

ANNA UNIVERSITY::CHENNAI 600 025
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS 2021
M. TECH. NANO SCIENCE AND TECHNOLOGY
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND I SEMESTER SYLLABUS
SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE- GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4157	Mathematical Modeling and Simulation	FC	4	0	0	4	4
2.	NT4101	Quantum Mechanics	PCC	3	0	0	3	3
3.	NT4102	Physics and Chemistry of Materials	PCC	3	0	0	3	3
4.	NT4103	Biological Nanostructures	PCC	3	1	0	4	4
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Professional Elective I	PEC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	NT4111	Computation and Simulation Laboratory	PCC	0	0	4	4	2
9.	NT4112	Nanomaterial Synthesis Laboratory	PCC	0	0	4	4	2
TOTAL				20	1	8	29	23

*Audit Course is optional

SEMESTER II

S. NO.	COURSE CODE.	COURSE TITLE	CATE- GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	NT4201	Imaging techniques for Nanotechnology	PCC	3	0	0	3	3
2.	NT4202	Physiochemical Characterization of Nanomaterials	PCC	3	0	0	3	3
3.	NT4203	Synthesis of Nanomaterials	PCC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Professional Elective IV	PEC	3	0	0	3	3
7.		Audit Course –II*	AC	2	0	0	2	0
PRACTICALS								
8.	NT4211	Materials Structural Characterization Laboratory	PCC	0	0	4	4	2
9.	NT4212	Physicochemical characterization Laboratory	PCC	0	0	4	4	2
10.	NT4312	Internship (2 weeks)	EEC	0	0	0	0	0
TOTAL				20	0	8	28	22

*Audit Course is Optional

SEMESTER III

S. NO.	COURSE CODE.	COURSE TITLE	CATE- GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective V	PEC	3	0	0	3	3
2.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
3.	NT4311	Project Work I	EEC	0	0	12	12	6
4.	NT4312	Internship	EEC	0	0	0	0	1
TOTAL				6	0	12	18	13

SEMESTER IV

S. NO.	COURSE CODE.	COURSE TITLE	CATE- GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	NT4311	Project Work II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

TOTAL NO, OF CREDITS: 70

LIST OF PROFESSIONAL ELECTIVES

SEMESTER I, ELECTIVE I

S. NO.	COURSE CODE.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4001	Lithography and Nanofabrication	PEC	3	0	0	3	3
2.	NT4002	Nanocomposite Materials	PEC	3	0	0	3	3
3.	NT4003	Nanoelectronics and Sensors	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4004	Nanotechnology in Agriculture and Food Industry	PEC	3	0	0	3	3
2.	NT4005	Nanomaterials for Energy and Environment	PEC	3	0	0	3	3
3.	NT4006	Nano Biophotonics	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4007	Advanced Drug Delivery System	PEC	3	0	0	3	3
2.	NT4008	Processing and Properties of Nanostructured Materials	PEC	3	0	0	3	3
3.	NT4009	MEMS and NEMS	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4010	Semiconductor Nanostructures	PEC	3	0	0	3	3
2.	NT4011	Nano-toxicology	PEC	3	0	0	3	3
3.	NT4012	Nanotechnology in Health Care	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4013	Nano Biosensors	PEC	3	0	0	3	3
2.	NT4014	Nanotechnology in Tissue Engineering	PEC	3	0	0	3	3
3.	NT4015	Entrepreneurship	PEC	3	0	0	3	3

AUDIT COURSES - I (AC)

REGISTRATION FOR ANY OF THESE COURSES IS OPTIONAL TO STUDENTS

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ்இலக்கியம்	2	0	0	0

COURSE OBJECTIVES:

This course will help the students to

- Acquire the knowledge of solving system of linear equations using an appropriate numerical methods.
- Approximate the functions using polynomial interpolation numerical differentiation and integration using interpolating polynomials.
- Acquire the knowledge of numerical solution of ordinary differential equation by single and multi step methods.
- Obtain the solution of boundary value problems in partial differential equations using finite differences.
- Study simulation and monte-carlo methods and their applications.

UNIT I MATRICES AND LINEAR SYSTEMS OF EQUATIONS 12

Solution of Linear Systems : Cramer's Rule - Gaussian elimination and Gauss Jordan methods - Cholesky decomposition method – Gauss Seidel iteration method - Eigenvalue problems : Power method with deflation for both symmetric and non symmetric matrices and Jacobi method for symmetric matrices.

UNIT II INTERPOLATION, DIFFERENTIATION AND INTEGRATION 12

Lagrange's interpolation - Newton's divided differences - Hermite's interpolation – Newton's forward and backward differences – Numerical differentiation – Numerical integration: Trapezoidal and Simpson's $\frac{1}{3}$ rules - Gaussian quadrature : 2 and 3 point rules.

UNIT III DIFFERENTIAL EQUATIONS 12

Initial value problems for first and second order ODEs : Single step methods - Taylor's series method – Euler's and modified Euler's methods - Runge - Kutta method of fourth order - Multi step methods : Milne's and Adam Bashforth methods - Boundary value problems : Finite difference approximations to derivatives - Finite difference method of solving second order ODEs .

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS 12

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

UNIT V SIMULATION AND MONTE CARLO METHODS 12

Random numbers : Random number algorithms and generators – Estimation of areas and volumes by Monte Carlo techniques - Numerical integration - Computing volumes – Simulation : Loaded Die Problem - Birthday problem - Buffon's needle problem - Two dice problem and Neutron shielding problem.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

- Solve an algebraic or transcendental equation and linear system of equations using an appropriate numerical method.
- Approximation of functions using polynomial interpolation, numerical differentiation and integration using interpolating polynomials.
- Numerical solution of differential equations by single and multistep methods.
- Solution of boundary value problems and initial boundary value problems in partial differential equations using finite differences.
- Simulation and Monte-Carlo methods and their applications.

REFERENCES:

1. Burden, R.L. and Faires, J.D. "Numerical Analysis", 9th Edition, Cengage Learning, Delhi, 2016.
2. Cheney, W and Kincaid D., "Numerical Mathematics and Computing", 7th Edition, CengageLearning, Delhi, 2014.
3. Jain, M.K., Iyengar, S.R.K. and Jain R.K. "Numerical Methods for Scientific and Engineering Computation", 6th Edition, New Age International Pvt. Ltd., Delhi, 2014.
4. Landau, D.P. and Binder, K., "A Guide to Monte - Carlo Simulations in Statistical Physics", 3rd Edition, Cambridge University Press, Cambridge, 2009.
5. Maki, D P and Thompson, M., "Mathematical Modelling with Computer Simulation", Cengage Learning, Delhi, 2011.
6. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning Pvt. Ltd., Delhi, 2012.
7. Taha, H.A. "Operations Research", 10th Edition, Pearson Education India, Delhi, 2018.

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NT4101

QUANTUM MECHANICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

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

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 of states, free electron theory of metals. The angular momentum problem. The spin half problem and properties of Pauli spin matrices.

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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.

TOTA: 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.

NT4102**PHYSICS AND CHEMISTRY OF MATERIALS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To gain knowledge on Physical and chemical aspects of 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, "Nanotechnology : A chemical approach to Nanomaterials", Royal Society of Chemistry, London 2005.
7. Atkins Peter, Paula Julio Physical Chemistry,

NT4103**BIOLOGICAL NANOSTRUCTURES****L T P C
3 1 0 4****COURSE OBJECTIVES:**

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

UNIT I CELLULAR NANOSTRUCTURES**12**

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

UNIT II DNA NANOARCHITECTURE**12**

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 – DNA varieties: A, B, and Z – Applications of DNA nanostructures.

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: Preparation, immobilization, kinetic properties and applications of enzyme nanoparticles in day-day to life– Synzymes, ribozymes.

UNIT IV CARBOHYDRATES AND GLYCO NANOPARTICLES**12**

Properties and Function of Carbohydrates– Sugars: disaccharides, trioses, tetroses, pentoses, hexoses – Stereoisomers - Aminosugars, phosphosugars, sugar derivatives, deoxysugars – Oligosaccharides –Polysaccharides - Homo and hetero polysaccharides, amylose, amylopectin, dextrans – starch –Glycogen: synthesis and degradation-glycolysis, TCA cycle, glycosyl moieties, cell wall polysaccharides – cellulose, chitin; Preparation of glyconanoparticles – Applications.

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 –Different types of lipid nanostructures: Preparation, applications – Lipid-based nanomaterials-Lipid-polymer nanoparticles and solid lipid nanoparticles–.

TOTAL: 60 PERIODS**COURSE OUTCOMES:**

CO1: Comprehend the nanoscale phenomenon associated with cellular nanostructures

CO2: To reveal the nature of DNA nanostructures like DNA bricks, aptamers and origami

CO3: Design and utilize protein and enzyme based nanostructures

CO4: Classify glycol nanostructures based on their binding ligands

CO5: Have knowledge about membrane transport and membrane based nanostructures and their uses

REFERENCES:

1. Barnard, Amanda S., and Haibo Guo, eds. Nature's Nanostructures. CRC Press, US, 2012.
2. Strosio MA and Dutta M, Biological nanostructures and applications of nanostructures in biology: Electrical, Mechanical and Optical properties. Kluwer academic publishers New York, 2004.
3. Iglič, Aleš, Damjana Drobne, and Veronika Kralj-Iglic. Nanostructures in biological systems: theory and applications. CRC Press, US, 2015.
4. Mendes, Paula M., Chun L. Yeung, and Jon A. Preece. "Bio-nanopatterning of surfaces." Nanoscale research letters 2.8 (2007): 373-384.
5. Häfeli, U. O., R. Arshady, and K. Kono. "Smart Nanoparticles in Nanomedicine-the MML Series." (2006): 77.
6. Durán, Nelson, et al. "Mechanistic aspects in the biogenic synthesis of extracellular metal nanoparticles by peptides, bacteria, fungi, and plants." Applied microbiology and biotechnology 90.5 (2011): 1609-1624.
7. Lehninger, Principles of Biochemistry, 5th edition, David L Nelson; Michael M Cox. W.H. Freeman Publishers, New York, 2012.
8. E.D.P. De Robertis, Cell & Molecular Biology, 8th edition, Lippincott publishers, 2010.
9. Lewin Benjamin, Genes, 9th edition, CBS Publishers and Distributors, 2007
10. Yonggang Ki, 3D DNA Nanostructure, Humana Press Inc., New York, 2015.
11. Bujold, Katherine E., Aurélie Lacroix, and Hanadi F. Sleiman. "DNA nanostructures at the interface with biology." Chem 4.3 (2018): 495-521.
12. Nanomechanical Devices Based on DNA, Christof M. Niemeyer and Michael Adler, Angew. Chem. Int. Ed. 2002, 41, No. 20, 3779-83
13. Hawkins, Michael J., Patrick Soon-Shiong, and Neil Desai. "Protein nanoparticles as drug carriers in clinical medicine." Advanced drug delivery reviews 60.8 (2008): 876-885.
14. Pundir, Chandra S. Enzyme nanoparticles: preparation, characterization, properties and applications. William Andrew, UK, 2015.
15. Carlos Aelman, Peptide Materials: From Nanostructures to Applications, Wiley UK, 2013.
16. Luigi Sasso, Self-Assembled Peptide Nanostructures: Advances and Applications in

- Nanobiotechnology. Pan Stanford Publishing, US, 2012.
17. Keith J. Stine, Carbohydrate Nanotechnology, Wiley, New Jersey, 2015.
 18. Reichardt, Niels C., Manuel Martín-Lomas, and Soledad Penadés. "Glyconanotechnology." Chemical Society Reviews 42.10 (2013): 4358-4376.
 19. Tresset, Guillaume. "The multiple faces of self-assembled lipidic systems." PMC biophysics 2.1 (2009): 1-25.
 20. Gordillo-Galeano, Aldemar, and Claudia Elizabeth Mora-Huertas. "Solid lipid nanoparticles and nanostructured lipid carriers: A review emphasizing on particle structure and drug release." European Journal of Pharmaceutics and Biopharmaceutics 133 (2018): 285-308.
<https://nptel.ac.in/courses/118/106/118106019/>

RM4151	RESEARCH METHODOLOGY AND IPR	L T P C
		2 0 0 2
UNIT I	RESEARCH DESIGN	6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.		
UNIT II	DATA COLLECTION AND SOURCES	6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.		
UNIT III	DATA ANALYSIS AND REPORTING	6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.		
UNIT IV	INTELLECTUAL PROPERTY RIGHTS	6
Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.		
UNIT V	PATENTS	6
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.		
		TOTAL : 30 PERIODS

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, Business Research Methods, Tata McGraw Hill Education, 11e (2012)
2. Intellectual property: patents, trademarks, copyrights, trade secrets. By Catherine J. Holland. Entrepreneur Press, 2007
3. Patent searching: tools & techniques. By David Hunt, et al. Wiley, 2007.
4. Professional Programme Intellectual Property Rights, Law and practice, The Institute of Company Secretaries of India, Statutory body under an Act of parliament, September 2013

COURSE OBJECTIVES:

- To Acquire knowledge on various scientific modelling and simulation techniques.
 - To Understand various syntax and command code for wide used modelling and simulation softwares.
 - To Acquire knowledge to theoretically simulate the physical and chemical properties of various nanomaterials based on available data
1. Numerical programme to plot the first four Eigen functions of a one - dimensional rectangular potential well with infinite potential barrier.
 2. Numerical solution of the Schrodinger wave equation for a rectangular potential well with infinite potential barrier using numerical programme.
 3. Toy model in molecular electronics: IV characteristics of a single level molecule
 4. To determine the lattice constant and lattice angles for atomically resolved STM image of HOPG (Highly Oriented Pyrolytic Graphite using offline Scanning Probe Imaging Processor (SPIP) Software.
 5. To determine the surface roughness of raw and processed AFM images of glass, silicon and films made by different methods using offline SPIP software.
 6. Simulation of I-V Characteristics for a single Junction circuit with a single quantum Dot using MOSES 1.2 Simulator.
 7. Study of Single Electron Transistor using MOSES1.2 Simulator.
 8. Simple Mathematical Operation – Basic Command in MATLAB – 2D lot – 3D plot – curve fitting interpolation – Simulink – introduction – physics with Simulink
 9. Equations modelling for circular motion – circular motion in Simulink – electronics in Simulink – introduction to logic gates – logical gates in Simulink

TOTAL:60 PERIODS

COURSE OBJECTIVES:

- To train research skills and methodology for novel chemical, physical and biological synthesis and processing approaches of nanomaterials

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

NT4001**LITHOGRAPHY AND NANOFABRICATION****L T P C**
3 0 0 3**COURSE 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 no fabrications
 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. Fundamental Principles of Optical Lithography: The Science of Microfabrication Chris Mack. ISBN: 978-0-470-01893-4
2. Third edition : Fundamentals of Microfabrication and Nanotechnology Volume II. Fabrication of polymer photonic crystals using nanoimprint lithography
3. Nanofabrication : Nanolithography techniques and their applications, Editor José María De Teresa, Online ISBN: 978-0-7503-2608-7. IOP Publishing Ltd 2020
4. Ziaie B., Baldi A., Atashbar M. (2007) Introduction to Micro/Nanofabrication. In: Bhushan B.(eds) Springer Handbook of Nanotechnology. Springer Handbooks. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-29857-1_7
5. Helmut Schiff, Sunggook Park, Bokyoung Jung, Choon-Gi Choi, Chul-Sik Kee, Sang-Pil Han, Keun-Byoung Yoon and Jens Gobrecht <https://doi.org/10.1088/0957-4484/16/5/023>

Journals:

Technological processes in microand nanoelectronics. Optical maskless lithography. G. V. Belokopytov and Yu. V. Ryzhkova russian microelectronics vol. 40 no. 6 2011

NT4002

NANOCOMPOSITE MATERIALS

L T P C
3 0 0 3

COURSE 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**STUDENT LEARNING OUTCOMES:**

- ✓ 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. Introduction to nanocomposite materials : properties, processing, characterization by Thomas E Twardowski
3. Carbon Nanotubes and Graphene. K. Tanaka, S. Iijima Newnes, 10-Jul-2014 - Technology & Engineering
4. Advanced Structural Ceramics Author(s):Bikramjit Basu, Kantesh Balani 21 September 2011 DOI:10.1002/9781118037300
5. Nanocomposite Membrane Technology, Fundamentals and Applications. P.K. Tewari 2016 by Taylor & Francis Group
6. Ceramic nanocomposites Edited by Rajat Banerjee and Indranil Manna 2013

Journal papers and review articles in references

1. Adv. Mater. **2017**, 29, 1702959
2. Materials Today Volume 20, Number 4 May 2017
3. RSC Advances, 2012, 2, 7617–7632
4. Manoj B. Gawande, Anandarup Goswami, Tewodros Asefa, Huizhang . Core-shell nanoparticles: synthesis and applications in catalysis and electrocatalysis. Chem. Soc. Rev., 2015, 44, 7540
5. Polymers 2017, 9, 494; doi:10.3390/polym9100494 www.mdpi.com/journal/polymers
6. Hongbo Feng, Xinyi Lu , Weiyu Wang , Nam-Goo Kang and Jimmy W. Mays . Review : Block Copolymers: Synthesis, Self-Assembly, and Applications.

NT4003**NANOELECTRONICS AND SENSORS****L T P C
3 0 0 3****COURSE 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 – electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas 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 nanoelectronics
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.

AUDIT COURSES

AX4091

ENGLISH FOR RESEARCH PAPER WRITING

L T P C

2 0 0 0

COURSE OBJECTIVES

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

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING

6

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

UNIT II PRESENTATION SKILLS

6

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

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1 –Understand that how to improve your writing skills and level of readability

CO2 – Learn about what to write in each section

CO3 – Understand the skills needed when writing a Title

CO4 – Understand the skills needed when writing the Conclusion

CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:

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.

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION**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**COURSE OUTCOMES:**

At the end of the course, students will be able to

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

REFERENCES:

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.

AX4093

CONSTITUTION OF INDIA

L T P C
2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

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

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

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. Panchayati raj: Introduction, Panchayat: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: 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

COURSE OUTCOMES:

Students will be able to:

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

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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நற்றமிழ்இலக்கியம்

L T P C
2 0 0 0

UNIT I

சங்க இலக்கியம்

6

1. தமிழின்துவக்கநூல்தொல்காப்பியம்
- எழுத்து, சொல், பொருள்
2. அகநானூறு(82)
- இயற்கைஇன்னிசைஅரங்கம்
3. குறிஞ்சிப்பாட்டின்மலர்க்காட்சி
4. புறநானூறு(95,195)
- போரைநிறுத்தியஒளவையார்

UNIT II

அறநெறித்தமிழ்

6

1. அறநெறிவகுத்ததிருவள்ளுவர்
- அறம்வலியுறுத்தல், அன்புடைமை, ஒப்புறவுஅறிதல், ஈகை, புகழ்
2. பிறஅறநூல்கள்- இலக்கியமருந்து
- ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை
(தூய்மையைவலியுறுத்தும்நூல்)

UNIT III

இரட்டைக்காப்பியங்கள்

6

- 1.கண்ணகியின்புரட்சி
- சிலப்பதிகாரவழக்குரைகாதை

2. சமூகசேவைஇலக்கியம்மணிமேகலை
- சிறைக்கோட்டம்அறக்கோட்டமாகியகாதை

UNIT IV

அருள்நெறித்தமிழ்

6

1. சிறுபாணாற்றுப்படை
- பாரிமுல்லைக்குத்தேர்கொடுத்தது, பேகன் மயிலுக்குப்
போர்வை கொடுத்தது,
அதியமான்ஒளவைக்குநெல்லிக்கனிகொடுத்தது, அரசர்
பண்புகள்
2. நற்றிணை
- அன்னைக்குரியபுன்னைசிறப்பு
3. திருமந்திரம் (617, 618)
- இயமம்நியமம்விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
- சிறுவனேவள்ளலானான்
6. அகநானூறு (4) - வண்டு
நற்றிணை (11) - நண்டு
கலித்தொகை (11) - யானை, புறா
ஐந்திணை 50 (27) - மான்
ஆகியவைபற்றியசெய்திகள்

UNIT V

நவீனதமிழ்இலக்கியம்

6

1. உரைநடைத்தமிழ்,
- தமிழின்முதல்புதினம்,
- தமிழின்முதல்சிறுகதை,
- கட்டுரைஇலக்கியம்,
- பயணஇலக்கியம்,
- நாடகம்,
2. நாட்டுவிடுதலைபோராட்டமும்தமிழ்இலக்கியமும்,
3. சமுதாயவிடுதலையும்தமிழ்இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில்
தமிழ்
இலக்கியமும்,
5. அறிவியல்தமிழ்,
6. இணையத்தில்தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ்இலக்கியவெளியீடுகள் / புத்தகங்கள்

1. தமிழ்இணையகல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ்விக்கிப்பீடியா (Tamil Wikipedia) - <https://ta.wikipedia.org>
3. தர்மபுரஆதினவெளியீடு
4. வாழ்வியல்களஞ்சியம் - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக்களஞ்சியம் - தமிழ்வளர்ச்சித்துறை (thamilvalarchithurai.com)
6. அறிவியல்களஞ்சியம் - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்