DEPARTMENT OF BIOTECHNOLOGY

ANNA UNIVERSITY, CHENNAI

Vision:

The Department of Biotechnology is committed to evolve as a world class science and technology centre by integrating quality and ethics in teaching and research.

Mission:

The mission of the department is

- To provide students a unique and multidisciplinary learning experience that will foster the young minds to develop as a researcher, entrepreneur etc.
- To enhance academic and industrial collaborative research initiatives for the development of biotechnological, food and therapeutic products.
- To emphasise and equip the students towards innovative industrial and research updates.
- To serve the society with utmost

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ANNA UNIVERSITY::CHENNAI:600 025

UNIVERSITY DEPARTMENTS

REGULATIONS – 2019

M. TECH. NANO SCIENCE ANDTECHNOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS)

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

1. To prepare students to outshine in academics and research in different motifs of Nanoscience and Nanotechnology through post graduate education.

2. To provide students with a solid foundation in Synthesis and Characterization of novel nanomaterials with multiple applications.

3. To train students with good theoretical and practical knowledge so as to comprehend, analyze, design, and create novel products and solutions for the real life problems.

4. To coach students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate nanotechnology to address environmental issues.

5. To provide students with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career

2. PROGRAMME OUTCOMES (POs):

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

PO	Post Graduate Attribute	Program Outcome
1.	Engineering Knowledge	Graduates will demonstrate good knowledge of Physics, Chemistry, Synthesis & Characterization of Nanomaterials to solve engineering and research problems
2.	Problem Analysis	They will be able to demonstrate independently and perform experiments in areas of Photonics, Lithography, MEMS, NEMS, Sensors, Nano -Electronics & Nano – Agriculture. Develop skill in modeling, simulation & Nano fabrication.
3.	Design/development of solutions	They will be able to design and conduct experiments, analyze and interpret data
4.	Conduct investigations of complex Problems	The graduates will be capable of demonstrating an ability to design an experiment, component or process as per needs and specifications.
5.	Modern tool usage	The graduate will be adept at performing experiments in cutting edge areas of modern Nanotechnology
6.	The engineer and society	Conduct themselves to uphold the professional and social obligations
7.	Environment and sustainability	Design the system with environmental

		consciousness and sustainable development. Problems of social relevance such as energy, environment, medicine, agriculture, health care & toxicology will be understood.
8.	Ethics	Interact in industry, business and society in a professional and ethical manner They will demonstrate the ability and requirements to sense the needs of the nation and their role in nation building.
9.	Individual and team work	Function in a multidisciplinary team
10.	Communication	The student is trained in both verbal and written communication in English.
11.	Project management and finance	Having undergone a project the student is capable of designing, performing and interpreting the results of their experiment. Thereby implement cost effective and improved system
12.	Life-long learning	Graduate will develop confidence for self education and ability for life-long learning.

3. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

Programme Educational Objectives	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	PO12
1.	✓	✓	✓	✓		✓		✓		✓		✓
2.	✓	✓	✓			✓		✓		✓		✓
3.	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
4.	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
5.	✓	✓					✓	✓	✓		✓	✓

4. MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

			PROGRAMME OUTCOMES (POs)											
		SUBJECTS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR 1	SEMESTER I	Mathematical modeling and simulation	✔	✔	✔			✔						
		Quantum Mechanics	✔	✔		✔								
		Synthesis and Applications of Nanomaterials	✔	✔					✔		✔			
		Biological Nanostructures	✔	✔				✔	✔					
		Research Methodology and IPR	✔				✔	✔						
		Audit Course – I								✔	✔	✔		
		Lab I Computation & Simulation		✔		✔	✔							✔
		Lab II Material Synthesis	✔	✔				✔						✔
	SEMESTER II	Imaging techniques for Nanotechnology	✔	✔			✔	✔						
		Physicochemical methods for characterization of Nanomaterials	✔	✔			✔	✔						
		Physics and Chemistry of Materials	✔	✔				✔			✔			
		Program Elective I	✔	✔		✔					✔			
		Program Elective II	✔	✔		✔					✔			
		Audit Course –II								✔	✔	✔		
		Lab III Materials Structural characterization Lab	✔		✔			✔						✔
		Lab IV Physicochemical characterization lab	✔		✔			✔						✔
YEAR 2	SEMESTER III	Program Elective III	✔	✔		✔					✔			
		Program Elective IV	✔	✔		✔					✔			
		Program Elective V	✔	✔		✔					✔			
		Open Elective								✔	✔			
		Project Phase I			✔	✔					✔	✔	✔	✔
	SEMESTER IV	Project Work Phase – II			✔	✔					✔	✔	✔	✔

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2019

M. TECH. NANO SCIENCE ANDTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABI FOR I TO IV SEMESTER

SEMESTER I

S. NO.	CODE NO.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	NT5101	Mathematical Modeling and Simulation	PCC	3	1	0	4	4
2.	NT5102	Quantum Mechanics	PCC	3	1	0	4	4
3.	NT5103	Synthesis and Applications of Nanomaterials	PCC	3	1	0	4	4
4.	NT5104	Biological Nanostructures	PCC	3	1	0	4	4
5.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
7.	NT5111	Computation and Simulation lab	PCC	0	0	4	2	2
8.	NT5112	Nanomaterial Synthesis Lab	PCC	0	0	4	2	2
			TOTAL	16	4	8	24	**22**

*Audit Course is Optional

SEMESTER II

S. NO.	CODE NO.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	NT5201	Imaging techniques for Nanotechnology	PCC	3	0	0	3	3
2.	NT5202	Physicochemical characterization of Nanomaterials	PCC	3	0	0	3	3
3	NT5203	Physics and Chemistry of Materials	PCC	3	0	0	3	3
4		Program Elective I	PEC	3	0	0	3	3
5		Program Elective II	PEC	3	0	0	3	3
6		Audit Course –II*	AC	2	0	0	2	0
PRACTICALS								
7	NT5211	Materials Structural characterization Laboratory	PCC	0	0	4	2	2
8	NT5212	Physicochemical characterization lab	PCC	0	0	4	2	2
			TOTAL	17	0	8	21	**19**

*Audit Course is Optional

SEMESTER III

S. NO.	CODE NO.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Program Elective III	PEC	3	0	0	3	3
2		Program Elective IV	PEC	3	0	0	3	3
3		Program Elective V	PEC	3	0	0	3	3
4		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
1.	NT5311	Project Phase I	EEC	0	0	12	12	6
			TOTAL	12		12	24	**18**

SEMESTER IV

S. NO.	CODE NO.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	NT5411	Project Phase II	EEC	0	0	24	24	12
			TOTAL	0	0	24	24	**12**

Total Credits: 71

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

PROGRAM CORE COURSES (PCC)

S. No.	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	NT5101	Mathematical Modeling and Simulation	3	1	0	4	1
2.	NT5102	Quantum Mechanics	3	1	0	4	1
3.	NT5103	Synthesis and Applications of Nanomaterials	3	1	0	4	1
4.	NT5104	Biological Nanostructures	3	1	0	4	1
5.	NT5111	Computation and Simulation lab	0	0	4	2	1
6.	NT5112	Nanomaterial Synthesis Lab	0	0	4	2	1
7.	NT5201	Imaging techniques for Nanotechnology	3	0	0	3	2
8.	NT5202	Physicochemical characterization of Nanomaterials	3	0	0	3	2
9.	NT5203	Physics and Chemistry of Materials	3	0	0	3	2
10.	NT5211	Materials Structural characterization Laboratory	0	0	4	2	2
11.	NT5212	Physicochemical characterization lab	0	0	4	2	2

PROGRAMME ELECTIVE COURSES (PEC)

S. No	CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	NT5001	Nanocomposite Materials	PEC	3	3	0	0	3
2.	NT5002	Nanomaterials for Energy and Environment	PEC	3	3	0	0	3
3.	NT5003	Processing and properties of Nanostructured Materials	PEC	3	3	0	0	3
4.	NT5004	Lithography and Nanofabrication	PEC	3	3	0	0	3
5.	NT5005	Nanotechnology in agriculture and Food industry	PEC	3	3	0	0	3
6.	NT5006	Nanoelectronics and Sensors	PEC	3	3	0	0	3
7.	NT5007	Biophotonics	PEC	3	3	0	0	3
8.	NT5008	MEMS and NEMS	PEC	3	3	0	0	3
9.	NT5009	Nanotoxicology	PEC	3	3	0	0	3
10.	NT5010	Advanced Drug Delivery systems	PEC	3	3	0	0	3
11.	NT5011	Photonics for Nanotechnology	PEC	3	3	0	0	3
12.	NT5012	Semiconductor Nanostructures	PEC	3	3	0	0	3
13.	NT5013	Nanotechnology in Health Care	PEC	3	3	0	0	3
14.	NT5014	Nano Biosensors	PEC	3	3	0	0	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No	Code No.	Course Title	Periods Per Week			Credits	Semester
			L	T	P		
1	RM5151	Research Methodology and IPR	2	0	0	2	1

OPEN ELECTIVE COURSES [OEC]*

*(Out of 6 Courses one Course must be selected)

I.No.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OE5091	Business Data Analytics	3	0	0	3	3
2.	OE5092	Industrial Safety	3	0	0	3	3
3.	OE5093	Operations Research	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	3	0	0	3	3
5.	OE5095	Composite Materials	3	0	0	3	3
6.	OE5096	Waste to Energy	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

S. NO.	COURSE CODE	COURSETITLE	PERIODSPERWEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	Code No.	Course Title	Periods Per Week			Credits	Semester
			L	T	P		
1.	NT5311	Project Phase I	0	0	12	6	3
2.	NT5411	Project Phase II	0	0	24	12	4

SUMMARY

S.NO.	Subject Area	Credits per Semester				Credits Total
		I	II	III	IV	
1	PCC	20	13	-	-	33
2	PEC	-	6	9	-	15
3	OEC	-	-	3	-	3
4	EEC	-	-	6	12	18
5	RMC	2	-	-	-	2
6	AC(Non Credit)	0	0	-	-	
	Total	22	19	18	12	**71**
	Audit courses	*	*			

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

SYLLABI
SEMESTER I

NT5101 MATHEMATICAL MODELING AND SIMULATION L T P C
3 1 0 4

OBJECTIVES:

- To gain knowledge on Numerical methods and scientific computing.
- To know more about modeling equations and their applications.
- To learn about data processing and simulation.

UNIT I NUMERICAL METHODS AND SCIENTIFIC COMPUTING 12

Mathematical problems and analytic solutions - Numerical analysis and numerical methods - Approximations of functions – Taylor's series applications – Error analysis-Numerical Algorithms and examples- Evaluation of functions - Newton-Raphson method - Numerical Differentiation - Numerical integration – Numerical linear algebra – Solving systems of equations-Eigen value of matrices.

UNIT II MATHEMATICAL MODELING 12

Mathematical modeling – Physical variables, parameters - stages of mathematical modeling and life cycle - Advantages of modeling and limitations – ODE modeling equations and examples – Numerical solutions of ODE (single step only) - Euler's method– Taylor series method – Runge - Kutta 2nd and 4th order methods.

UNIT III PDE MODEL EQUATIONS AND THEIR APPLICATIONS 12

Classification of second order PDEs – Equations of mathematical physics – boundary values- Finite difference approximations to partial derivatives - Solution of one dimensional heat conduction equation - Laplace equation using standard five point formula - Solving of Poisson equation.

UNIT IV DATA PROCESSING AND SIMULATION 12

Data formats, Data manipulation – Curve fitting and interpolation techniques – Structural and material properties – Material databases - Basic concepts of simulation- Model descriptors **-**Three dimensional models examples -. Molecular dynamics (MD) simulation -Trajectory, coordinates and acceleration - Newton's equation - Energy conservation – MD Applications

UNIT V MONTE CARLO METHODS AND FIRST PRINCIPLE METHODS 12

Basics of the Monte Carlo method-Algorithms for Monte Carlo simulation-Applications to systems of classical particles-modified Monte Carlo techniques-percolation system variation Monte Carlo method-diffusion Monte Carlo method - Quantum Monte Carlo method.

TOTAL :60 PERIODS

COURSE OUTCOMES:

CO1: Gaining knowledge about various numerical methods for solving mathematical problems

CO2: Have knowledge in solving ordinary and partial differential equations

CO3: The students will acquire knowledge about data manipulations, curve fitting and materials properties

CO4: Have exposure about molecular dynamics simulations and its applications

CO5: Acquire knowledge about scientific computing, simulation and their applications

REFERENCES:

1. S.C. Chapra and R.P.Canale, "Numerical methods for Engineers", Tata McGraw Hill, New Delhi, 2009 (Sixth Edition).
2. Erwin Kreyzig, "Advanced Engineering Mathematics", John Wiley & Sons, London, 2011 (10^{th} Edition).
3. R.J. Schilling and S.L. Harris, "Applied Numerical Methods for Engineers using MATLAB and C", Thomson publishers, New Delhi, 2004.
4. F R Giordano, W P Fox, S B Horton and M D Weir, "Mathematical Modeling Principles and Applications", CENGAGE Learning, New Delhi, 2014 (Fifth Edition)
5. D. Frenkel and B. Smith, "Understanding molecular simulation from algorithm to applications", Kluwar Academic Press, Berlin, 2001.
6. A.R. Leach, Molecular Modeling – Principles and Applications, Pearson, London, 2001
7. K. Ohno, K. Esfarjani and Y. Kawazoe, "Introduction to Computational Materials Science from ab initio to Monte Carlo Methods", Springer-Verlag, Berlin, 1999.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	.Gaining knowledge about various numerical methods for solving mathematical problems	3	3		3					2	2		
CO2	Have knowledge in solving ordinary and partial differential equations	3	3		3					2	2		
CO3	The students will acquire knowledge about data manipulations, curve fitting and materials properties	3	3		3					2	2		
CO4	Have exposure about molecular dynamics simulations and its applications	3	3		3					2	2		
CO5	.Acquire knowledge about scientific computing, simulation and their applications	3	3		3					2	2		
Overall CO		3	3		3					2	2		

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

NT5102 **QUANTUM MECHANICS** **L T P C**
3 1 0 4

OBJECTIVES:

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

UNIT I BASICS OF QUANTUM MECHANICS 9

Wave-particle duality, group velocity, Phase velocity, De-Broglie wavelength, Uncertainty principle and Schrödinger equation.

UNIT II TIME DEPENDENT SCHRÖDINGER EQUATION 9

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

UNIT III TIME INDEPENDENT SCHRÖDINGER EQUATION 9

Particle in a three dimensional box, linear harmonic oscillator and its solution, density ofstates, free electron theory of metals. The angular momentum problem. The spin halfproblem and properties of Pauli spin matrices.

UNIT IV APPROXIMATE METHODS 9

Time independent and time dependent perturbation theory for non-degenerate and degenerate energy levels, the variational method, WKB approximation, adiabatic approximation, sudden approximation

UNIT V QUANTUM COMPUTATION 9

Concept of quantum computation, Quantum Q-bits, Introduction to nuclear spin, quantum confinement, quantum devices, single electron devices.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. Beiser - Modern Physics –2009, 6th edition.
2. Bransden and Joachen - Quantum Mechanics - 2000. 2nd edition
3. Eisberg,Robert; Resnick, Robert -Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, 1985, 2nd Edition,
4. Ajoy Ghatak -Quantum Physics –Theory and application, Springer 2004.
5. R. Shankar, Principles of Quantum Mechanics – 2000, 2nd edition.
6. Cohen-Tannoudji , Quantum Mechanics - Vol 1&2 ,1997.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	.Gaining knowledge about basics of wave-particle duality and Quantum mechanics	3	3	3	3					2	2		
CO2	Acquire knowledge about wave function and free electron theory	3	3	3	3					2	2		
CO3	Acquire knowledge about Quantum computation and approximation methods	3	3	3	3					2	2		
Overall CO		3	3	3	3					2	2		

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5103 SYNTHESIS AND APPLICATIONS OF NANOMATERIALS L T P C
3 1 0 4

OBJECTIVES

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

Unit I MECHANICAL ALLOYING AND MILLING 9

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

UNIT II CHEMICAL APPROACHES 9

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

UNIT III PHYSICAL APPROACHES 9

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

UNIT IV NANOPOROUS MATERIALS 9

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

UNIT V APPLICATION OF NANOMATERIALS 9

Overview of nanomaterials properties and their applications, nanopaints, nano coating, nanomaterials for renewable energy, Nanoelectronics – Nanobots- Biological Applications.

TOTAL :45 PERIODS

COURSE OUTCOMES:

CO1: . At the end of the course the student would Gain knowledge on the variou process techniques to synthesis nanostructured materials by clear understanding of growth controlling actors of nanomaterial

CO2: The students acquire knowledge about various kind of nanoporous materials

CO3: The course also gives clear knowledge on the application and implementation of nanomaterials to solve the societal problems

REFERENCES:

1. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, London 2004.
2. T. Pradeep, Nano: The Essentials Understanding nanoscience and nanotechnology, Tata McGrawHill Publishing Company Limited NEW DELHI, 2007.
3. A S Edelstein and R C Cammarata, Nanomaterials Synthesis, Properties and Applications, IOP Publishing Ltd 1996.
5. Frank J. Owens and Charles P.Poole, The Physics and Chemistry of Nano Solids, Wiley-Interscience, 2008

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	. At the end of the course the student would Gain knowledge on the various process techniques to synthesis nanostructured materials by clear understanding of growth controlling factors of nanomaterials	3	3				3						2
CO2	The students acquire knowledge about various kind of nanoporous materials	3	3				3						2
CO3	The course also gives clear knowledge on the application and implementation of nanomaterials to solve the societal problems	3	3				3						2
Overall CO		3	3				3						2

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5104	BIOLOGICAL NANOSTRUCTURES	L T P C 3 1 0 4

OBJECTIVES:

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

Unit I CELLULAR NANOSTRUCTURES 12

Cellular elements in developing functional nanostructures and nanomaterials-nanopatterning . Cytoskeletal nanomechanics. Bacterial and viral nanostructured materials. Plant derived nanostructures-types, evolution and applications. Phytochemicals in the genesis of nanoparticles.

Unit II DNA NANOTECHNOLOGY 12

Genome structure and organization in prokaryotes and eukaryotes. Structure and function of nucleic acids. The Central Dogma of life. DNA tile assembly, brick assembly, 3D DNA nanostructures, Organic and inorganic DNA nanostructures. DNA aptamer and DNA origami.

Unit III PROTEIN AND ENZYME NANOPARTICLES 12

Proteins- Structure, Classification and functions. Protein nanoparticles- Designing, synthesis strategy, ligands used and their applications. Enzymes and Enzyme nanoparticles- properties, structure,.Synzymes, ribozymes.Preparation, immobilization and kinetic properties and applications of enzyme nanoparticles in day-day to life.

Unit IV CARBOHYDRATES AND GLYCO NANOPARTICLES 12

Classification, Nomenclature, Structure, Function of carbohydrates. Glyco-metal nanoparticles and glycocarbon nanotubes conjugates. Fate of glyco-based nanoparticles.

Unit V LIPIDS AND LIPID BASED NANOPARTICLES 12

Structure, function and significance of lipids and membrane transport. Membranous nanostructures and their role in cellular traffic. Lipid-based nanomaterials- lipid-polymer nanoparticles and solid lipid nanoparticles.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

CO1: Comprehend the nanoscale phenomenon associated with cellular nanostructures
CO2: To reveal the nature of DNA bricks, aptamers and origami
CO3: Design and utilize the protein and enzyme based nanostructuers
CO4: Classify glycol nanostructures based on their binding ligands
CO5: Have knowledge about membrane transport and membrane based nanostructures and their uses

REFERENCES:

1. CS. Pundir, Enzyme nanoparticles, Elsevier UK, 2015.
2. AlešIglič, Damjana Drobne, Veronika Kralj-Iglič, Nanostructures in Biological Systems: Theory and Applications Pan Stanford Publishing US, 2015.
3. Stroscio MA and Dutta M, Biological nanostructures and applications of nanostructures in biology: Electrical, Mechanical and optical properties. Kluwer academic publishers New York, 2004.
4. Luigi Sasso,Self-Assembled Peptide Nanostructures: Advances and Applications in Nanobiotechnology. Pan Stanford Publishing US, 2012.
5. Carlos Aelman, Peptide Materials: From Nanostuctures to Applications, Wiley UK, 2013.

6. Keith J. Stine,Carbohydrate Nanotechnology, Wiley New Jersey, 2015 .
7. YonggangKi,3D DNA Nanostructure, Humana Press Inc.New York, 2015.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	. Comprehend the nanoscale phenomenon associated with cellular nanostructures	3			3		2			2	2		
CO2	To reveal the nature of DNA bricks, aptamers and origami	3			3		2			2	2		
CO3	Design and utilize the protein and enzyme based nanostructuers	3			3		2			2	2		
CO4	Classify glycol nanostructures based on their binding ligands	3			3		2			2	2		
CO5	Have knowledge about membrane transport and membrane based nanostructures and their uses	3			3		2			2	2		
Overall CO		3			3		2			2	2		

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

RM5151 **RESEARCH METHODOLOGY AND IPR** **LT P C**
2 0 0 2

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5111 **COMPUTATION AND SIMULATION LAB** **L T P C**
0 0 4 2

OBJECTIVES:

To learn about programming on modeling and simulation of mathematical equations.

- Numerical programme to plot the first four Eigen functions of a one – dimensional rectangular potential well with infinite potential barrier.
- Numerical solution of the Schrodinger wave equation for a rectangular potential well with infinite potential barrier using numerical programme.
- Toy model in molecular electronics: IV characteristics of a single level molecule
- To determine the lattice constant and lattice angles for atomically resolved STM image of HOPG (Highly Oriented Pyrolytic Graphite using offline Scanning Probe Imaging Processor (SPIP) Software.
- To determine the surface roughness of raw and processed AFM images of glass, silicon and films made by different methods using offline SPIP software.
- Simulation of I-V Characteristics for a single Junction circuit with a single quantum Dot using MOSES 1.2 Simulator.
- Study of Single Electron Transistor using MOSES1.2 Simulator.

TOTAL :60 PERIODS

COURSE OUTCOMES:

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

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	.Gaining knowledge on modeling and simulation of equations using MATLAB			3		3				2		2	2
CO2	Acquiring knowledge on image processing and analysis			3		3				2		2	2
CO3	Able to interpret the TEM, STEM and AFM images			3		3				2		2	2
Overall CO				3		3				2		2	2

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5112 **NANOMATERIAL SYNTHESIS LAB** **L T P C**
0 0 4 2

OBJECTIVES:

To synthesize Nano materials by various chemical and physical methods.

- Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloidalsol; Mie formalism; Estimation of size by curve fitting
- Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap
- estimation from the band edge
- Aqueous to organic phase transfer of Ag and CdS nanoparticles; Confirmation by UV-Visible absorption
- Microwave assisted polymerization synthesis of ZnO nanowires
- Sol gel synthesis of metal oxide (ZnO, TiO_2, CdO) nanoparticles:
- Sol-gel spin coating route to SnO_2 nanothin films: surface roughness measurement by AFM
- Electro spraying route to carbon nanofibers: surface morphology by SEM
- Hydrothermal synthesis of ZnS Nanorods: Nanorods formation by SEM analysis
- Mechanical ball milling technique to oxide ceramics preparation: crystallite size measurement by XRD

TOTAL :60 PERIODS

COURSE OUTCOMES:

CO1: Thorough hands on training and knowledge and skills on Nano materials synthesis using various chemical and physical methods

CO2: Able to synthesis metal oxide nanomaterials by bottom up synthesis method

CO3: Able to synthesis metal oxide nanomaterials by top down method

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Thorough hands on training and knowledge and skills on Nano materials synthesis using various chemical and physical methods			3		3				2		2	2
CO2	Able to synthesis metal oxide nanomaterials by bottom up synthesis method			3		3				2		2	2
CO3	Able to synthesis metal oxide nanomaterials by top down method			3		3				2		2	2
Overall CO				3		3				2		2	2

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

SEMESTER II

NT5201 IMAGING TECHNIQUES FOR NANOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

- This course introduces the student to the most important techniques available for micro and nano- materials characterization necessary for the development of micro- and nano-manufacturing

UNIT I OPTICAL MICROSCOPY 9

Concept of resolution and depth of field/focus in imaging, types of aberrations (spherical, chromatic, diffraction and astigmatism), Optical microscopy (OM) – reflected/transmitted light microscopy, theoretical and practical resolution of an optical microscope, numerical aperture, principles of image formation, dark field, polarized light and phase contrast microscopy and applications of each in metallurgical and materials engineering, sample preparation for optical microscopy and limitations.

UNIT II SCANNING ELECTRON MICROSCOPY 9

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

UNIT III TRANSMISSION ELECTRON MICROSCOPY 9

Principles of transmission electron microscopy - Modes of operation – construction, ray-diagram, working, sample preparation – contrast mechanisms (mass-thickness, phase and diffraction contrast), imaging modes, Diffraction in imperfect crystals – HRTEM use in nanostructures.

UNIT IV ATOMIC FORCE MICROSCOPY 9

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

UNIT V SCANNING TUNNELING MICROSCOPY 9

Principle- Instrumentation- importance of STM for surface and molecular manipulation, 3D map of electronic structure.

TOTAL : 45 PERIODS

COURSE OTCOMES:

CO1: . Upon completion of the course, the students will be able to: - describe fundamental principles of operation of four materials characterization techniques, namely optical microscopy, scanning electron microscopy, transmission electron microscopy and scanning probe microscopy

CO2: Explain the production of x-rays, electrons and the electron-specimen interaction mechanisms

CO3: Select appropriate characterization methods to the analysis and characterization of materials and apply the microstructural characterization techniques to the analysis of materials at the micro and nano-scale

Attested

REFERENCES

1. J. Goldstein, D. Newbury, D. Joy, C. Lyman, P. Echlin, E. Lifshin, L. Sawyer and J. Michael, “Scanning Electron Microscopy and X-ray Microanalysis” 3rd Edition, Springer Science, Berlin 2003.
2. Ray Egerton: “Physical Principles of Electron Microscopy” Springer Science, Berlin, 2005.
3. D. Brandon and W. Kaplan: “Microstructural Characterization of Materials”, John Wiley and Sons, London, 2008.
4. Douglas B. Murphy : "Fundamentals Of Light Microscopy And Electronic Imaging", John Wiley and Sons, London, 2001

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	. Upon completion of the course, the students will be able to: - describe fundamental principles of operation of four materials characterization techniques, namely optical microscopy, scanning electron microscopy, transmission electron microscopy and scanning probe microscopy	3	3		3					2			2
CO2	Explain the production of x-rays, electrons and the electron-specimen interaction mechanisms	3	3		3					2			2
CO3	Select appropriate characterization methods to the analysis and characterization of materials and apply the microstructural characterization techniques to the analysis of materials at the	3	3		3					2			2

	micro and nano-scale												
Overall CO		3	3		3					2			2

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

NT5202 PHYSICOCHEMICAL CHARACTERIZATION OF NANOMATERIALS L T P C
4 0 0 4

OBJECTIVES

- To learn advanced analytical method used to study nanomaterials.
- To know about qualitative and quantitative analysis techniques employed for studying nanomaterials.
- To understand the mechanical analytical techniques used to study nanomaterials.

UNIT I SPECTROSCOPIC TECHNIQUES 9

Introduction to Molecular Spectroscopy and Differences-With Atomic Spectroscopy-Infrared (IR) Spectroscopy and Applications- Microwave Spectroscopy- Raman Spectroscopy and CARS Applications-Electron Spin Resonance Spectroscopy; NMR Spectroscopy; Dynamic Nuclear Magnetic Resonance; Dynamic light scattering (DLS), Double Resonance Technique.

UNIT II DIFFRACTION METHODS 9

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

UNIT III THERMAL ANALYSIS METHODS 9

Principle and Instrumentation of Thermogravimetry; Differential Thermal Analysis and Differential scanning calorimetry-Importance of thermal analysis for nanostructures.

UNIT IV QUALITATIVE AND QUANTITATIVE ANALYSIS 9

Electron Energy Loss Spectroscopy; High Resolution Imaging Techniques, Atom probe field ion microscopy-X-Ray Photoelectron Spectroscopy - X-ray fluorescence (XRF) -EDAX and WDA analysis – EPMA – ZAP corrections.

UNIT V NANOMECHANICAL ANALYSIS 9

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

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. B. D.Cullity, “Elements of X-ray Diffraction”, 4th Edition, Addison Wiley, 1978.
2. M. H.Loretto, “Electron Beam Analysis of Materials”, Chapman and Hall, 1984.
3. R.M.Rose, L.A.Shepard and J.Wulff, “The Structure and Properties of Materials”, Wiley Eastern Ltd, 1996.
4. B.W.Mott, “Micro-Indentation Hardness Testing”, Butterworths, London, 1956

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Students will learn about advanced analytical techniques for nanomaterials	3	3		3					2			2
CO2	Students will learn about qualitative and quantitative analysis techniques employed for studying nanomaterials	3	3		3					2			2
CO3	Understand the mechanical analytical techniques used to study nanomaterials	3	3		3					2			2
Overall CO		3	3		3					2			2

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5203 PHYSICS AND CHEMISTRY OF MATERIALS L T P C
3 1 0 4

OBJECTIVES:

- To gain knowledge on Physical and chemical aspects of Nano materials.
- To know about diffusion and surface defects, nanostructures and Nano systems.

UNIT I PHYSICS ASPECTS 9

Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area and aspect ratio- band gap energy- quantum confinement size effect.

UNIT II CHEMISTRY ASPECTS 9

Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nanocatalysis - Nanoscale heat transfer - Electron transport in transition metals and semiconducting nanostructures.

UNIT III DIFFUSION AND SURFACE DEFECTS 9

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

UNIT IV NANOSTRUCTURES 9

Classifications of nanomaterials - Zero dimensional, one-dimensional and two dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites.

UNIT V NANOSYSTEMS 9

Nanoparticles through homogeneous and heterogeneous nucleation-Growth controlled by surface and diffusion process- Oswald ripening process - influence of reducing agents solid state phase segregation- Mechanisms of phase transformation- grain growth and sintering- precipitation in solid solution- Hume-Rothery rule.

TOTAL :45 PERIODS

COURSE OUTCOMES:

CO1: Gaining knowledge on physical and chemical aspects of Nano materials
CO2: Students will understand about the diffusion and surface defects in nanomaterials
CO3: Students will learn about various kinds of nanostructures and Nano systems

REFERENCES

1. K.W. Kolasinski, "Surface Science: Foundations of Catalysis and Nanoscience", Wiley, London, 2002.
2. G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties & Applications , Imperial College Press, London, 2004.
3. Joel I. Gersten, "The Physics and Chemistry of Materials", Wiley, London 2001.
4. A. S. Edelstein and R. C. Cammarata, "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Pub., London,1998.
5. S.Yang and P.Shen: "Physics and Chemistry of Nanostructured Materials", Taylor & Francis, New York, 2000.
6. G.A. Ozin and A.C. Arsenault, "Nanochemistry : A chemical approach to Nanomaterials", Royal Society of Chemistry, London 2005.
7. Atkins Peter, Paula Julio Physical Chemistry,

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Gaining knowledge on physical and chemical aspects of Nano materials	3	3		3					2			2
CO2	Students will understand about the diffusion and surface defects in nanomaterials	3	3		3					2			2
CO3	Students will learn about various kinds of nanostructures and Nano systems	3	3		3					2			2
Overall CO		3	3		3					2			2

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5211 MATERIALS STRUCTURAL CHARACTERIZATION LAB L T P C
0 0 2 2

OBJECTIVES

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

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome										
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Will get experience in analysing the nanomaterials		3		3	3				2			2
CO2	Able to interpret SEM and AFM images		3		3	3				2			2
CO3	XRD interpretations of Nanopowders are gained and crystallanity can be analysed		3		3	3				2			2
Overall CO			3		3	3				2			2

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5212 PHYSICOCHEMICAL CHARACTERIZATION LAB L T P C
0 0 2 2

OBJECTIVES

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

1. FTIR analysis of Nanostructures
2. FTIR interpretation of results
3. RAMAN Analysis of Nanostructures
4. RAMAN interpretation of results
5. TGA analysis of nanomaterials
6. TGA interpretation of results
7. DSC analysis of nanomaterials
8. DSC interpretation of results
9. UV-vis analysis of nanomaterials
10. UV-vis interpretation of nanomaterials
11. Preparation of CdS quantum dots loaded photoanode, fabrication of Quantum dot sensitized solar cells and performance analysis of the cell.
12. Preparation of GO and rGO, fabrication of an EDLC based electrode materials and electrochemical performance analysis of the electrode.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Students can able to analyze and interpret various spectroscopic techniques		3		3	3				2			2
CO2	Optical properties of QDs and graphene based materials can be analysed		3		3	3				2			2
CO3	Able to characterize the fabricated device and interpret the results		3		3	3				2			2
Overall CO			3		3	3				2			2

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

ELECTIVES

NT5001 **NANOCOMPOSITE MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

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

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

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

UNIT III POLYMER BASED NANOCOMPOSITES 9

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

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

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

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: The students will learn about fundamental aspects and fabrication technologies of nanocomposites

CO2: Will gain knowledge about applications of nanocomposites in various industries

CO3: At the end of this course students would be able to design, build nanocomposite materials for engineering applications

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	The students will learn about fundamental aspects and fabrication technologies of nanocomposites	3	3		3					2			
CO2	Will gain knowledge about applications of nanocomposites in various industries	3	3		3					2			
CO3	At the end of this course students would be able to design, build nanocomposite materials for engineering applications	3	3		3					2			
Overall CO		3	3		3					2			

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

NT5002 NANOMATERIALS FOR ENERGY AND ENVIRONMENT L T P C
3 0 0 3

OBJECTIVES:

- To be aware of the challenges and demand for Energy
- To study about the nanomaterials used in Energy applications
- To enhance our knowledge on the role of nanomaterials in remediation applications and its impact on the environment.

UNIT I INTRODUCTION 9

Sustainable energy - Materials for energy - Green house effect - CO_2 emission - Energy demand and challenges.

UNIT II RENEWABLE ENERGY TECHNOLOGY 9

Development and implementation of renewable energy technologies. Nano, micro and mesoscale phenomena and devices. Energy conversion, transport and storage. High efficiency Photovoltaic solar cells. High performance thermoelectric systems - Integration and performance of DSSC-Quantum dots based solar cells.

UNIT III NANOMATERIALS IN FUEL CELL AND STORAGE TECHNOLOGY 9

Micro-fuel cell technologies, integration and performance for micro-fuel cell systems - thin film and microfabrication methods - design methodologies - micro-fuel cell power sources - Supercapacitors - Specific energy- charging/discharging - EIS analysis.

UNIT IV HYDROGEN STORAGE AND PHOTOCATALYSIS 9

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

UNIT V ENVIRONMENTAL APPLICATIONS & IMPACTS OF NANOMATERIAL 9

Nanomaterials as adsorbents - Nanocomposite membrane systems for water remediation: Membrane fabrication; Membrane reactors & Active Membrane systems -Ecotoxicological impacts of nanomaterials - Lifecycle assessment of nanomaterials.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. J. Twidell and T. Weir, Renewable Energy Resources, Taylor & Francis Group, 2014 (4th Edition).
2. Ram B.Gupta, Hydrogen Fuel,CRC Press, Taylor and Francis Group, New York, 2009
3. Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, Taylor and Francis Group New York, 2003.
4. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London, 2003
5. Zhen Fang, Richard L Smith, Xinhua Qi, Production of Hydrogen from Renewable Resources, , Springer, London, 2016
6. Mark R. Wiesner, Jean-Yves Bottero, Environmental Nanotechnology: Applications and Impacts of Nanomaterials, McGraw Hill, New York, 2007.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Students will gain familiarity with renewable energy technologies updated with nano devices and different fabrication methodologies	3	3		3			3		2			
CO2	Kinetic studies of dye degradation using nanophotocatalysts will be learned	3	3		3			3		2			
CO3	Students get acquainted with the application of nanomaterials and its impacts in environmental systems	3	3		3			3		2			
Overall CO		3	3		3			3		2			

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5003 PROCESSING AND PROPERTIES OF NANOSTRUCTURED MATERIALS L T P C
3 0 0 3

OBJECTIVES

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

UNIT I DEFORMATION PROCESSING AND METAL FORMING 9

Classification of engineering materials - Tensile testing – Stress strain curve – Flow stress - Mechanical properties – Formability - Deformation processes - Mechanics of metal working – Metal forming - forging, rolling, extrusion, wire drawing – Superplastic forming – Bulk nanostructured materials by Severe Plastic Deformation (SPD) - Comparison of processes.

UNIT II MICROSTRUCTURAL PROPERTIES 9

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

UNIT III PROCESSING OF POLYMERS 9

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

UNIT IV PROCESSING OF POWDERS OF METALS AND CERAMICS 9

Metal/Ceramic Powder synthesis - Selection and characterization of powders – compacting and sintering - Production of Porous and Dense Composite Components: Advanced composite materials - Metal- polymer- and ceramic- based composites and their properties – Fabrication of composite materials.

UNIT V PROCESSING OF FUNCTIONAL NANOMATERIALS 9

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

TOTAL :45 PERIODS

COURSE OUTCOMES:

CO1: Will acquire knowledge about the deformation and microstructural properties of the nanomaterials

CO2: Gaining knowledge about processes of polymers and nanostructured materials

CO3: Will understand the functional properties of nanomaterials and polymers for various applications

REFERENCES

1. H. Cottrell “The Mechanical Properties of Matter”, John Wiley, New York, 1964.
2. R. Asthana, A. Kumar and N. Dahotre “Materials Science in Manufacturing” Butterworth-Heinemann, Elsevier 2006.
3. G. E. Dieter, adapted by D Bacon, “Mechanical Metallurgy”, McGraw Hill, Singapore, 1988.
4. K. A. Padmanabhan, “Mechanical Properties of Nanostructured Materials”, Materials Science and Engineering, A 304-306 (2001) 200-205.
6. H. Gleiter, “Nanocrystalline Materials”, Progress in Materials Science Vol. 33,
7. C. Koch, “Nanostructured Materials: Processing, Properties and Applications”, 2nd Edition, Ed.: 2007

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Will acquire knowledge about the deformation and microstructural properties of the nanomaterials	3	3		3		3			2			
CO2	Gaining knowledge about processes of polymers and nanostructured materials	3	3		3		3			2			
CO3	Will understand the functional properties of nanomaterials and polymers for various applications	3	3		3		3			2			
Overall CO		3	3		3		3			2			

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5004 LITHOGRAPHY AND NANOFABRICATION L T P C
3 0 0 3

OBJECTIVES

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

UNIT I SEMICONDUCTOR PROCESSING AND MICROFABRICATION 9

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

UNIT II PHOTOLITHOGRAPHY AND PATTERNING OF THIN FILMS 9

Lithography -Optical lithography - different modes - Optical projection lithography - Multistage scanners – resolution and limits of photolithography – Resolution enhancement techniques - Photomask- Binary mask- Phase shift mask - Attenuated phase shift masks - alternating phase shift masks - Off axis illumination- Optical proximity correction - Sub resolution assist feature enhancement-Optical immersion lithography

UNIT III DIRECT WRITING METHODS-MASKLESS OPTICAL LITHOGRAPHY 9

Maskless optical projection lithography – types, Advantages and Limitations – required components - Zone plate array lithography - Extreme ultraviolet lithography – Light sources - Optics and materials issues

UNIT IV ELECTRON BEAM LITHOGRAPHY (EBL), X-RAY AND ION BEAM LITHOGRAPHY 9

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

UNIT V NANOIMPRINT LITHOGRAPHY AND SOFT LITHOGRAPHY 9

Nanoimprint lithography (NIL)- NIL - hot embossing - UV-NIL- Soft Lithography- Moulding/Replica moulding: PDMS stamps - Printing with soft stamps- Edge lithography - Dip-Pen Lithography-set up and working principle – Self-assembly – LB films – Rapid prototyping.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Will realize the importance of miniaturization and nanofabrications

CO2: Will learn about various types of lithographic techniques

CO3: The students will able to understand the merits and de-merits of each lithographic techniques used for nanofabrication

REFERENCES:

1. Chris Mack, Fundamental Principles of Optical Lithography: The Science of Microfabrication, Wiley, 2008.
2. D. S. Dhaliwal et al., PREVAIL –"Electron projection technology approach for next generation lithography", IBM Journal Res. & Dev. 45, 615 (2001).
3. M. Baker et al., "Lithographic pattern formation via metastable state rare gas atomic beams", Nanotechnology 15, 1356 (2004).
3. H. Schift et al., "Fabrication of polymer photonic crystals using nanoimprint lithography", Nanotechnology 16, 261, (2005).
4. R.D. Piner, "Dip-Pen" Nanolithography, Science 283, 661 (1999).

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Will realize the importance of miniaturization and nanofabrications	3	3	2	3					2			
CO2	Will learn about various types of lithographic techniques	3	3	2	3					2			
CO3	The students will able to understand the merits and de-merits of each lithographic techniques used for nanofabrication	3	3	2	3					2			
Overall CO		3	3	2	3					2			

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

NT5005 NANOTECHNOLOGY IN AGRICULTURE AND FOOD INDUSTRY L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I NANOTECHNOLOGY IN CROP PRODUCTION 9

Fertilizer – types and mode of action; Nanofertilizer – nanourea and mixed fertlizers; Nanomaterials as soil conditioners – zeolites, nanoclays, superabsorbent polymers, nanocomposites; Nanoemulsion based antitranspirants; Nanosensors for monitoring soil moisture; Effect of nanoparticles in seed – carbon based, TiO_2, aluminium, silver, copper, ZnO nanoparticles; Smart delivery systems for nanofertilizer release;

UNIT II NANOTECHNOLOGY IN PEST MANAGEMENT 9

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

UNIT III NANOTECHNOLOGY IN FOOD PROCESSING 9

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

UNIT IV NANOTECHNOLOGY IN FOOD PACKAGING 9

Nanocomposites; Nanostructured layers; Nanomaterials for food preservation; Nanopackaging for enhanced shelf life; Nanotechnology in intelligent packaging; Nanosensors for food safety monitoring.

UNIT V IMPACTS OF NANOAPPLICATION 9

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

TOTAL PERIODS: 45

COURSE OUTCOMES:

CO1: Student will learn the basic interaction of different molecules which are helpful inboth food and agricultural activities

CO2: Understand the importance of nanomaterials and devices in precision farming

CO3: Students will understand the importance of advanced materials used in agriculture and food industries

REFERENCES:

1. C.R.Chinnamuthu, B. Chandrasekaran C. Ramasamy- Nanotechnology Applications in Agriculture, 2008.
2. S.Choudary, Applied Nanotechnology in Agriculture. Arise Publications.ISBN:978-93-80162-54-6, 2011
3. Jain, P., S.Arora and T.Rai,. - Flavour encapsulation and its application, Beverage and Food World 24 (4), 21-24, 1997
4. Günter Oberdörster, Eva Oberdörster, Jan Oberdörster. 2005. NANOTOXICOLOGY: An Emerging Discipline Evolving from Studies of Ultrafine Particles Environ Health Perspect. July; 113(7): 823–839
5. Nancy A.Monteiro-Reviere and C.Lang Tran, Nanotoxicology-Charachterization, Dosing and Health Effects.Informa HealthCare, New York. 434p. 2009.
6. Monique A. V. Axelos (Editor), Marcel Van de Voorde (Editor), Nanotechnology in Agriculture and Food Science; ISBN: 978-3-527-69773-1; March 2017; 450p

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Student will learn the basic interaction of different molecules which are helpful inboth food and agricultural activities	3	3		3				2	2			2
CO2	Understand the importance of nanomaterials and devices in precision farming	3	3		3				2	2			2
CO3	Students will understand the importance of advanced materials used in agriculture and food industries	3	3		3				2	2			2
Overall CO		3	3		3				2	2			2

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

NT5006 NANOELECTRONICS AND SENSORS L T P C
3 0 0 3

OBJECTIVES:

- To learn about overview of nanoelectronics.
- To study the basic components of electronic systems.
- To learn about sensor fabrication and applications.

UNIT I OVERVIEW OF NANO-ELECTRONICS 9

Nano-scale electronics; Foundation of nano-electronics – low dimension transport, quantum confinement, Coulomb blockade and quantum dot; Ballistic transport and Quantum interferences; Landauer formula, quantization of conductance, example of Quantum point contact.

UNIT II TWO-TERMINAL JUNCTION TRANSISTORS 9

Basic CMOS process flow; MOS scaling theory; Issues in scaling MOS transistors; Requirements for non-classical MOS transistor; PMOS versus NMOS; Design and construction of MOS capacitor; Integration issues of high-k MOS – interface states, bulk charge, band offset, stability, reliability; MOS transistor and capacitor characteristics.

UNIT III GATE 9

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

UNIT IV SENSORS AND ACTUATOR CHARACTERISTICS 9

Basic types and working principles of sensors and actuators; Characteristic features: Range, Resolution, Sensitivity, Error, Repeatability, Linearity and Accuracy, Impedance, Nonlinearities, Static and Coulomb Friction, Eccentricity, Backlash, Saturation, Deadband, System Response, First Order System Response, Under-damped Second Order System Response, Frequency Response.

UNIT V MEMORY DEVICES AND SENSORS 9

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

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

1. W. Ranier, “Nano Electronics and Information Technology”, Wiley, (2003).
2. K.E. Drexler, “Nano systems”, Wiley, (1992).
3. M.C. Petty, “Introduction to Molecular Electronics”1995.
4. Vladimir V. Mitin, Vieatcheslov A. Kochelap, Micheal A. Stroscio, Introduction to Nanoelectronics, Cambridge University Press, London, 2008
5. Vinod Kumar Khanna, Nanosensors:Physical, Chemical and Biological, CRC Press, London, 2014
6. Supriyo Datta, Lessons from Nanoelectronics, World Scientific, Hong Kong, 2012

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Students will gain knowledge in basics of nanoelctronics	3	3	2	3					2			
CO2	Students will gather idea about materials and techniques used for sensor components	3	3	2	3					2			
CO3	Students will acquire information about fabrication of different sensors	3	3	2	3					2			
Overall CO		3	3	2	3					2			

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5007 **BIOPHOTONICS** **L T P C**
3 0 0 3

OBJECTIVES:

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

UNIT I BASICS OF LIGHT AND OPTICS 9

Interaction of light with cells, tissues, non-linear optical processes with intense laserbeams, photo-induced effects in biological systems.

UNIT II IMAGING TECHNIQUES 9

Light microscopy, wide-field, laser scanning, confocal, multiphoton, fluorescence lifetimeimaging, FRET imaging, Frequency-Domain lifetime imaging. Cellular Imaging, Imagingof soft and hard tissues and other biological structures.

UNIT III SINGLE MOLECULE SPECTROSCOPY 9

UV-VIS spectroscopy of biological systems, single molecule spectra and characteristics –IR and Raman spectroscopy and Surface Enhanced Raman Spectroscopy for single molecule applications.

UNIT IV OPTICAL FORCE SPECTROSCOPY 9

Generation optical forces – Optical trapping and manipulation of single molecules and cells in optical confinement - Laser trapping and dissection for biological systems – single molecule biophysics, DNA protein interactions.

UNIT V SENSORS AND OPTICAL TECHNIQUES 9

Biosensors, fluorescence immuoassay, flow cytometry, Fluorescence correlation spectroscopy, Fluorophores as cellular and molecular tags.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. Laser Tweezers in Cell Biology in Methods in Cell Biology, Vol.55, Michael P. Sheetz(Ed.), Academic Press 1997.
2. P.N. Prasad, Introduction to Biophotonics, John-Wiley, 2003.
3. G. Marriot & I. Parker, Methods in Enzymology, Vol.360,2003.
4. G. Marriot & I. Parker, Methods in Enzymology, Vol.361,2003.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Students will gain knowledge in basics of optics	3	3		3					2			
CO2	Students will gather idea about imaging techniques	3	3		3					2			
CO3	Students will acquire information about Biophotonics and advanced optical sensors	3	3		3					2			
Overall CO		3	3		3					2			

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5008 **MEMS AND NEMS** **L T P C**
3 0 0 3

OBJECTIVES:

- To learn about Micro fabrication and scaling of MEMS
- To study the Microsystem and materials used in MEMS Technology
- To learn about Biological MEMS Technology

UNIT I MEMS MICROFABRICATION 9

Historical Development of Microelectronics, Evolution of Microsensors, Evolution of MEMS, Emergence of Micromachines, Modeling - Finite Element Analysis, CAD for MEMS, Fabrication – ALD, Lithography Micromachining, LIGA and Micromolding, Saw-IDT Microsensor Fabrication, Packaging – Challenges, Types, Materials and Processes.

UNIT II SCALING OF MEMS 9

Introduction to Scaling Issues, Scaling effects on a cantilever beam, Scaling of electrostatic actuators, Scaling of thermal actuator, Scaling of Thermal Sensors, mechanics and electrostatistics. Influence of scaling on material properties.

UNIT III MICROSYSTEMS 9

Microsensors, microaccelerometer, microfluidics, Mechanics for Microsystems design-Thermomechanics, fracture mechanics, thin film mechanics. Microfluid mechanics.

UNIT IV MATERIALS FOR MEMS 9

Materials for mems and pro mems-silicon-metals and polymers-Substrate Materials for MEMS-Silicon-quartz-ceramics-Bulk metallic glasses-Sharp Memory alloys, Carbon based MEMS

UNIT V COMMERCIAL AND TECHNOLOGICAL TRENDS 9

Commercial trends in miniaturization – High density chip analysis-Micro-accelerometers micro-resonators-lab-in-chip for DNA and protein analysis – Nano HPLC system nanopatches.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. Marc Madou, Fundamentals of Microfabrication, CRC Press 1997.
2. MEMS and Microsystems design and manufacture, Tai-Ran Hsu,Tata Mc Graw Hill2011.
3. Sergey Edward Lyshevski, Nano- and Microelectromechanical Systems, CRC Press2000.
4. Vijay Varadan, Xiaoning Jiang, and Vasundara Varadan, Microstereolithography *and*other Fabrication Techniques for 3D MEMS*,* Wiley 2001.
5. Tai-Ran Hsu, MEMS and Microsystems: Design and Manufacture, McGraw-Hill 2001.
6. Ken Gilleo. MEMS/MOEMS Packaging: Concepts, Designs, Materials and Processes. McGraw-Hill, 2005.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Students would gain knowledge in microfabrication techniques and scaling process	3	3		3					2			
CO2	Would acquire knowledge about the Microsystem and materials used in MEMS Technology	3	3		3					2			
CO3	Students would acquire information about recent trends in MEMS and BioMEMS techniques	3	3		3					2			
Overall CO		3	3		3					2			

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5009 **NANOTOXICOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

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

UNIT I INTRODUCTION TO TOXICOLOGY 9

Concept of Toxicology-Types of toxicity based on route of entry, nature of the toxin.Toxicodynamics–Dose vs Toxicity Relationships. Toxico kinetics – ADME, LADMET hypothesis. Genotoxicity and carcinogenicity – Mechanisms and Tests. Organ toxicity – Respiratory**,** dermal, hepato, neuro and nephro.

UNIT II NANOTOXICOLOGY 9

Characteristics of Nanoparticles that determine Potential Toxicity. Bio-distribution ofnanoparticles. Interation of Nanoparticles with Biomembrane and genes. Evaluation ofNanoparticle transfer using placental models. Nanomaterial toxicity – Pulmonary**,** dermal,hepato, neuro, ocular and nephro; Estimation of Nanoparticle Dose in Humans.In vitro toxicity studies of ultrafine diesel exhaust particles; Toxicity studies of carbon nanotubes

UNIT III PROTOCOLS IN TOXICOLOGY STUDIES 9

Methods for toxicity assessment – Cyto, Geno, hepato, neuro, nephrotoxicity. Assessment of toxicokinetics. Assessment of oxidative stress and antioxidant status.

UNIT IV ANIMAL MODELS 9

Types, species and strains of animals used in toxicity studies. Dosing profile for animalmodels. Studies on toxicology, pathology and metabolism in mouse and rat. Laws andRegulations Governing Animal Care and Use in Research.

UNIT V RISK ASSESSMENT AND EXECUTION 9

SRisk assessment of Nanoparticle exposure. Prevention and control of nanoparticles exposure. Regulation and recommendations.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. John H. Duffus, Howard G. J. Worth, 'Fundamental Toxicology', The Royal Society of Chemistry 2006.
2. Nancy A. Monteiro-Riviere, C. Lang Tran., 'Nanotoxicology: Characterization, Dosing and Health Effects',Informa Healthcare publishers, 2007.
3. Lucio G. Costa, Ernest Hodgson, David A. Lawrence, Donald J. Reed,William F.Greenlee, 'Current Protocols in Toxicology', John Wiley & Sons, Inc. 2005.
4. Shayne C. Gad, 'Animal models in toxicology', Taylor & Francis Group, LLC 2007.
5. P. Houdy, M. Lahmani, F. Marano, 'Nanoethics and Nanotoxicology', Springer- Verlag Berlin Heidelberg 2011.
6. A Reference handbook of nanotoxicology by M.ZafarNyamadzi 2008.
7. Andreas Luch, 'Molecular, Clinical and Environmental Toxicology Volume 2: ClinicalToxicology', BirkhauserVerlag AG 2010.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Students will get knowledge on nanotoxicology and their effects on human and animals	3	3		3				3	2			3
CO2	They will acquire knowledge about various prevention methods	3	3		3				3	2			3
CO3	Gaining knowledge on the remedies for nanotoxicology	3	3		3				3	2			3
Overall CO		3	3		3				3	2			3

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

NT5010 ADVANCED DRUG DELIVERY SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I THEORY OF ADVANCED DRUG DELIVERY 9

Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery. Transport of Nanoparticles - In Vitro and Ex Vivo Models.

UNIT II POLYMERS 9

Dendrimers- Synthesis -Nanoscale containers- Dendritic Nanoscafold systems-Biocompatibility of Dendrimers, Gene transfection. pH based targeted delivery- chitosan and alginate. Copolymers in targeted drug delivery- PCL,PLA, PLGA.

UNIT III LIPID BASED NANOCARRIERS 9

Liposomes, niosomes and solid lipid nanoparticles. Ligand based delivery by liposomes. Cubosomes.

UNIT IV MICROBES AND ANTIBODY BASED NANOCARRIERS 9

Bacterial dependent delivery of vaccines. Drug delivery and subcellular targeting by virus, Drug packaging and drug loading. Delivery of therapeutics by antibodies and antibody bioconjugates.

UNIT V DEVICES FOR DRUG DELIVERY 9

Fabrication and Applications of Microneedles, Micropumps, microvalves. Implantable microchips.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. M. Salzman , Drug Delivery: Engineering Principles for Drug Therapy , Oxford University Press, 2001.
2. A.M. Hillery, Drug Delivery and Targeting, CRC Press, 2002.
3. B. Wang, Drug Delivery: Principles and Applications, Wiley Intersceince, 2005.
4. Ram B. Gupta, Uday B. Kompella , Nanoparticle Technology for Drug Delivery, Taylor& Francis, 2006.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Students will gain knowledge in basics of drug delivery systems	3	3	2	3					2			
CO2	Students will gather idea about materials and techniques used for drug coating and delivery	3	3	2	3					2			
CO3	Students will acquire information about recent trends equipments and delivery systems	3	3	2	3					2			
Overall CO		3	3	2	3					2			

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5011 **PHOTONICS FOR NANOTECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES

- To understand the nature of materials in nanosize and nano-structures.
- To learn plasmonics and photonics to enable students to take up researchtowards optoelectronics.
- To understand the mechanism of bio-photonic systems

UNIT I QUANTUM CONFINED MATERIALS 9

Quantum structures – optical transitions – absorption-inter-band transitions-quantum confinement intraband transitions-fluorescence/ luminescence–photoluminescence/ fluorescence optically excited emission, time resolved PL – electroluminescence emission .

UNIT II PLASMONICS 9

Internal reflection and evanescent waves- plasmons and surface plasmon resonance(SPR)- Attenuated total reflection- Grating SPR coupling- Optical waveguide SPRcoupling- SPR dependencies and materials- plasmonics and nanoparticles.

UNIT III NANOPHOTONICS 9

Near-Field Optics- Aperture near-field optics- Apertureless near-field optics- Near-field scanning optical microscopy (NSOM or SNOM)- SNOM based detection of plasmonic energy transport- SNOM based visualization of waveguide structures- SNOM in nanolithography- Surface enhanced Raman spectroscopy (SERS).

UNIT IV PHOTONIC CRYSTALS 9

Important features of photonic crystals- Presence of photonic bandgap- AnomalousGroup Velocity Dispersion- Microcavity - Effects in Photonic Crystals- Fabrication ofphotonic crystals- Dielectric mirrors and interference filters- Photonic Crystal Laser- PC based LEDs- Photonic crystal fibers (PCFs)- Photonic crystal sensing.

UNIT V BIOPHOTONICS 9

Interaction of light with cells- tissues- nonlinear optical processes with intense laser beams- photoinduced effects in biological systems-generation of optical forces-optical trapping and manipulation of single molecules and cells in optical confinement-laser trapping and dissection for biological systems-single molecule biophysics - DNA protein interactions.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1**:** Will understand the nano size effects in photonic materials

CO2: Plasmonics and Near field optics in nanostrucured materials will be learned

CO3: Acquire knowledge about photonic crystals and biophotonic systems

REFERENCES:

1. H.Masuhara, S.Kawata and F.Tokunaga, Nano Biophotonics, Elsevier Science,2007.
2. V.M. Shalaev and S.Kawata, Nanophotonics with Surface Plasmons (Advances in Nano-Optics and Nano-Photonics), 2007.
3. B.E.A. Saleh and A.C.Teich, Fundamentals of Photonics, John-Weiley & Sons, New York, 1993.
4. M.Ohtsu, K.Kobayashi, T.Kawazoe, and T.Yatsui, Principles of Nanophotonics (Optics and Optoelectronics), University of Tokyo, Japan, 2003.
5. P.N. Prasad, Introduction to Biophotonics, John Wiley & Sons, 2003.
6. J.D.Joannopoulos, R.D.Meade and J.N.Winn, Photonic Crystals, Princeton University Press, Princeton, 1995.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Will understand the nano size effects in photonic materials	3	3		3					2			
CO2	Plasmonics and Near field optics in nanostrucured materials will be learned	3	3		3					2			
CO3	Acquire knowledge about photonic crystals and biophotonic systems	3	3		3					2			
Overall CO		3	3		3					2			

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5012 **SEMICONDUCTOR NANOSTRUCTURES** **L T P C**
3 0 0 3

OBJECTIVES:

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

UNIT I SEMICONDUCTOR FUNDAMENTALS 9

Introduction to Semiconductor physics – Fabrication techniques – Semiconductor nanostructures – Electronic structure and physical process – Principles of semiconductor nanostructures based electronic and electro-optical devices – Semiconductor Quantum Dots – Quantum Lasers – Quantum Cascade Lasers – Quantum Dot Optical Memory.

UNIT II SEMICONDUCTOR NANOPARTICLE SYNTHESIS 9

Cluster compounds, quantum-dots from MBE and CVD, wet chemical methods, reverse micelles, electro-deposition, pyrolytic synthesis, self-assembly strategies.

UNIT III PHYSICAL PROPERTIES 9

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

UNIT IV SEMICONDUCTOR NANOPARTICLES – APPLICATIONS 9

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

UNIT V SEMICONDUCTOR NANOWIRES 9

Fabrication strategies, quantum conductance effects in semiconductor nanowires, porous Silicon, nanobelts, nanoribbons, nanosprings.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. Encyclopedia of Nanoscience and Nanotechnology- Hari Singh Nalwa, 2004.
2. Springer Handbook of Nanotechnology - Bharat Bhusan, 2004.
3. Handbook of Semiconductor Nanostructures and Nanodevices Vol 1-5- A. A.Balandin, K. L. Wang 2006.
4. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao,Guozhong, 2011.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Overall the students will get idea about basic and advanced concepts in electronics and quantum physics	3	3		3					2			
CO2	Will acquire knowledge about the physical and quantum aspects of semiconductors	3	3		3					2			
CO3	Students will acquire the ideas about optical applications of semiconductor nanostructures	3	3		3					2			
Overall CO		3	3		3					2			

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

NT5013 NANOTECHNOLOGY IN HEALTH CARE L T P C
3 0 0 3

OBJECTIVES

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

UNIT I TRENDS IN NANOBIOTECHNOLOGY 9

Nanotechnology in gene therapy. Stem Cell technology. PCR, ELISA, DNA Profiling and Blotting techniques-Nanoprobes.

UNIT II NANOIMMUNOTECHNOLOGY 9

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

UNIT III NANOTECHNOLOGY BASED MEDICAL DIAGNOSTICS 9

Improved diagnosis by i*n vivo* imaging - detection of tumors, plaque and genetic defects. Nanobot medical devices. Cantilever Sensors.

UNIT IV PROSTHETIC AND MEDICAL IMPLANTS 9

Prosthesis and implants. neural, ocular, cochlear, dental implants. implants and prosthesis of skin, limb, bone. Artficial organ and Organ transplant. Nano fibre scaffold technology.

UNIT V BIOMEDICAL APPLICATIONS OF NANOTECHNOLOGY 9

Nano-bioconjugates and their significance. Nanoscaffolds. Magnetic Nanoparticles. Multifunctional Inorganic and organic nanoparticles and their biomedical applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. Brian, R Eggins, Chemical Sensors and Biosensors; Wiley; New York, 2002.
2. L Gorton, Biosensors and modern biospecific analytical techniques, Wilson & Wilson's Comprehensive Analytical Chemistry Elsevier, Amsterdam, London; 2005.
3. David Wild; The Immunoassay Handbook; 3rd ed.; Amsterdam: Elsevier; 2005.
4. Allen J Bard and LarryR Faulkner;Electrochemical Methods: Fundamentals and Applications; Wiley, New York, 2nd ed.; 2001.
5. Vladimir M. Mirsky, Ultrathin Electrochemical Chemo- and Biosensors: Technology and Performance in Springer Series on Chemical Sensors and Biosensors; Springer, Berlin; 2004

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Comprehend the nanoparticles-based gene therapy, nanoprobing and profiling techniques and their application	3	3		3				3	2			2
CO2	Understand the use of metal nanoparticles and antibodies in diagnosis of biomarkers with high sensitivity	3	3		3				3	2			2
CO3	Be aware of the principle and uses of cantilever sensors and imaging of plaques and tumors	3	3		3				3	2			2
CO4	Completely understand the ocular, cochlear, dental implants and nanofiber technology								3				2
CO5	Have knowledge on functionalised nanoscaffolds, magnetic, organic and inorganic nanoparticles								3				2
Overall CO		3	3		3				3	2			2

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

NT5014 **NANOBIOSENSORS** **L T P C**
3 0 0 3

OBJECTIVES:

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

UNIT I ESSENTIALS OF BIOSENSORS 9

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

UNIT II PROTEIN BASED BIOSENSORS 9

Nano structure for enzyme stabilization – single enzyme nano particles – nano tubes microporus silica – protein based nano crystalline. Diamond thin film for processing.

UNIT III DNA BASED BIOSENSOR 9

Heavy metal complexing with DNA and its determination, sensing in water and food samples – DNA zymo Biosensors.

UNIT IV SENSING OF CELLS AND PATHOGENS 9

Nanoscale biosensors. Nanobiosensors for cellular biosensing and sensing of rare cells. Detection of pathogens in food and water samples.

UNIT V APPLICATIONS OF BIOSENSORS 9

Designed protein pores and protein cages -as components of biosensors. Biosensors for pharma and medicine, bioremediation, defense and food technology, wearable biosensor.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Students will acquire knowledge in basics of Biosensors

CO2: Students will gain idea about fabrication techniques of biosensors

CO3: Students will gain information about recent trends in nanobiosensors and application in various fields

REFERENCES:

1. J.Cooper, C.Tass Biosensors: APractical Approach, Oxford Univ Press, 2004.
2. Cs. Kumar, Nanomaterials for Biosensors, , Wiley – VCH, 2007.
3. G.K. Knoff, A.S. Bassi, Smart Biosensor Technology, , CRC Press, 2006.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	Students will acquire knowledge in basics of Biosensors	3	3		3					2			
CO2	Students will gain idea about fabrication techniques of biosensors	3	3		3					2			
CO3	Students will gain information about recent trends in nanobiosensors and application in various fields	3	3		3					2			
Overall CO		3	3		3					2			

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop– RDBMS versus Hadoop–Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop– Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. VigneshPrajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, UmeshaNayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

OE5092 **INDUSTRIAL SAFETY** **LT P C**
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn ,Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook,Eighth Edition,2008

OE5093 OPERATIONS RESEARCH LT P C
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method,Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENTOF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

OE5095 **COMPOSITE MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identifythe various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION **9**

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS **9**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES **9**

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES **9**

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH **9**

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5				✓	✓		✓					

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, WestGermany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNITI INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNITIIBIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNITIII BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNITIV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNITV BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

AUDIT COURSES (AC)

AX5091 ENGLISHFOR RESEARCHPAPERWRITING L T P C
2 0 0 0

OBJECTIVES

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

UNITI INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

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

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

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

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 –Learn about what to write in each section
CO3 –Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

AX5092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

OBJECTIVES

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

UNIT I INTRODUCTION **6**

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

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS **6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA **6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT **6**

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

UNIT V RISK ASSESSMENT **6**

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

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
3. Sahni, Pardeep Et.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094	VALUE EDUCATION	L T P C 2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Workethics,Indianvisionofhumanism.Moralandnon-moralvaluation.Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love fornature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the over all personality.

Suggested reading

1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

AX5095	CONSTITUTION OF INDIA	L T P C 2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:

History, Drafting Committee, (Composition &Working)

UNIT II PHILOSOPHYOFTHE INDIANCONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:

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

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- DiscussthegrowthofthedemandforcivilrightsinIndiaforthebulkofIndiansbeforethe arrival of Gandhi in Indian politics.
- Discusstheintellectualoriginsoftheframeworkofargumentthatinformedtheconceptualization
- of social reform sliding to revolution in India.
- DiscussthecircumstancessurroundingthefoundationoftheCongressSocialistParty[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- DiscussthepassageoftheHinduCodeBillof1956.

Suggested reading

1. TheConstitutionofIndia,1950(BareAct), Government Publication.
2. Dr. S. N. Busi, Dr. B. R.AmbedkarframingofIndianConstitution,1st Edition,2015.
3. M.P. Jain,IndianConstitutionLaw,7th Edn.,Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis,2015.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

AX5096 **PEDAGOGY STUDIES** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OFPEDAGOGICALPRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- Whatpedagogicalpracticesarebeingusedbyteachersinformalandinformalclassrooms in developing countries?
- What is the evidence on the effectiveness soft he sepedagogical practices, in what conditions, and with what population of learners?
- How can teacher education(curriculum and practicum)and the school curriculum and guidance materials best support effective pedagogy?

Suggested reading

1. Ackers, HardmanF(2001)ClassroominteractioninKenyanprimaryschools,Compare,31(2): 245-261.
2. AgrawalM (2004)Curricular reform in schools: The importance of evaluation, JournalofCurriculumStudies,36(3):361-379.
3. AkyeampongK(2003)TeachertraininginGhana-doesitcount?Multi-siteteachereducationresearchproject(MUSTER) country report 1.London:DFID.
4. Akyeampong K,LussierK, PryorJ, WestbrookJ (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. ChavanM (2003) Read India: Amass scale, rapid, 'learningtoread 'campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do's and Don't'sin life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTEDREADING

1. 'YogicAsanasforGroupTarining-Part-I":JanardanSwamiYogabhyasiMandal, Nagpur
2. "Rajayogaorconquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department),Kolkata

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To a waken wisdom in students

UNIT I

Neetishatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses-71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 -Personality of role model - shrimadbhagwadgeeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad- Bhagwad- Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025