashby, P.J. Ferreira, D.L, Elsevier, (2009).
5	Elementary Organic Spectroscopy, Y.R. Sharma, S. Chand Publishing, (2007).
Book (s) for Reference	
1	March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Michael B. Smith, 8th Edition, Wiley, (2019).
2	Nanoparticle Technology Handbook, Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama, Elsevier Publications, (2007).
3	Encyclopedia of Materials Characterization, Series Editors: Butxetworch-Heinemann, C. Richard Brundle and Charles A. Evans. Jr, a division of Reed Publishing CUSA) Inc, (1992).
4	Introduction to Nanoscience and Nanotechnology, K K Chattopadhyay, Arghya Narayan Banerjee, PHI Learning, (2009).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://swayam.gov.in/nd1_noc19_mm21/preview
2	https://swayam.gov.in/nd1_noc19_mm22/preview

Course Designed By	**DrP. Sakthivel**	e-mail	sakthivel.p@buc.edu.in

Course code	2GS	Applications of Nanotechnology	L	T	P	C
Supportive			2	0	0	2
Pre-requisite		Should have studied Physics/ Chemistry/ Biology/ Fundamentals of Nanoscience/Any Allied Subject during Graduate Programme	Syllabus Version		2025 -2026	

Course Objectives:

1. Develop an understanding of the applications of nanotechnology in energy, agriculture, environment, and healthcare.
2. Encourage critical thinking and innovative approaches to research problems in nanotechnology.
3. Enable students to apply nanoscience principles in designing and fabricating nanodevices.
4. Provide practical insights into the role of nanomaterials in sustainable development.
5. Motivate students to explore interdisciplinary applications of nanotechnology.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain the applications of nanomaterials in solar energy, storage, agriculture, environment, and healthcare.	K1
2	Apply knowledge of nanoscience to demonstrate natural dye-based DSSCs.	K3
3	Differentiate between various types of nanomaterial-enabled energy devices and their working principles.	K2
4	Propose nanotechnology-based solutions for wastewater purification.	K4
5	Design a nanodevice for biological and medical applications.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit:1	Nanomaterials for Solar Cells	6 hours

Principles of photovoltaic (PV) energy conversion, Types of photovoltaic cells, Physics of photovoltaic cells, Organic photovoltaic cells, Dye-sensitized solar cells (DSSCs), Quantum dot (QD)-sensitized solar cells (QD-SSC), Organic-inorganic hybrid bulk heterojunction (BHJ-SC) solar cells, Current status and future trends.

Unit:2	Nanomaterials for Energy Storage	6 hours

Introduction of energy storage devices, Issues and challenges of nanomaterials for electrochemical energy storage systems, Primary and secondary batteries (Lithium ion Batteries), Supercapacitor, Current status and future trends.

Unit:3	Nanomaterials for Agricultural Applications	6 hours

Nanotechnology in agriculture-Precision farming, Smart delivery system- Nanofertilizers: Nanourea and mixed fertilizers, Nanofertigation - Nanopesticides, Nanoseed.

Unit:4	Nanomaterials for Environmental Applications	6 hours

Environmental pollutants in the air, water, soil, hazardous and toxic wastes- Applications of nanotechnology in the remediation of Pollution in industrial and wastewater treatment- Drinking water and Air/Gas purifications.

Unit:5	Nanomaterials for Biological Applications	6 hours

Development of nanomedicines- Nanotechnology in the diagnostic application. Preformulation Studies: on various dosage forms such as tablets, capsules- suspension-creams- emulsion-

injectables- ophthalmic and aerosols, etc. Gold nanorods: Multifunctional agents for cancer imaging and therapy- Fluorescent silica nanoparticles for tumor imaging		
Unit:6	**Contemporary Issues**	**1 hours**
Expert lectures, online seminars– webinars		
	Total Lecture hours	**31 hours**

Book (s) for Study	
1	Handbook of Batteries, D. Linden Ed., 2nd Edition, McGraw-Hill, New York, (1995).
2	Introduction to Nanotechnology, Charles P. Poole, Jr. Frank J. Owens, A John Wiley 81Sons, Inc., Publication, (2003).
3	Nanotechnology: Applications in Energy, Shafiquzzaman Siddiquee, Gan Jet Hong Melvin, and Md. Mizanur Rahman, Drug and Food, Springer, Cham, (2019).
4	C. Kumar, Nanomaterials for Medical Diagnosis and Therapy, Wiley –VCH, USA, (2007).
5	Wiesner M R and Bottero JY, Environmental Nanotechnology: Applications and Impacts of Nanomaterials, McGraw-Hill New York,(2007).
Book (s) for Reference	
1	Polymer Matrix Composites and Technology, Ru-Min Wang Shui-Rong Zheng Yujun Zheng, 1stEdition, Woodhead Publishing, (2011).
2	Nanoparticles Deliver RNAi Therapy, Materials Today, Martin C. Woodle, Patrick Y. Lu,(2005).
3	Nanotechnology 101, John Mongillo, Greenwood Press, (2007).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/113/106/113106093/
2	https://nptel.ac.in/courses/102/107/102107058/
3	https://nptel.ac.in/courses/102/104/102104069/
4	https://nptel.ac.in/courses/112/107/112107283/

Course Designed By	**Dr P. Sakthivel**	e-mail	sakthivel.p@buc.edu.in

Value Added Courses

ANTIMICROBIAL TESTING	
Name of the Department	**Nanoscience and Technology**
Name of the Faculty Member i/c With Complete Address with Phone and e-mail	Dr P. Premasudha Assistant Professor Department of Nanoscience and Technology Bharathiar University Coimbatore 641 046 Mobile: 9843620645 Email : premasudha@buc.edu.in
Inter / Intra Department Course	Intra Department
Duration of the Course	30 hours
Eligibility	Microbiology / Biotechnology / Biochemistry /Botany / Zoology / Nanoscience
Number of Candidates to be Admitted	20
Registration Procedure	

Job Opportunities:

Pursue a career as a Microbiology Laboratory Technician for culture testing

Learn to suggest appropriate antibiotics

The objectives of the Course are:

The main objectives of this course are:

1. To understand the fundamental principles of antimicrobial testing.
2. To utilize standard protocols to evaluate microbial susceptibility to antibiotics.
3. To differentiate the range and spectrum of activity of various antimicrobial agents.
4. To evaluate advantages and limitations of different susceptibility testing methods.
5. To explain and apply concepts such as Minimal Inhibitory Concentration (MIC) and
6. Minimal Bactericidal Concentration (MBC).

Expected Course Outcomes are :

CO1	Recall and explain the occurrence of microbes (bacteria and fungi) relevant to antimicrobial testing.	K1
CO2	Describe and classify probiotics and pathogenic microorganisms with examples.	K2
CO3	Summarize the discovery and development of antibiotics and antibiotic resistance.	K2
CO4	Analyze factors governing antibiotic resistance in microbes.	K4
CO5	Apply different antimicrobial testing protocols for bacteria and fungi.	K3

CO6 Evaluate the antimicrobial activity of nanomaterials and interpret results. K5

CO7 Propose future nanotechnology-based antimicrobial strategies.

Course Content	Lecture / Practical / Project / Internship	
Module 1	Introduction and Occurrence of Microorganisms	**3 - hours**

	(Bacteria and Fungi)	
Module 2	Probiotics and Pathogenic Microorganisms	**3- hours**
Module 3	Discovery of Antibiotics Development	**3- hours**
Module 4	Development of Antibiotic Resistant Microbes.	**3- hours**
Module 5	Factors Governing in the Development of Antibiotic Resistant Microbes	**3- hours**
Module 6	Introduction of Antimicrobial Testing	**3- hours**
Module 7	Antimicrobial Testing Protocols - Bacteria	**3- hours**
Module 8	Antimicrobial Testing Protocols - Fungi	**3- hours**
Module 9	Nanomaterials in Antimicrobial Activity	**3- hours**
Module 10	Future Perspectives and Conclusion	**3- hours**

Book(s) for Study	
1	Geeta Sumbali and Mehrotra RS (2009). Principles of Microbiology. First edition,
2	Dubey RC and Maheswari DK (2012). A Text of Microbiology. Revised edition, S. Chand and Company Ltd., New Delhi
3	Ananthanarayan & Paniker's. (2013). Text Book of Microbiology, 9th Edition, Universities Press.
Book (s) for Reference	
1	Prescott L M, J P Harley and D A Klein (2005). Microbiology. Sixth edition, International edition, McGraw Hill.
2	Pelczar TR M J Chan ECS and Kreig N R (2006). Microbiology. Fifth edition, Tata McGraw-Hill INC. New York.
Related Online Contents	
1	Khan, Z. A., Siddiqui, M. F., & Park, S. (2019). Current and emerging methods of antibiotic susceptibility testing. Diagnostics, 9(2), 49. https://dx.doi.org/10.3390%2Fdiagnostics9020049
2	Reller, L. B., Weinstein, M., Jorgensen, J. H., & Ferraro, M. J. (2009). Antimicrobial susceptibility testing: a review of general principles and contemporary practices. Clinical infectious diseases, 49(11), 1749-1755. https://doi.org/10.1086/647952

ORGANIC SOLAR CELLS: MATERIALS DESIGN AND DEVICE CHARACTERIZATION		
Name of the Department	Nanoscience and Technology	
Name of the Faculty Member i/c With Complete Address with Phone and e-mail	Dr. P. Sakthivel Professor Department of Nanoscience and Technology Bharathiar University, 0422-428428, 9677560890	
Inter / Intra Department Course	Inter Department Course	
Duration of the Course	40 hours	
Eligibility	Chemistry, physics, Electronics, Nanoscience and Technology	
Number of Candidates to be Admitted	20	
Registration Procedure		
Job Opportunities: • Employment in solar cell industries and renewable energy companies • Research opportunities in photovoltaic materials and device fabrication • Prospects in sustainable energy technology development		
The objectives of the Course are:		
The main objectives of this course are to:		
• Differentiate between small molecules and polymers in organic photovoltaics. • Design conjugated small molecules and macromolecules for solar energy applications. • Theoretically tune HOMO, LUMO, and band gap energy levels for optimized performance. • Identify suitable donor and acceptor materials for bulk heterojunction (BHJ) device fabrication. • Gain hands-on exposure to organic solar cell device fabrication and performance evaluation.		
Course Content	Lecture	
Module 1	Introduction and overview of alternative energy sources and utilization	3 hours
Module 2	Principles of energy conversion: thermodynamic first and second laws, the Carnot cycle	3 hours
Module 3	Solar energy: Solar intensity and spectrum, global solar energy potential and current level of utilization	3 hours
Module 4	Review on Renewable and Nonrenewable energy resources	3 hours
Module 5	Discussion of different types of Organic Solar cells materials and state-of-the-art	4 hours
Module 6	Working principles of BHJ Devices with D-A Type DONOR and Fullerene ACCEPTORS	4 hours
Module 7	Designing DSSCs and conjugated Small/polymer solar cell materials and energy levels	5 hours
Module 8	Fullerene Acceptors Synthesis and Structural Studies	5 hours
Module 9	Overview of perovskite solar cell and state-of-the-art	5 hours
Module 10	Organic solar cells device fabrication techniques and Applications	5 hours
Book(s) for Study		
1	Wolfgang Tress, Organic Solar Cells, Theory, Experiment, and Device Simulation, Springer, Cham, 2014.	
2	S. Hegedus and A. Luque, "Handbook of Photovoltaics", 2nd Ed. 2005.	
3	Martin A. Green "Solar Cells: Operating Principles, Technology and System Applications"(Prentice-Hall, Englewood Cliffs, N.J., 1982)ISBN: 0-85823-580-3.	

Book (s) for Reference	
1	Christoph Brabec, Ullrich Scherf, Vladimir Dyakonov, Organic Photovoltaics, Wiley-VCH, 2014
2	Modest Voronov, Organic Solar Cells: Advances in Research and Applications, NOVA Science Publisher, 2017.
Related Online Contents	
1	Prof. Soumitra Satpathi, Dept of Physics, IIT Roorkee, Solar Photovoltaics Fundamentals, Technology And Applications, https://nptel.ac.in/courses/115/107/115107116/
2	G. Chidichimo and L. Filippelli, Organic Solar Cells: Problems and Perspectives, Review Article | Open Access, 2010 |International Journal of Photoenergy, Article ID 123534 | 11 pages

PRACTICAL METHODS IN NANOTOXICOLOGY AND MOLECULAR GENETICS	
Name of the Department	**Nanoscience and Technology**
Name of the Faculty Member i/c With Complete Address with Phone and e-mail	**Dr. P. P. Vijaya** **Professor** **Department of Nanoscience and Technology** **Bharathiar University** **Coimbatore – 641 046** **Phone: +91 9840868328** **E-mail: vijayaparthasarathy@buc.edu.in**
Inter / Intra Department Course	**Inter and Intra Department Course**
Duration of the Course	**40 hours**
Eligibility	**B.Sc.,**
Number of Candidates to be Admitted	**25 – 50**
Registration Procedure	**Online**

Job Opportunities: CSIR-CLRI, CSIR-CDRI, Pharmaceutical R&D, Biotech Start-ups, Forensic and Clinical Diagnostic Laboratories.

The objectives of the Course are:

The main objectives of this course are:

1. Reinforce fundamental knowledge of molecular biology and biochemistry for experimental design.
2. Provide hands-on training in DNA isolation, purification, and amplification techniques.
3. Develop practical skills for analyzing DNA, proteins, and chromosomal abnormalities.
4. Introduce the basics of recombinant DNA technology and genetic engineering.
5. Train students in essential nanotoxicology-related molecular assays relevant to research and industry.

Course Content	Lecture / ✔ Practical / Project / Internship

Module 1	DNA Isolation - Isolation of genomic DNA from bacteria and plant cell.	**3 hours**
Module 2	Isolation of plasmid DNA from different type of bacteria by adopting different methods.	**3 hours**
Module 3	Purification and calculation of molecular weight of plasmid DNA. , plasmid curing (acridine orange, heat shock).	**3 hours**
Module 4	DNA and Protein Analysis: DNA: Southern and Northern Hybridization.	**3 hours**
Module 5	DNA Sequence Analysis (e.g Sangers Method), Automated Sequencing, RFLP and RAPD.	**3 hours**
Module 6	Protein: Western Blotting, ELISA and its variations	**3 hours**
Module 7	Human chromosomal aberrations- Plant (Allium cepa and Human lymphocyte cells); normal and abnormal karyotypes.	**3 hours**
Module 8	Preparation of E coli competent cells and their transformation using plasmid offering antibiotic resistance to the host cells	**3 hours**
Module 9	Restriction mapping of genomic/plasmid DNA (E.coli)	**3 hours**
Module 10	Competent cell preparation. Preparation of competent cells in E.coli and yeast.	**3 hours**

Book(s) for Study

1	Molecular Biology of the Cell: Alberts et al., 6th Edition, Garland Publications,2015.

2	Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology", 4th Edition, Greene Publishing Associates, NY, 2008
3	Strachan T and Read A P, Human molecular genetics, 3rd Edition Wiley Bios, 2006.
Book(s) for reference	
1	Old RW, Primrose SB, "Principles of Gene Manipulation, An Introduction To Genetic Engineering", 3rd Edition, Blackwell Science Publications, 2009.
2	Jane K. Setlow, Genetic Engineering: Principles and Methods, Volume 27, Springer Science & Business Media, 2006
Related Online Contents	
1	Essentials of Molecular Biology, Fourth Edition (2012) by V. Malathi., Pearson Education India.
2	Microbial Genetics (2012) by **K. Chaudhuri, The Energy and Resources Institute, TERI.**
3	Genetics – A Molecular Approach, 6th Edition (2013) by Bahman Yazdi Samadi , Mostafa Valizadeh, University of Tehran Press.

Certificate Courses

1	**Name of the Course**	**Solar Panel Installation Technician**
2	**Name of the Department**	Nanoscience and technology
3	**Name of the Faculty Member**	**Dr. C. Viswanathan** Professor Department of Nanoscience and Technology Bharathiar University
4	**Inter/Intra Department**	**Inter Department**
5	**Objectives of the Course**	The prime objective of this course is to train highly skilled and technically qualified professionals in solar panel installation with comprehensive knowledge of design, installation, troubleshooting, and maintenance of solar PV systems. It also aims to provide career guidance for opportunities in the solar power industry. By the end of this course, the learner will be able to: 1. Understand the fundamentals of electricity and solar energy. 2. Assess site suitability and equipment requirements for solar PV installations. 3. Design solar PV systems based on customer requirements, codes, and standards. 4. Install and commission solar PV systems safely and effectively. 5. Carry out routine operation, maintenance, and troubleshooting. 6. Follow safety protocols in solar PV system handling and operation. 7. Apply project management skills in solar PV system installation.
6	**Topics to be Covered**	i. Understand the basics of electricity and solar energy ii. Understand the site and equipment related requirements for solar PV installation iii. Design a solar PV system as per customer's requirements as well as appropriate codes and standards iv. Install a solar PV system based on the relevant designs v. Maintain a solar PV system and identify and troubleshoot problems vi. Ensure safety while installation and operation vii. Undertake project management for installation of a solar PV system
7	**Duration of the Course**	1 year
8	**Eligibility**	B.Sc, in Physics or Electronics

9	**Registration**	
10	**Description of the Course**	➢ Developing the knowledge basis of the trainee by covering various aspects of solar PV feasibility studies, basics of design, installation, operation and maintenance of solar panels ➢ Providing updated teaching materials ➢ Covering the technical and other capacity requirements for the solar industry ➢ Providing hands-on training in fabrication, design and installation of solar panels ➢ Exploring the local and global sectors from the experts
11	**Job Opportunities**	Solar panel Installation Technician at various electronic sector
12	**Number of Candidates**	15 No's per year
13	**Course Fee**	

ORGANIC SOLAR CELLS DEVICE FABRICATION		
Name of the Department	Nanoscience and Technology	
Name of the Faculty Member i/c With Complete Address with Phone and e-mail	Dr P. Sakthivel	
Inter / Intra Department Course	Inter Department	
Duration of the Course	3- 6 month/ 45 hours	
Eligibility	M.Sc. First/Second years: Physics, Chemistry, Electronics, Nanoscience	
Number of Candidates to be Admitted	20	
Mode of the Course	Both Regular and Online	
Collaboration if any with Companies (if Yes, Full Address of the Company Address , Name of the Contact Person, Phone, e-mail etc.)		
Registration Procedure	As per University Norms	

Job Opportunities:

- Organic Solar Cell (OSC) Device Fabrication Industries
- Solar and Renewable Energy Companies
- Research and Development Labs in Energy Materials
- Higher Education and Research Opportunities (Ph.D./Post-Doctoral Studies)

The objectives of the Course are:

The main objectives of this course are to:

- Understand the role of conjugated organic small molecules and macromolecules in OSCs.
- Study conduction mechanisms, active layers, and transporting layers in OSC devices.
- Explore the factors influencing power conversion efficiency (PCE), Jsc, Voc, and fill factor (FF).
- Learn about the choice of solvents, additives, and acceptor materials.
- Acquire skills in device fabrication, characterization, and stability analysis of OSCs.

Course Content	Lecture / Practical / Project / Internship	
Module 1	Primer of renewable energy: basics and production of energy with different resources	2 hours
Module 2	Fundamentals of Organic solar cells: Overview of organic molecules, conjugated small and polymers	4 hours
Module 3	Detailed study of Weak DONOR Alternate double bond systems and stability	4 hours
Module 4	Primary requirements for choosing ACCEPTOR and study of LUMO energy levels	5 hours
Module 5	Characteristic behaviors of Electrodes, transporting layers, and active layers	5 hours
Module 6	Study of mono layer, bilayer Organic Solar cells device fabrications	5 hours
Module 7	Bulk heterojunction solar cell device fabrications and their review on power conversion efficiency	5 hours

Module 8	Tandem organic solar cells device fabrication and their merits and demerits	5 hours
Module 9	Inverted organic solar cells device fabrication and stability study	5 hours
Module 10	Characterizations and OSCs Applications	5 hours

Book (s) for Study	
1	Christoph Brabec, Vladimir Dyakonow, and Ullrich Scherf, Organic Photovoltaics: Materials, device physics, and manufacturing technology, Wiley VCH, 2009
2	Brutting W, Physics of Organic Semiconductors, Wiley VCH, 2005
Book (s) for Reference	
1	Hadziioannou G, Malliarass G. G, Semiconducting Polymers: Chemistry, Physics, and Engineering, Wiley VCH, 2007
2	Klauk H, Organic Electronics: Materials, Manufacturing, and Applications, Wiley VCH, 2006
Related Online Contents	
1	Prof. Soumitra Satpathi, Dept of Physics, IIT Roorkee, Solar Photovoltaics Fundamentals, Technology And Applications, https://nptel.ac.in/courses/115/107/115107116/
2	G. Chidichimo and L. Filippelli, Organic Solar Cells: Problems and Perspectives, Review Article | Open Access, 2010 |International Journal of Photoenergy, Article ID 123534 | 11 pages

NANOTOXICOLOGY – RISK ASSESSMENT AND MANAGEMENT		
Name of the Department	**Nanoscience and Technology**	
Name of the Faculty Member i/c With Complete Address with Phone and e-mail	**Dr P. P. Vijaya** **Professor** **Department of Nanoscience and Technology** **Bharathiar University** **Coimbatore – 641 046** **Phone: +91 9840868328** **E-mail: vijayaparthasarathy@buc.edu.in**	
Inter / Intra Department Course	**Intra Department Course**	
Duration of the Course	**6 months**	
Eligibility	**I OR II M.Sc.,**	
Number of Candidates to be Admitted	**25 – 50**	
Mode of the Course	✔ **Regular / Online / Both Regular and Online**	
Collaboration if any with Companies (if Yes, Full Address of the Company Address , Name of the Contact Person, Phone, e-mail etc.)	**Nil**	
Registration Procedure	**Online**	

Job Opportunities:

- Toxicity Testing Laboratories (e.g., CSIR-CLRI, CSIR-CDRI, Universities)
- Pharmaceutical and Healthcare Companies (Nanotoxicology Testing, Regulatory Affairs)

The objectives of the Course are:

The main objectives of this course are to:

1. Provide a comprehensive understanding of the importance of nanotoxicology and its regulatory framework in nanotechnology applications.
2. Examine the mechanisms of toxicity induced by nanomaterials and approaches to mitigate them.
3. Explore nanomaterial interactions with biological systems and their environmental impacts.
4. Equip students with practical skills to design, conduct, and analyze nanotoxicity experiments.
5. Create awareness on the ethical, legal, and social implications (ELSI) of nanotechnology.

Course Content	✔ Lecture / ✔ Practical / Project / Internship	
Module 1	Introduction – Definition of terms-Toxicity-Hazards and hazard types and assessment of risk.	**6 hours**
Module 2	Concept of Nanotoxicology - Laboratory rodent studies - Ecotoxicologic studies - Methodology for Nanotoxicology - in vitro and in vivo toxicity testing	**6 hours**
Module 3	Mechanism of nanosize particle toxicity - Reactive oxygen species meditated NSP toxicity - Interactions between Nanoparticles and Living Organisms: Mechanisms and Health Effects	**6 hours**
Module 4	Interactions of Nanoparticles with Cells and their Cellular Nanotoxicology - Cytotoxicity of Ultrafine Particles -	**6 hours**

	Cytotoxicity and Potential Mechanism of Nanomaterials- Immunotoxicity	
Module 5	Nanopollution – Nanomaterials in Environment - Toxicology of Airborne - Manufactured nanomaterials in the environment- Physicochemical characteristics of nanomaterials.	**6 hours**
Module 6	Biological Activities of Nanoparticles - nanoparticles interaction with biological membrane-Entry routes into the human body- Disposition of NSPs in the respiratory	**6 hours**
Module 7	Portals of entry and target tissue – Risk assessment – Ethical – Legal and Social Implications	**6 hours**
Module 8	Nanoparticle Toxicology and Ecotoxicology, The Role of Oxidative Stress – Development of Test Protocols for Nanomaterials – Regulation of Engineered Nanomaterials.	**6 hours**
Module 9	Nanotechnological Risks – Understanding of Nanotechnology's Social Impacts -Nanotechnology in the Media. Educating Undergraduate Nanoengineers, Education Opportunities – Human Resources for Nanotechnology	**6 hours**
Module 10	Ethical Issues in Nanoscience and Nanotechnology – Ethics & Law in a New Frontier- An Exploration of Patent Matters Associated with Nanotechnology	**6 hours**

Book(s) for Study

1	N. Duran, S.S. Guterres, O.L. Alves, Nanotoxicology: Materials, Methodologies, and Assessments, Springer, Newyork, 2014.
2	T. Otsuki, Y. Yoshioka, A. Holian, Biological Effects of Fibrous and Particulate Substances, Springer, Japan, 2016.
3	A.M. Gatti, S. Montanari, Case Studies in Nanotoxicology and Particle Toxicology, Academic Press, UK, 2015.

Book(s) for reference

1	Nancy A. Monteiro-Riviere, C. Lang Tran, Nanotoxicology: Progress towards Nanomedicine, Second edition, CRC Press, Taylor and Franscis, Boca Raton, 2014.
2	G. Ramachandran, Assessing Nanoparticle Risks to Human Health, William Andrew, Elsevier, USA, 2011.
3	J. Njuguna, K. Pielichowski, H. Zhu, Health and Environmental Safety of Nanomaterials: Polymer Nancomposites and other material containing nanoparticles, Woodhead Publishing, Elsevier, UK, 2014.

Related Online Contents

1	Encyclopedia of Toxicology (Third Edition), 2014.
2	Current Nanotoxicity and Prevention. Volume 1, 2 Issues, 2020 ISSN: 2665-9816.
3	Toxicology of Nanomaterials Editor(s): Yuliang Zhao, Zhiyong Zhang, Weiyue Feng, 2016.

Course code	----	REGENERATIVE MEDICINE	L	T	P	C
Certificate Course			4	0	0	4

Name of the Department	**Nanoscience and Technology**
Name of the Faculty Member i/c With Complete Address with Phone and e-mail	**Dr A. M. Ballamurugan Associate Professor Department of Nanoscience and Technology Bharathiar University Coimbatore – 641 046 Phone: +91 9443871751 E-mail:balamurugan@buc.edu.in**
Inter / Intra Department Course	**Intra Department Course**
Duration of the Course	**6 months**
Eligibility	**I OR II M.Sc.,**
Number of Candidates to be Admitted	**25 – 50**
Mode of the Course	**✔Regular / Online / Both Regular and Online**
Collaboration if any with Companies (if Yes, Full Address of the Company Address , Name of the Contact Person, Phone, e-mail etc.)	**Nil**

Pre-requisite	This course is unique and innovative, designed to provide students with exposure to recent advances in regenerative medicine. Students are expected to have a sound background in material science and a basic understanding of biological systems.	**Syllabus Version**	**2020 -2021**

Course Objectives:

1. Provide in-depth knowledge of regenerative medicine, from the biology of stem cells to therapeutic applications.
2. Equip students with translational skills and hands-on exposure to medical nanotechnology and tissue engineering.
3. Enable students to understand nanomaterials, biomaterials, and scaffold-based regenerative approaches.
4. Train students in evaluating contemporary research trends, regulatory challenges, and ethical issues in regenerative medicine.
5. Develop skills in scientific writing, critical analysis, and presentation of research findings.

Expected Course Outcomes:

After the completion of the course, the student will have the following capabilities:

1	Explain the fundamental concepts and characteristics of regenerative medicine.	K2
2	Apply tissue engineering approaches and regenerative techniques for replacing damaged or diseased tissues.	K3
3	Analyze nanomaterial-based strategies for regenerative medicine applications in human diseases.	K4
4	Evaluate current methods, techniques, and translational practices in regenerative medicine.	K5
5	Compile and present research results effectively through oral and written communication.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**Basics of Regenerative Medicine**	**12 hours**

Regenerative Medicine: Introduction- Bioreactors-Key Features-Controlled culture-Physical condition of developing tissues-Bioreactor based products.		
Unit:2	**Nanomaterials for Regenerative medicine**	**12 hours**
Nanomaterials and Nanocomposites for Regenerative medicine: Perspective introduction-Types of nanocomposite 3D scaffolds-Drug free organ replacement-Carbon based composite regenerative medicine.		
Unit:3	**Surface Modification for Cell Interaction**	**12 hours**
Chemical and Physical modified biomaterials for cell adhesion: General introduction-Methods to generate the nanostructured surface-Self assembled monolayer based poly (organosiloxanes)-**Injective hydrogels:** Introduction-Methods of preparation-Chemical and Physical reticulation process-Properties-Major issues on injectable process.		
Unit:4	**Cellular Therapeutics**	**12 hours**
Introduction to stem cells-Molecular and cellular bases of tissue and organ development-Therapeutic uses of stem cells-Molecular bases of dieases-Bio-Artificial organs.		
Unit:5	**Tissue Therapy**	**12 hours**
Engineering of small and large diameter blood vessels-Cardiac tissue-Intracorporeal kidney support-Genito urinary system-Reproductive system-Tissue therapy implications of regenerative medicine-Current issues and challenges.		
Unit:6	**Contemporary Issues**	**2 hours**
Current challenges and regulatory issues will be addressed by the experts in the respective domain.		
	Total Lecture hours	**62 hours**

Text Books	
1	Principles of Regenerative Medicine, Anthony Atala, Robert Lanza, Tony Mikos, Robert Nerem, 3rd edition, **2018**, **ISBN: 9780128098806.**
2	Nanomaterials for regenerative medicine, Tekinay, Ayse, Springer, 2019, ISBN: 978-3-030-31202-2.
Reference Books	
1	Foundation of Regenerative Medicine, Anthony Atala, 1rd edition, **2009, ISBN: 9780123785626.**
2	Advances in Regenerative Medicine: Role of Nanotechnology, and Engineering Principles, Venkatram Prasad Shastri, George Altankov, Andreas Lendlein, ISBN 978-90-481-8788-1, 2007.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.ncbi.nlm.nih.gov
2	https://onlinelibrary.wiley.com

Course Designed By	**Dr A. M. Ballamuragan**	e-mail	balamurugan@buc.edu.in

The M.Sc. Nanoscience and Technology programme is a two-year postgraduate degree designed to provide advanced knowledge, hands-on skills, and interdisciplinary research exposure in nanoscience and nanotechnology. The curriculum integrates physical, chemical, and biological sciences with technological applications, preparing students for careers in academia, research, and industry.

- **Duration**: 2 Years (4 Semesters)
- **Level**: Post-Graduation
- **Type**: P.G. Degree (Regular)
- **Eligibility**: Any Undergraduate Science Degree recognized by the UGC

Mission

The Department of Nanoscience and Technology is committed to:

- Providing knowledge and skills in Nanoscience and Technology through postgraduate and doctoral programmes.
- Undertaking frontier research in emerging areas of physical, chemical, and biological sciences with nanoscience and technology, and transforming findings for societal benefit.
- Addressing environmental issues through academic and research initiatives.
- Equipping students with a strong foundation in physical, chemical, and biological sciences to pursue advanced research in nanoscience and technology.

Career Opportunities

Graduates of M.Sc. Nanoscience and Technology have a wide range of career prospects in academia, industry, and research, including but not limited to:

- **Research Scientist / Formulation Scientist**
- **Nanomaterial Product Developer**
- **Regulatory Analyst / Officer** in Government Agencies
- **Patent Examiner and Intellectual Property Specialist**
- **Entrepreneurship in Nanotechnology-based Ventures**
- **Consultancy Roles** in Pharmaceuticals, Energy, Materials Science, Medicine, Agriculture, and Environmental Protection
- **Employment in National and International Scientific Research Organizations**
- **Pursuit of Higher Degrees (Ph.D./Postdoctoral Research)** in India or abroad
- **Healthcare Industry Roles** in diagnostics, imaging, and nanomedicine
- **Teaching Faculty** positions through Teachers Recruitment Board (TRB), Tamil Nadu, and equivalent academic recruitme

☑ REGULATIONS & ASSESSMENT

- **Internal Assessment**: 25 Marks (Tests, Assignments, Seminars)
- **End Semester Examination**: 75 Marks
- **Pass Minimum**: 50% (Aggregate)
- **Attendance**: 75% minimum to appear for exams
- **Project Evaluation**: As per University guidelines
- **CBCS Norms**: Credit-based progression and choice of electives

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📞 CONTACT

The Professor and Head
Department of Nanoscience and Technology
Bharathiar University, Coimbatore – 641 046
✉ Email: nanoscience@buc.edu.in; office.bunst@gmail.com
📞 Phone: +91-422-2428 424