ACADEMIC YEAR 2019-2021
CENTRE FOR NANOSCIENCE AND TECHNOLOGY
INSTITUTE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech. (NT), COURSE STRUCTURE AND SYLLABUS (CBCS)
COURSE SCHEME FOR M.TECH (NANOTECHNOLOGY)

M.Tech SEM-I

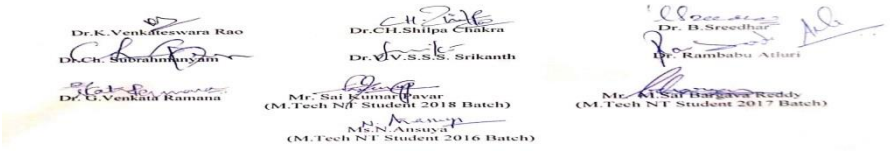
Course Number	Subject	Scheme Of Studies Per Week			Credits	Int Marks	Ext Marks
		L	T	P			
1NT01	Program Core-I: Synthesis/Processing and Properties of nanostructures	3	0	0	3	30	70
1NT02	Program Core-II: Materials Characterization Techniques	3	0	0	3	30	70
1NTPE01	Program Elective-I: 1.Structure, Bonding and Quantum Mechanics 2.Physics And Chemistry Of Materials 3. Photonics(quantum confinement of materials) 4. Statistical Thermodynamics For Nanosystems	3	0	0	3	30	70
1NTPE02	Program Elective-II: 1. Nano biomedical Applications 2. Nano Bio Technology 3. Bio nanostructures	3	0	0	3	30	70
1A01	Research Methodology & IPR	2	0	0	2	30	70
1A02	Audit Course –I 1. English for Research Paper Writing 2. Disaster Management 3. Sanskrit for Technical Knowledge 4. Value Education 5. Constitution of India 6. Pedagogy Studies 7. Stress Management by Yoga 8. Personality Development through Life Enlightenment Skills	2	0	0	0	0	0
1NT03	Synthesis, Fabrication and Characterization Lab	0	0	4	2	30	70
1NT04	Simulation Lab-I	0	0	4	2	30	70
Total credits:		**16**	**0**	**8**	**18**	**210**	**490**

M.Tech SEM-II

Course Number	Subject	Scheme Of Studies Per Week			Credits	Int Marks	Ext Marks
		L	T	P			
2NT05	Program Core- III :Nano Sensors and Devices	3	0	0	3	30	70
2NT06	Program Core- IV: Industrial trends and Applications of Nanotechnology	3	0	0	3	30	70
2NTPE03	Program Elective III: 1.Nanotechnology For Energy Systems 2. Nano Electronics and Nano Photonics 3. Nano Composites Design and Synthesis	3	0	0	3	30	70
2NTPE04	Program Elective -IV 1.Science & Technology of Thin Films 2. Lithographic Techniques 3.MEMS and NEMS Design and Applications	3	0	0	3	30	70

2A03	Audit Course-II 1. English for Research Paper Writing 2. Disaster Management 3. Sanskrit for Technical Knowledge 4. Value Education 5. Constitution of India 6. Pedagogy Studies 7. Stress Management by Yoga 8.Personality Development through Life Enlightenment Skills	2	0	0	0	0	0
2NT07	Nanostructured Material Application Lab	0	0	4	2	30	70
2NT08	Simulation Lab-II	0	0	4	2	30	70
2A04	Mini Project with Seminar	2	0	0	2	30	70
Total credits:		**16**	**0**	**8**	**18**	**210**	**490**

*Students be encouraged to go to Industrial Training/Internship for at least 2-3 months during semester break



M.Tech Sem- III

Course No.	Subject	Scheme of Studies Periods Per Week			Credits	Int Marks	Ext Marks
		L	T	P			
3NTPE05	Program Elective -V: 1.NPTEL-12 Weeks 2. Nanotoxicology 3. Societal Impact of Nanotechnology	3	0	0	3	30	70
3NTOE	Open Elective: 1. Business Analytics 2. Industrial Safety 3. Operations Research 4. Cost Management of Engineering Projects 5. Composite Materials 6. Waste to Energy 7.Introduction to Nanotechnology	3	0	0	3	30	70
	Dissertation-I						
	a) Project Review-I				0	0	0
3A05	b) Project Review-II	0	0	20	10	100	0
Total Credits:		**6**	**0**	**20**	**16**	**160**	**140**

*Students going for Industrial Project/Thesis will complete these courses through MOOCs.

M.Tech Sem- IV

	Subject	Scheme of Studies Per Week			Credits	Int Marks	Ext Marks
		L	T	P	C	0	0
	Dissertation -II (Project Review-III 30 Marks+Project Evaluation 70 Marks=100 Marks)						
4A06	Project Review-III	0	0	32	16	30	0
4A07	Project Evaluation (Viva-Voce)	--	---	---	0	0	70
Total credits:		**0**	**0**	**32**	**16**	**30**	**70**

(L: Lecture periods, T: Tutorial periods, P: Practical periods)

Total Credits of the Programme: 68

Dr.K.Venkateswara Rao
Dr.Ch. Subrahmanyam
Dr. G.Venkata Ramana
Dr.CH.Shilpa Chakra
Dr.V.V.S.S.S. Srikanth
Mr. Sai Kumar Pavar
(M.Tech NT Student 2018 Batch)
Ms.N.Ansuya
(M.Tech NT Student 2016 Batch)
Dr. B.Sreedhar
Dr. Rambabu Atluri
Mr. M.Sai Bargava Reddy
(M.Tech NT Student 2017 Batch)

1NT01 Synthesis/Processing and Properties of Nanostructures

Objective: To bring out the distinct properties like electrical, magnetic, optical, thermal and mechanical properties of nanostructures.

Outcome of the study:

1. To develop knowledge about the electronic properties of semiconductor devices.
2. To construct the magnetic properties of bulk Nano structured materials.
3. To visualize the effect of optical properties of various materials
4. Students can able to acquire knowledge based on the thermal properties of nanomaterials
5. To understand advanced mechanical properties of nanostructured materials.

Pre-requisite:

1. Familiarization on energy band gap
2. Basics physics & mechanics of solids

Unit-I: Scientific Revolutions, Nanotechnology and Nanomachines,The Periodic Table, Atomic Structure, Molecules and Phases, Energy, Molecular and Atomic size, Surfaces and Dimensional Space, Top down and Bottom up approach

Unit-II: Optical properties , Photonic crystals, optical properties of semiconductors, band edge energy, band gap, Core-shell nanomaterials, Quantum dots etc., for size influences of optical properties, optical transitions, absorptions, interband transitions, quantum confinements, Fluorescence/luminescence, photoluminescence/fluorescence, optically excited emission, electroluminescence, Laser emission of quantum dot, Photo fragmentation and columbic explosion, luminescent quantum dots for biological labeling.

Unit-III: Thermal properties of nanostructures- thermal conductivity measurements for nanowires, nanotubes, thin films. Mechanical Propertiesof nanomaterials, Types of indentation: Oliver & Pharr, Vickers indentation process, Nano Indentation by AFM, Young's modulus, Contact angle, Scratch implant measurements.

Unit-IV: Physical methods: Inert gas condensation, Arc discharge, RF-plasma, electric explosion of wires, ball milling, molecular beam epitaxy, PVD, CVD, Chemical methods: Nanocrystals by chemical reduction, photochemical synthesis, electrochemical synthesis, co-precipitation method, Nanocrystals of semiconductors and other materials by arrested precipitation, emulsion synthesis, sono-chemical routes, microwave assisted synthesis, Template based synthesis of nanomaterials.

Unit–V: Thermolysis route - spray pyrolysis and solvated metal atom dispersion, sol-gel method, Polymer based synthesis techniques, solvothermal and hydrothermal routes, solution combustion synthesis.Chemical methods: Nanocrystals by chemical reduction, photochemical synthesis, electrochemical synthesis, co-precipitation method, Nanocrystals of semiconductors and other materials by arrested precipitation, emulsion synthesis, sono-chemical routes, microwave assisted synthesis, Template based synthesis of nanomaterials. Biological methods – use of bacteria, fungi, actinomycetes for nano-particle synthesis-magnetotatic bacteria for natural synthesis of magnetic nano-particle, role of plants in nanoparticle synthesis, Synthesis of dendrimers, Cell and material Immobilisation.

Text & Reference books:

1. Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens.Wiley India Pvt.Ltd.
2. Nanoindentation by Anthony C Fisher-cripps springer
3. Encyclopedia of Nano Technology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X Campus books.
4. Thermal nanosystems and Nanomaterials Sebastian Voltz
5. Hand book of Nano structured materials Vol I & V
6. Encyclopedia of Nano Technology by H.S.Nalwa
7. Hand book of Nanotechnology by Bharat Bhushan springer
8. Nanostructured materials: Processing, Properties and Potential Applications, edited by C.C.Koch, Noyes Publications (2002).

9. Introduction to Nanoscience, S.M. Lindsay, 2009
10. Inorganic Materials Synthesis and Fabrication by J.N. Lalena, D.A. Cleary, E.E. Carpenter, N.F. Dean, John Wiley & Sons Inc.
11. Introduction to Nano Technology by Charles P. Poole Jr and Frank J. Owens. Wiley India Pvt Ltd.
12. The Chemistry of nanomaterials: Synthesis, Properties and Applications, Vol-I by C.N.R. Rao, A. Muller and A.K. Cheetham

Reference books:

1. Encyclopedia of Nanotechnology by M.BalakrishnaRao and K.Krishna Reddy, Vol I to X, Campus books.
2. Encyclopedia of Nanotechnology by H.S. Nalwa
3. Nano: The Essentials — by T.Pradeep; Tata Mc.Graw Hill

Journal references:

1. K K Nanda, Pramana J. Phys., Vol. 72, No. 4, April 2009
2. V P Skripov, V P Koverda and V N Skokov, Phys. Status Solid A66, 109 (1981)
3. R Goswami and K Chattopadhyay, Act Mater. 52, 5503 (2004)
4. V. Germain et al. J. Phys. Chem. B, Vol. 107, No. 34, 2003

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1NT02 MATERIALS CHARACTERIZATION TECHNIQUES

Objective:

To familiarize students with Spectroscopic, Electrical, Thermal and Magnetic Characterization techniques and interpretation of results including standards etc.

Outcome of the study:

1. To evaluate the spectroscopic characterization techniques of nano materials.
2. To compare various compositional and structural characterization techniques.
3. To infer the importance of advanced characterization techniques.
4. Student can able to develop knowledge about various electrical and magnetic characterization technique.
5. Gain overall knowledge of various thermal and magnetic characterization techniques.

Pre-requisite:

1. Basic band gap, Electrical, Thermal and Magnetic characterization.
2. Mechanics of solids, metallurgy and materials science, and spectroscopic techniques.

Unit-I: Interaction of electromagnetic spectrum with matter, Spectroscopic Techniques: UV- Visible Spectroscopy, Photo-luminescence Spectroscopy, Mossbauer spectroscopy, Fourier Transform infrared (FTIR) spectroscopy, Raman spectroscopy techniques: micro Raman and laser Raman, SERS (surface enhanced raman spectroscopy).

Unit-II: Compositional and structural Characterization techniques: X-ray Photoelectron Spectroscopy (XPS), Energy Dispersive X-ray analysis (EDAX), Principles and applications of X-ray diffraction; electron diffraction, Electron probe microanalysis (EPMA), Ion beam techniques: SIMS & RBS, BET, PSA and Zeta sizer.

Unit-III: Advanced Microscopy Techniques: High resolution microscopy; Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), scanning tunneling microscopy (STM).

Unit-IV: Electrical and Magnetic characterization techniques: Measurement of resistivity by 4-prob method, Hall measurement, Electron beam induced current measurement (EBIC), Vibrating Sample Magnetometer, SQUID magnetometer, Impedance analyzer

Unit-V: Thermal and Mechanicalcharacterizationtechniques:Thermal-analysis:TGA,DTA,DSC,DMA; Nanoindentation technique, Micro tensile testing, Micro UTM

Text books:

1. Nano: The Essentials -Understanding Nano Science and Nanotechnology by T.Pradeep, TataMc.Graw Hill
2. Introduction to Nano Technology by Charles. P. Poole Jr and Frank J. Owens, Wiley India Pvt Ltd.
3. A practical approach to X-Ray diffraction analysis by C.Suryanarayana
4. Electron Microscopy and analysis by P.J. Goodhew and F.J. Humpreys
5. Characterization of nanostructured materials by Z.L. Wang
6. Modern Raman Spectroscopy: A practical approach by E. Smith and G.Dent
7. Principles of Instrumental analysis by D.A. Skoog, F.J. Hollen and T.A. Niemann
8. Atomic and Molecular Spectroscopy: Basic Aspects and Applications by S.Svanberg.

Reference Books:

1. Nanotechnology: Principles and Practices – Sulabha K. Kulkarni – Capital Publishing Company
2. Specimen preparation for Transmission Electron microscopy by John &Bravmno et al, published by MRS
3. Photoelectron spectroscopy by JHD Eland, Butterworth & Co. publishers, 2nd education.
4. Encyclopedia of Nanotechnology by H.S. Nalwa

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1NTPE01: STRUCTURE, BONDING AND QUANTUM MECHANICS

Objective:

The course is intended to cover, basics concepts of crystallography, quantum mechanics, matter and energy relations, de-Broglie hypothesis, wave function analogies, Schrodinger equation, quantum dot, wires and wells etc.

Outcome of the study:

1. Student can able to theorize the importance of crystal structure for property evaluation.
2. Student canasses different types of chemical bonding in materials.
3. To evaluate nano structured in quantum mechanical approaches.
4. Students can able to distinguish between classical electromagnetic theory and quantum mechanics.
5. To predict the free electron gas theory of metals and in Hydrogen atom.

Pre-requisite:

1. Basics physics
2. Quantum mechanics
3. Basic chemistry
4. Basic material science

Unit-I: Crystal structure: Crystalline and amorphous solids- Crystal lattice and crystal structure- Translational symmetry-space lattice-unit cell and primitive cell-symmetry elements in crystal-the seven crystal systems-Miller indices-Miller-bravais indices-Indices of a lattice direction. Reciprocal lattice and crystal imperfections: Bragg law- Reciprocal lattice – Properties of Reciprocal lattice- Reciprocal lattice of simple cube- Reciprocal lattice of bcc- Reciprocal lattice of fcc- diffraction conditions- Brillouion zones. Importance of lattice imperfections- types of imperfection-Point defects-dislocations.

UNIT II: Bonds: Chemical bonding, Valance shell, Types of bonds and its characteristics, Sigma bond, Pi bond, Ionic bond, Covalent bond, Coordinative covalent bond, Polar bond, Hydrogen bond, Modern theories of chemical bonding, Valance bond theory, Molecular orbital theory.

Unit-III: Introduction-Why quantum mechanics - matter waves-length scales - De-Broglie hypothesis – wave particle duality- Heisenberg's uncertainty principle-Schrodinger wave equation – General postulates of Quantum mechanics- particle in one dimensional box, Bohr's correspondence principle.

Unit-IV: Quantum mechanics of electronics: Electron as particle and electron as wave-Time independent Schrodinger equation and boundary condition on the wave function-Analogies between quantum mechanics and classical electromagnetic theory-Probabilistic current density-multiple particle systems.

Unit-V: Free and confined electrons: Free electrons-the free electron gas theory of metals-electrons confined to abounded region of space and quantum numbers-electrons confined to atom-the hydrogen atom and the periodic table-quantum dots-wires-wells , Fermi level and Fermi function.

Textbooks:

1. An introduction to solid states electronic devices by Ajay kumarsaxena Macmillan India Ltd {Unit-I, II}
2. Solid state Physics by Kittle {Unit-I,II}
3. P.M.Mathews and K.Venkatesan, "A textbook of Quantum Mechanics", Tata McGraw HillPublishing Company Ltd {Unit-III}
4. Quantum Mechanics – Schiff {Unit-III}
5. Quantum Mechanics by B.k.Agarwal and Hariprakash, PHI {Unit-III}
6. Fundamentals of nanoelectronics by George W.Hanson Pearson education {Unit-IV,V}

Reference Books:

1. Introduction to Nanotechnology by Charles P.PooleJr& Frank J. Owens;Wiley India Pvt. Ltd
2. The Feynman lectures on Physics; Vol I to III
3. Quantum mechanics by Brandsen&Joachem
4. J.J.Sakurari, "Modern Quantum Mechanics Mc.Graw Hill, Addison Wesley Longman Inc., USA, 1999
5. Nano Technology and Nano Electronics – Materials, devices and measurement Techniques by WR Fahrner – Springer

1NTPE01 PHYSICS AND CHEMISTRY OF MATERIALS

Objective:

The course is intended to cover, physical properties, chemical aspects, and nanosytems.

Outcome of the study:

1. Student can study physical and chemical properties of materials
2. Student can study aspects of nanostructures

Pre-requisite:

1. Basics physics
2. Basic chemistry

UNIT-I: PHYSICAL PROPERTIES:

Melting point and phase transition processes- quantum-size-effect (QSE). Size-induced metal-insulator-transition (SIMIT)- nano-scale magnets, transparent magnetic materials, and ultrahigh-density magnetic recording materials-chemical physics of atomic and molecular clusters.

UNIT-II: PHYSICAL CHEMISTRY OF SOLID SURFACES: Surface energy – chemical potential as a function of surface curvature-Electrostatic stabilization- surface charge density-electric potential at the proximity of solid surface-Van der Waals attraction potential.

UNIT-III: CHEMISTRY ASPECTS :

Photochemistry; Photoconductivity; Electrochemistry of Nanomaterials-Diffusion in Nanomaterials; Nanoscale Heat Transfer; Catalysis by Gold Nanoparticles; Transport in Semiconductor Nanostructures; Transition Metal Atoms on Nanocarbon Surfaces; Nanodeposition of Soft Materials; Nanocatalysis.

UNIT-IV: NANOSTRUCTURES:

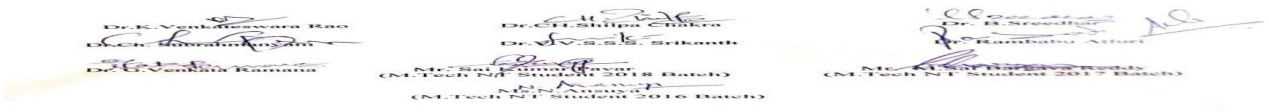
Electronic Structure of Nanoparticles- Kinetics in Nanostructured Materials- Zero dimensional, one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors, nanowires, nanostructured beams, and nanocomposites-artificial atomic clusters-Size dependent properties-size dependent absorption spectra-phonons in nanostructures.

UNIT-V: NANOSYSTEMS:

Nanoparticles through homogeneous nucleation-Growth controlled by diffusion-growth controlled by surface process-influences of reduction reagents-solid state phase segregation-kinetically confined synthesis of nanoparticles-template based synthesis.

References:

1. K.W. Kolasinski, "Surface Science: Foundations of Catalysis and Nanoscience", Wiley, 2002.
2. Joel I. Gersten, "The Physics and Chemistry of Materials", Wiley, 2001.
3. A. S. Edelstein and R. C. Cammarata, "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Pub., 1998.
4. S.Yang and P.Shen: "Physics and Chemistry of Nanostructured Materials", Taylor & Francis, 2000.
5. G.A. Ozin and A.C. Arsenault, **"**Nanochemistry :A chemical approach to nanomaterials"**,** Royal Society of Chemistry, 2005.



1NTPE01 PHOTONICS (QUANTUM CONFINED MATERIALS)

Objective:

The course is intended to cover, physical properties, chemical aspects, and nanosytems.

Outcome of the study:

1. To extend the knowledge on Spintronics and Nano photonics
2. To study about approaches in Nanophotonics

Pre-requisite:

1. Basics physics
2. Basic chemistry

UNIT-I: Quantum dots – optical transitions – absorption-inter-band transitions-quantum confinement intraband transitions-fluorescence/luminescence–photoluminescence /fluorescence optically excited emission – electroluminescence emission .

UNIT-II: PLASMONICS:

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

UNIT-III: NEW APPROACHES IN NANOPHOTONICS:

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- SNOM based optical data storage and recovery.

UNIT-IV: BIOPHOTONICS:

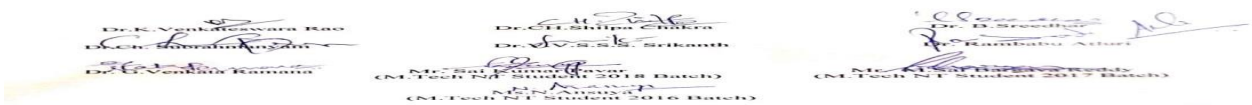
Interaction of light with cells- tissues- nonlinear optical processes with intense laser beams- photoinduced effects in biological systems-generation of optical forces-optical trapping and manipulation of single molecules and cells in optical confinement-laser trapping and dissection for biological systems-single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

UNIT-V: PHOTONIC CRYSTALS:

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

References:

1. H.Masuhara, S.Kawata and F.Tokunaga, NanoBiophotonics, 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.



1NTPE01 STATISTICAL THERMODYNAMICS FOR NANOSYSTEMS

Objective:

To introduce to the students the basic principles of statistical thermodynamic principles for nanosystems and to lay emphasis on the fundamentals

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Outcome of the study:

1. The objective of this course is to make the students acquire depth of knowledge in the concepts of statistical mechanics and thermodynamics and to apply it to different nano scale systems.

2. The objective of this course is to make the students understand the thermodynamics of small systems and non-equilibrium thermodynamics

3. The objective of this course is to make the students apply the principles of thermodynamics and Statistical mechanics in new formulations

Pre-requisite: Basic physics, Chemistry, Thermodynamics.

UNIT I - THERMODYNAMICS OF SMALL SYSTEMS

Non-intensivity and Nonextensivity of Nanosystems -The Gibbs Equation for Nanosystems-Statistical Mechanics and Thermodynamic Property Predictions – Standard polymorphs-formalisms of controlled nucleation and growth of nanocystallites from a vitreous state-thermodynamics of polymorphic transformations in non-porous and nanoporous solids.

UNITII - NANOTHERMODYNAMICS

Different Approaches to Nanothermodynamics-surface thermodynamics-Phase transitions in nanoparticles-quasi chemical description of solid nanoparticles- size dependent interface energy-thermodynamics of confined fluids in nanopores-structural properties of nanoclusters-Hill,s approach to Nanothermodynamics-Phase transition in nanosystems-symmetry of fullerenes-PI index of some carbon nanotubes.

UNIT III - NON-EQUILIBRIUM THERMODYNAMICS

Thermostated Dynamical Systems - The Transient Fluctuation Theorem Thermodynamic Interpretation of the Dissipation Function - The Dissipation Theorem- NonequilibriumWork Relations-NonequilibriumWork Relations for Thermal Processes - Corollaries of the Fluctuation Theorem and NonequilibriumWork Relations -Generalized Fluctuation Theorem - Integrated Fluctuation Theorem - Second Law Inequality - Nonequilibrium Partition Identity - The Steady State Fluctuation Theorem-Minimum Average Work Principle.

UNIT IV - NONEQUILIBRIUM NANOSYSTEMS

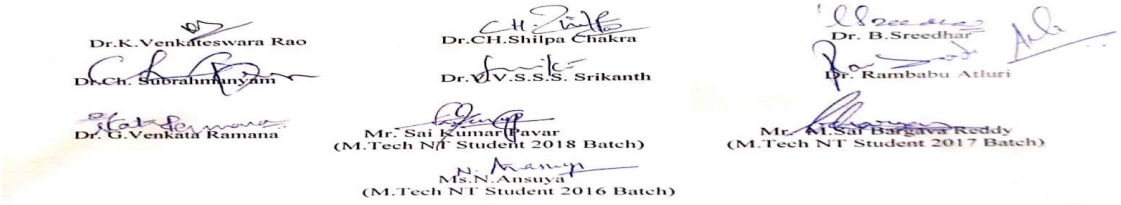
Basics-Nanosystems Driven by Time-Dependent Forces-Jarzynski'sNonequilibrium Work Theorem-Mechanical Nanosystems- Friction in Double-Walled Carbon Nanotubes-Electromagnetic Heating of Microplasmas-Mechanochemical Nanosystems-F1-ATPase Motor-Continuous state description-Discrete state description- Chemical Nanosystems- Chemical Transistor- Chemical Clocks in Field Emission Microscopy-DNA replication.

UNIT V - THERMODYNAMICS OF BIOLOGICAL SYSTEMS

Crystal-melt interfacial energies and solubilites for nanosized systems- Via the Ostwald-Freundlich equation, the size-selective growth process of nanoparticles-Bulk memberane partition-Nanothermodynamics of a Single Molecule- The Concept of Pseudoequilibrium- Cellular and Subcellular Systems

REFERENCES

1. Ragone. D. V "*Thermodynamics of Materials"*, John Wiley & Sons, 1994.
2. David. R, Gaskell, "*Introduction to the Thermodynamics of Materials"*, Taylor & Francis, 2002.
3. Michael Rieth and Wolfram Schommers, *"Handbook of Theoretical and Computational Nanotechnology"*, American Scientific Publishers, 2005.
4. Lupis. C. H. P, "*Chemical Thermodynamics of Materials"*, Prantice Hall, 2000.
5. Christian. J. W,"*Theory of Phase Transformations in Metals and Alloys"*, Pergamon Press, 2001.
6. Günter Radons, BennoRumpf and Heinz Georg Schuster, **"***Nonlinear Dynamics of Nanosystems",* Wiley publishers, 2010.



1NTPE02 NANO-BIOMEDICAL APPLIATIONS

Objective:

The course is intended to cover fundamental terms and basics of biotechnology and building blocks; biological nanostructures, biosensors and biomedical applications of nanotechnology, nanodrugs and drug delivery systems.

Outcome of the study:

1. To familiarize students with biological systems, materials and building blocks.
2. To understand the concepts of Biological Nanostructures
3. To familiarize about Biomedical Applications
4. To prioritize the role of nano structured materials in diagnosis
5. To gain the improvements in drug delivery system using nanotechnology.
6. To study various Nanopharmacology& Drug Targeting and drugs delivery systems

Pre-requisite:

1. Basics of organic chemistry
2. Basics of Biology

Unit–I: Fundamentals terms in biotechnology, Biological building blocks:Sizes of building blocks and Nanostructures, nucleic acids, genetic code and protein synthesis, Enzymes, DNA Nanotechnology, protein nanoparticles and polypeptide nanowires, Protein &Glyco Nanotechnology, Lipid nanotechnology: Lipid based carrier systems(liposomes, solid-lipid nanoparticles), applications .

Unit-II: Biological Nanostructures: Bio-mimitics with examples, Bio mineralization, Biocompatible Bio sensors, Examples of proteins, micelles, vesicles, bilayers, and Multilayer films, application of bio-nanotechnology: bio nano machines.

Unit-III: Nano bio-sensors and biomedical applications, organic semiconductors, biological neurons and their functions, bio-chemical and quantum mechanical computers: DNA computers, parallel processing, Bit and 'Q' bit, Quantum parallelism.

Unit-IV: Nanomaterials for Cancer Diagnosis, Carbon Nanomaterials inbiomedical applications, nanoscale polymer fabrication for biomedical application, nanotechnology in cancer drug therapy: A biocomputational approach, Nanotoxicology.

Unit-V:

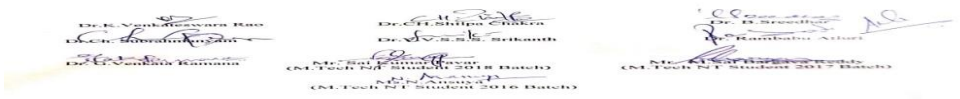
Nanotechnology in Organ Printing: Organ Printing, types of organ printing, 3D Bio Printing approachs, Nanotechnology for organ printing.Nanotechnology in Tissues Engineering, Nano Artificial Cells: Artificial RBC, applications of artificial cells, synthetic cells and its applications, Nanotechnology in Point of Care Diagnostics: point-of-care tests, paper based diagnosis, Nanotechnology for point-of-care testing.

Text books:

1. Bio Nano Technology by Good Sell, Wiley Liss
2. Nanotechnology by John F. Mongillo
3. Introduction to Nanotechnology by Charles. P.PooleJr and Frank J. Owens, Wiley India Pvt Ltd.
4. Nano Technology, A gentle introduction to the next big idea by Mark Ranter and Daniel Ranter,Pearson education
5. Nanotechnology – science, innovation and opportunity by Lynn E Foster, Prentice Hall – Pearson education.

Reference books:

1. Encyclopedia of Nanotechnology by H.S.Nalwa
2. Encyclopaedia of Nanotechnology by M.BalakrishnaRao and K.Krishna Reddy (VolI to X).



1NTPE02 NANO BIO-TECHNOLOGY

Objective:

The course is intended to cover Biomedical Application and Drug Delivery, Cell Behavior TowardNano topographic.

Outcome of the study:

1. Students can able to develop deep understanding of Biomedical Application.
2. Student can able to compile all the Drug Delivery Systems.
3. To know the importance of Cell Behavior Toward Nanostructured Surfaces.
4. To prioritize the role of Orthopedic Interface.
5. To gain the improvements in Tissue Engineering/Regenerative Medicine.
6. To Understand the Nanostructures for Cancer Diagnostics

Pre-requisite:

1. Basics of Biomedical Application
2. Basics of Biology

Unit–I: Micro/Nanomachining and Fabrication of Materials for Biomedical Applications: Introduction, Overview of Ion Implantation Process, Micro/Nanomachining of Soft Polymeric Biomaterials, Micro/Nanomachining of Hard Metallic Biomaterials, Novel Biocompatible Photoresists, Three-Dimensional Lithography.

Unit–II: Nanotechnology and Drug Delivery:Introduction, Advantages of Nanostructured Delivery Systems, Activation and Targeting of Nanotechnology-Based Drug Delivery Systems (Externally and Internally), Drug Targeting through Targeting Molecules, Multifunctional Nanoparticle Systems, Exploiting Inherent Material Properties.

Unit–III: Cell Behavior Toward Nanostructured Surfaces: Introduction, Nanotopographic Surfaces: Fabrication Techniques, Cell Behavior Toward Nanotopographic Surfaces Created by: Electron Beam Lithography, Photolithography,Composed of Aligned Nanofibers by Electrospinning, Nanoimprinting, Self-Assembly,Phase Separation, Colloidal Lithography, Composed of Random Nanofibers, Electrospinning, Chemical Etching, Incorporating Carbon Nanotubes/Nanofibers, Polymer Demixing.

Unit–IV: MultiscaleCoculture Models for Orthopedic Interface Tissue Engineering: Introduction,Cellular Interactions and the Soft Tissue-to-Bone Interface, Types of Coculture Models, Coculture Models for Orthopedic Interface Tissue Engineering, Macro- and MicroscaleCoculture, Two-Dimensional (2D) and Three-Dimensional (3D) Cocultures, Mechanism of Cellular Interactions During Coculture

Unit–V: Nanostructures for Tissue Engineering/Regenerative Medicine: Introduction, Nanofibrous Scaffolds, Surface Patterned Scaffolds, Relevance of Nanostructured Scaffolds in Regenerative Medicine, Role of Nanostructured Scaffolds in Tissue Engineering

Text books:

1. Bio-Medical nanostructures edited by Kenneth Gonsalves, Craig R Halberstadt, Wiley-Interscience A John Wiley & Sons, Inc., Publication
2. Introduction to Nanotechnology by Charles. P.PooleJr and Frank J. Owens, Wiley India Pvt Ltd.
3. Nano Technology, A gentle introduction to the next big idea by Mark Ranter and Daniel Ranter,Pearson education

Reference books:

1. Encyclopedia of Nanotechnology by H.S.Nalwa
2. Encyclopaedia of Nanotechnology by M.BalakrishnaRao and K.Krishna Reddy (VolI to X).

1NTPE02 BIONANOSTRUCTURES

Objective:

The course is intended to cover Bionanotechnology, Biomimicry and Nanomaterials for cancer diagnosis

Outcome of the study:

1. Students can able to develop deep understanding of Bionanotechnology
2. Student can able to study about bio-mimicry

Pre-requisite:

1. Basics of Biomedical Application
2. Basics of Biology

Unit–I: Introduction to bionanotechnology, Multi-DNA Nanomotors, Single DNA Nanomotors, Proteins—Collagens and Elastins and polypeptide nanowires, Glycoproteins, Lipid based carrier systems, applications.

Unit-II: Clinical Applications of Micro- and Nanoscale Biosensors: Classes of Biosensors:Method of Biological Signaling, Method of Transduction, Types of In Vitro Diagnostics: Cantilever-Based Biosensors, Cell and Protein Arrays, In Vivo Diagnostics: Quantum Dots, MRI Contrast Agents, Current and Emerging Clinical Applications of Micro- and Nanoscale Biosensors: Glucose Detection In Vivo, Bacterial Urinary Tract Infections, Human Immunodeficiency Virus (HIV) Detection, Cancer Cell Targeting.

Unit-III: Bio-mimicry: Introduction, concepts of biomimicry and bioinspiration in chemistry, Biomimcry and nanostructures, Bioinspired self-assembled structures Self assempled liposome-like systems, Bio mineralization, Biocompatible Bio sensors, Examples of proteins, micelles, vesicles, bilayers, and Multilayer films, application of bio- nanotechnology: bio nano machines.

Unit-IV: Nanomaterials for Cancer Diagnosis: Cancer and Early Diagnosis,Cancer and Chemotherapy, Nanotools for Early Cancer Detection , Carbon Nanomaterials in biomedical applications, nanoscale polymer fabrication for biomedical application, nanotechnology in cancer drug therapy: A biocomputational approach, Nanotoxicology.

Unit-V: Nano Artificial Cells: Artificial RBC, applications of artificial cells, synthetic cells and its applications, Nanotechnology in Organ Printing: Organ Printing, types of organ printing, 3D Bio Printing approachs, Nanotechnology for organ printing.Nanotechnology in Tissues Engineering, Nanotechnology in Point of Care Diagnostics: point-of-care tests, paper based diagnosis, Nanotechnology for point-of-care testing.

Text books:

1. Bio Nano Technology by Good Sell, Wiley Liss
2. Nanotechnology by John F. Mongillo
3. Introduction to Nanotechnology by Charles. P.PooleJr and Frank J. Owens, Wiley India Pvt Ltd.
4. Nano Technology, A gentle introduction to the next big idea by Mark Ranter and Daniel Ranter,Pearson education
5. Nanotechnology – science, innovation and opportunity by Lynn E Foster, Prentice Hall – Pearson education.
6. Bio-Medical nanostructures edited by Kenneth Gonsalves, Craig R Halberstadt, Wiley-Interscience A John Wiley & Sons, Inc., Publication
7. Bioinspiration and biomimcry in chemistry-reverse engineering nature , Gerhard F. Swiegers, Wiley -A John Wiley & Sons, Inc., Publication

Reference books:

1. Encyclopedia of Nanotechnology by H.S.Nalwa
2. Encyclopaedia of Nanotechnology by M.BalakrishnaRao and K.Krishna Reddy

1A01 RESEARCH METHODOLOGY & IPR

Outcome of the study:

- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Unit I: 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 researchproblem.Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Unit II: Effective literature studies approaches, analysis Plagiarism, Research ethics

Unit III: 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: 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: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases.Geographical Indications.

Unit VI: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2 ndEdition , "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974.
7. Asimov , "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

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1NT03 SYNTHESIS, FABRICATION AND CHARACTERIZATION LAB

Objective: The course is intended to cover basic preparation methods of nanomaterials
The outcome of the study is:
1. Gain knowledge on the synthesis techniques involved in experiments.
2. Students can acquire knowledge on equipment handling like XRD, PSA, UV etc.
3. To construct a theoretical knowledge on the experiment.
4. The ability to write and present the laboratory reports.
5. To maximize knowledge regarding synthesis and characterization of nanomaterials.

Pre-requisite: Basic chemistry, synthesis techniques characterization

Experiments:

1. Synthesis of ZnO nanoparticles using Urea as fuel by Solution Combustion Method
2. Synthesis of PVP capped Cadmium Sulfide (CdS) nanoparticles ChemicalCo-Precipitation Method
3. Synthesis of silica gel (SiO_2) using Sol-Gel method
4. Synthesis of the TiO_2 nanoparticles by using green synthesis from Aloe vera extract.
5. Synthesis of Graphene oxide by using hummers method
6. Fabrication of thin film by Dip coating
7. Fabrication of thin film by Spin coating
8. Fabrication of thin film by Spray Pyrolysis
9. Determination of average Crystallite size and Macrostrain by using X-Ray diffraction Analysis.
10. Determination of average particle size and zeta potential by using Dynamic light scattering
11. Calculation of band gap with error bar values by using U-V Visible spectroscopy.
12. Study of thermal properties by using TG/DTA analysis
13. Humidity Sensor applications
14. In-house Chemical sensor testing unit for detection of poisonous and flammable gases
15. Antibacterial applications
16. Seed germination using nanomaterials

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1NT04 SIMULATION LAB-I

Objective: The course is intended to cover understanding of nanomaterial fabrication technique and modeling.

Outcome of the study:

1. To gain knowledge on design and construction of carbon molecules.
2. Student can develop math work and gain knowledge on Mat-Lab.
3. To construct a theoretical knowledge on the experiment.
4. The ability to write and present the laboratory reports.
5. To maximize knowledge regarding simulation components.

Pre-requisite: Strategies to simplify the process of implementation

List of the Experiments:

I. ARGUS LAB

1. Construction of fullerene & its energy calculations
2. Construction of Bucky balls (C20, C40, C60, C80, C100, C120, C140)
3. Construction of Carbon nanotubes

II.MATLAB

1. Introduction to MATLAB Programming
2. Program assembly, Execution, Data processing and graphic analysis
3. Study of Fermi – Dirac distribution function
4. Introduction to symbolic math computations
5. MATLAB program to plot the one-dimensional rectangular potential well with infinite potential barrier

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2NT05 NANO SENSORS AND DEVICES

Objective:
The course is intended to cover sensors and different types of sensors with their characteristics and their applications

Outcome of the study:
1. To develop knowledge about Sensors, Characteristics, design and its Applications.
2. To persuade about the Physical Effects of Sensor.
3. To visualize the concept of Mass Sensitivity and Conductive Sensors.
4. To understand the importance of Electro Chemical Sensors and its measurement types.
5. Student can able attain knowledge on Thermometric & Optical sensors.

Pre-requisite:
1. Basics of nano liners optics and electronics
2. Basic of sensors, physical, chemical, mechanics phenomenon's related to sensors.

Unit I: Introduction &Sensor Characteristics: Nanotechnology, Sensors, Nanotechnology Enabled Sensors, Sensor Characteristics and Terminology, Static Characteristics, Dynamic Characteristics, Physical Effects Employed for Signal Transduction, Design and Applications.

Unit-II: Sensors& Physical Effects: Photoelectric Effect, Photo-dielectric Effect , Photo-luminescence Effect,Electroluminescence Effect, Chemiluminescence Effect, Doppler Effect, Barkhausen E ffect, Hall Effect, Nernst/Ettingshausen Effect, Thermoelectric (Seebeck/Peltier and Thomson) Effect, Thermoresistive Effect, Piezo resistive Effect, Piezoelectric Effect, Pyroelectric effect, Magneto-Mechanical Effect (Magnetostriction) , Magneto resistive Effect, Faraday-Henry Law.

Unit-III: Mass-Sensitive & Conductivity Sensors: BAW Sensors, SAW Sensors, Conductometric Sensors, Resistive and Capacitive Gas Sensors,Gas Sensors Based on PolycrystallineSemiconductors, GasSensors Made of Polymers and Gels, Resistive and Capacitive Sensors for Liquids.

Unit-IV Electrochemical Sensors: Potentiometric Sensors, Selectivity of Potentiometric SensorsIon Selective Electrodes,The Ion Selective Field Effect Transistor (ISFET), Measurement with Potentiometric S ensors, Amperometric Sensors Selectivity of Amperometric Sensors, Electrode Design and Examples, Mea surement with Amperometric Sensors, Sensors Based on Other Electrochemical Methods, Electro-Chemical Biosensors, Classes of Electrochemical Biosensors.

Unit-V: Thermometric & Optical Sensors: Sensors with Thermistors and Pellistors, Pyroelectric Sensors, Sensors Based on Other Thermal Effects, Optical Fibres as a Basis for Optical Sensors, Fibre Sensors without Chemical Receptors (Mediators), Optodes: Fibre sensors with a chemical receptor, Optodes with simple receptor layers, Optodes with complex receptor layers, Pressure Sensors

Text Books:
1. Nanotechnology-Enabled Sensors, KouroshKalantar-zadeh, Springer publications (2007)
2. Chemical Sensors-An Introduction for Scientists and Engineers,PeterGr¨undler, Springer publications (2006)
3. Design and Applicationsof Nanomaterials for Sensors by Jorge M. Seminario, Jerzy Leszczynski, Springer, Volume-16, 2014.

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2NT06: INDUSTRIAL TRENDS AND APPLICATIONS OF NANOTECHNOLOGY

Objective: To provide knowledge of various industrial applications of nanotechnology.

Outcome of the study:

1. To elucidate on advantages of nanotechnology based applications in industries.
2. To provide instances of contemporary industrial applications of nanotechnology.
3. To provide an overview of future technological advancements and increasing role of nanotechnology in Industries.

Pre-requisite:

1. Study of Microelectronics, sensors, Solar cells, Biological materials.

Unit–I: NANOTECHNOLOGY IN ELECTRONICS AND ENERGY

Miniaturization- Nano electronic devices and circuits – Semiconductor Memories - Dynamic Radom Access Memory- Nonvolatile Semiconductor Memories- Quantum Dot based Memory Cell- Sensors; physical and chemical- Electronic noses- Actuators- Micro and Nano-Electromechanical systems– Lighting and Displays –Quantum optical devices- Lasers – Batteries – Super capacitors- Fuel cells–role of nanomaterials in fuel cell applications- Photovoltaic cells –Application of nanotechnology in solar cells- Application of power in transportation including space Carbon Nano structures and types of Carbon Nano tubes, growth mechanisms, Mechanical reinforcements, Graphene, Carbon Nano fibers, Carbon clusters, Diamond

Unit–II: NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY

Nanoparticles and Micro–organism- Biosensors- Bioreceptors and their properties - Biochips- Integrated nanosensor networks for detection and response- DNA based biosensors and diagnostics- Natural nanocomposite systems; spider silk, bones, shells - Nanomaterials in bone substitutes and dentistry – Implants and Prosthesis –Tissue Engineering – Neuroscience -Neuro-electronic Interfaces -Nanorobotics– Photodynamic Therapy - Protein Engineering – Nanosensors in Diagnosis–Drug delivery – Cancer therapy and other therapeutic applications.

Unit–III: NANOTECHNOLOGY IN AGRICULTURE AND FOOD SECTOR

Nanotechnology in Agriculture -Precision farming, Smart delivery systems – Insecticides using nanotechnology – Potential of nano-fertilizers – Potential benefits in Nanotechnology in Food industry – Global Challenges- Product innovation and Process improvement- Consumer benefits- Food processing - Packaging- - Packing materials; physical properties- Improvements of mechanical and barrier properties- Antimicrobial functionality- Active packaging materials- -Information and communication technology- Sensors- RF identification- Food safety- Nanomaterial based Food diagnostics – Contaminant detection – Intelligent packaging- Nanoengineered Food ingredients- Potential risks to Nanofood to consumers.

UNIT IV - NANOTECHNOLOGY IN TEXTILES AND COSMETICS

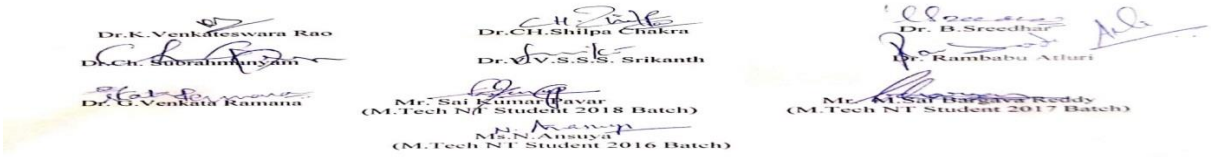
Nanofibre production – Electrospinning and charge injectionmethod – morphological control- yarns and polymidenanofibers- Carbon Nanotube and Nanofibre Reinforced Polymer Fibres- multifunctional polymer nanocomposites- Improvement of polymer functionality- Nylon-6 nanocomposites from polymerization- Dyeable Polypropylene - nanocoatings and surface modifications - Nano-filled polypropylene fibers - UV resistant, antibacterial, self-cleaning, flame retardant textiles – Lightweight bulletproof vests and shirts, Colour changing property, Waterproof and Germ proof, Cleaner kids clothes, Wired and Ready to Wear textiles- Cosmetics; Formulation of Gels, Shampoos, Hair-conditioners– Nanomaterials in Sun-screen UV protection – Color cosmetics

UNIT V - NANOTECHNOLOGY IN DEFENCE AND AEROSPACE

Pathways to Physical protection- Detection and diagnostics of chemical and biological agents, methods- Chemical and Biological counter measures- Decontamination- Post exposure and pre exposure protection and decontamination- Nanotechnology enabled bio chemical weapons- Influence operations- Evasion of medical countermeasures- Nanotechnology based satellite communication system- Guidance, Navigation and control- Spacecraft thermal control- mini, micro, nanosatellite concepts- Fiber optic and Chemical microsensors for space craft and launch support- Micro/Nano pressure and temperature sensors for space missions

Text books and References:

1. Mark. A, Ratner and Daniel Ratner, “Nanotechnology: A Gentle Introduction to the Next Big Idea”, Pearson, 2003.
2. Bharat Bhushan, “Springer Handbook of Nanotechnology”, Barnes & Noble 2004.
3. Neelina. H, Malsch (Ed.), “Biomedical Nanotechnology”, CRC Press 2005.
4. Udo. H, Brinker, Jean-Luc Mieusset (Eds.), “Molecular Encapsulation: Organic Reactions in Constrained Systems”, Wiley Publishers 2010.
5. Jennifer Kuzma and Peter VerHage, “Nanotechnology in agriculture and food production”, Woodrow Wilson International Center, 2006.
6. Lynn. J, Frewer, WillehmNorde. R. H, Fischer and Kampers. W. H “Nanotechnology in the Agri- food sector”, Wiley-VCH Verlag, 2011.
7. Brown. P. J and Stevens. K “Nanofibers and Nanotechnology in Textiles”, Woodhead Publishing Limited, Cambridge, 2007.
8. Mai. Y-W “Polymer Nano composites”, Woodhead publishing, 2006.
9. Chang. W.N “Nanofibres fabrication, performance and applications”, Nova Science Publishers Inc, 2009.
10. Helvajian. H and. Robinson. E.Y “micro and nanotechnology for space systems” the aerospace corporation, Micrograph , 1997.
11. Margaret. E, Kosal, “Nanotechnology for Chemical and Biological defence, Springer 2009.



2NTPE03 NANO TECHNOLOGY FOR ENERGY SYSTEMS

Objective:

The course covers the various energy forms, alternate and renewable energy system using nanotechnology.

Outcome of the study:

1. Study the basic Energy need and role of Battery materials
2. To grade up knowledge of Super Capacitors, and its Applications.
3. Study the role of nano structured material to meet Energy Challenges.
4. Learn about the concept of Hydrogen Storage Technology.
5. Gain knowledge on role of Fuel Cell Technology.

Pre-requisite:

Different technologies like Renewable energy technology, supercapacitors and Hydrogen storage technology.

Unit–I:Energy studies: Why clean energy, Different energies: Nuclear energy, Hydro power, Wind energy, Battery: Introduction to Battery materials and batteries: Lithium-Ion based batteries, Sodium-Ion batteries, Redox-Flow batteries.

Unit–II: Super capacitors: Super capacitor characterisation, Types of super capacitors, double layer and pseudo capacitance, hybrid super capacitors, super capacitors: Electrochemical double layer and pseudo-capacitors, Hybrid supercapacitors, advantages and disadvantages of electrochemical double layer, Psudocapacitors and hybrid supercapacitors., Applications of supercapacitors.

Unit–III: Renewable energy Technology: Energy challenges, nanomaterials and nanostructures in energy harvesting, developments and implementation of nanotechnology based renewable energy technologies, solar cell structures: quantum well and quantum dot solar cells, photo- thermal cells for solar energy harvesting, Thin film solar cells, CIGS solar cells, Die sensitized solar cells, Perovskite solar cells.

Unit–IV:Hydrogen storage Technology: Hydrogen production methods, purification, hydrogen storage methods and materials: metal hydrides and metal-organic framework materials, volumetric and gravimetric storage capacities, hydriding and dehydriding kinetics, high enthalphy formations and thermal management during hydriding reaction, multiple catalytic – degradation of sorption properties, automotive applications.

Unit–V:Fuel cell Technology: Fuel cell Principles, types of fuel cells (Alkaline Electrolyte, Phosphoric acid, Molten Carbonate, solid oxide and direct methanol and Proton exchange fuel cells), Principle and operation of Proton Exchange Membrane (PEM) fuel cell, Materials and fabrication methods for fuel cell technology, micro fuel cell power sources – Biofuels, Microbial biofuels.

Text Books & References:

1. Electrochemical supercapacitors for energy storage and delivery by Aiping Yu, Tay.& Franc, 2013.
2. Renewable Energy Resources by J. Twidell and T.Weir, E&FN Spon Ltd.
3. Hydrogen from Renewable Energy Source by D.Infield
4.Fundamentals of Industrial Catalytic Process by C.H. Bartholomew and Robert J. Farraoto, John
5. Fuel storage on Board Hydrogen storage in Carbon Nanostructures by R.A. Shatwell
6. Fuel cell Technology Handbook by Hoogers, CRC Press
7. Electrochemical Supercapacitors , B E Conway, Kluwer Academic/Plenum publishers, NY 1999.

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2NTPE03 NANO ELECTRONICS AND NANO PHOTONICS

Objective:

This course is intended to cover basics of electronics, transistor, band structure models, nanocapacitors, coulomb blockade, single electron transistor and nanophotonics.

Outcome of the study:

1. To assess knowledge on Single Electron and few Electron phenomenon.
2. To determine theory behind Scanning Tunneling Microscope by Applications of Tunneling.
3. Study the basics of coulomb blockade in Quantum mechanics.
4. To persuade Single Electron Transistor and Carbon Nano tubeTransistor.
5. To extend the knowledge on Spintronics and Nano photonics.

Pre-requisite:

1. Basics of nano linear optics and electronics

Unit-I: Single-electron and few-electron phenomena and devices: Tunnel junction and applications of tunneling, Tunneling Through a Potential Barrier, Potential Energy Profiles for Material Interfaces, Metal—Insulator, Metal-Semiconductor, and Metal-Insulator-Metal Junctions,

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Unit-II: Applications of Tunneling; Field Emission, Gate—Oxide Tunneling and Hot Electron Effects in MOSFETs, Theory of Scanning Tunneling Microscope, Double Barrier Tunneling and the Resonant Tunneling Diode.

Unit-III:Coulomb Blockade: Coulomb Blockade, Coulomb Blockade in a Nanocapacitor, Tunnel Junctions, Tunnel Junction Excited by a Current Source, Coulomb Blockade in a Quantum Dot Circuit.

Unit-IV: The Single-Electron Transistor: The Single-Electron Transistor Single-Electron Transistor Logic, Other SET and FET Structures, Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs, Molecular SETs and Molecular Electronics.

Unit –V: Spintronics: Spintronics -GMR & TMR effects and Foundations of nano-photonics - OLED

Text books:

1. Fundmentlas of nano electronics by George W Hanson Pearson publications ,India 2008
2. Introduction to photoelectron Spectroscopy (Chemical Analysis Vol. 67) by P.K. Ghosh;
3. Nanophotonics by P.N.Prasad – Springer Education series.

Reference books:

1. Encyclopaedia of Nano Technology by M.Balakrishna Rao and K.Krishna Reddy (Vol I to X) Campus books.
2. Spin Electronics by M. Ziese and M.J. Thornton
3. Introduction to Nanoscience by S.M Lindsay, 2009.

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2NTPE03 NANO COMPOSITES DESIGN AND SYNTHESIS

Objective:

This course intended to cover nanocomposites, reinforcing nanostructures dispersed in various matrix materials like polymers, ceramics, metals, etc,. The subject covers mainly the synthesis methods, modeling and evaluation of nanocomposites.

Outcome of the study:

1. Student can able to discuss the basic concepts of Nano Composites.
2. Student can able to prioritize the role of Ceramic Metal Composites in Nano Technology.
3. To understand the role of Synthesis Methods for various Nano Composite materials.
4. Learn about the concepts of Indentations and types of Indentations.
5. Correlate the applications of Polymer Nano Composites and ImpregnationTechniques.

Pre-requisite:

Basics of composites, properties of bulk composites

Unit–I: Introduction to Nanocomposites, Composite material, Mechanical properties of Nanocomposite material: stress - strain relationship, toughness, strength, plasticity.

Unit–II: Ceramic-Metal Nanocomposites, Ceramic based nanoporous composite, Metal matrix nanocomposites, Polymer-based nanocomposites Carbon nanotube based nanocomposites and Natural nanobiocomposites, Biomimetic nanocomposites and Biologically inspired nanocomposites.

Unit–III: Synthesis methods for various nanocomposite materials: mechanical alloying, thermal spray synthesis etc. Nano composites for hard coatings; Multi layered coatings; Thin film nanocomposites; Modeling of nanocomposites.

Unit–IV: Types of indentation: Oliver & Pharr, Vickers indentation process, Nano- Indentationby AFM.Influence of Interface, Molding, Injection molding, Design Selection Methodology for Composite Structures.

Unit–V: Processing of polymer nanocomposites, properties of nanocomposites, Infiltration techniques, Stir mixing, Extrusion method, Intercalation and Exfoliation, Solution casting method, impregnation techniques: Hot melt impregnation, solution impregnation, spin coating.

Text books:

1. Nanocomposite Science & Technology by P.M. Ajayan, L.S. Schadler and P.V. Braun, Wiley-VCH GmbH Co.
2. Introduction to Nano Technology by Charles. P.PooleJr and Frank J. Owens;Wiley India Pvt Ltd.
3. Nanotechnology, A gentle introduction to the next big idea by Mark Ratner, Daniel Ratner Pearson
4. Polyoxometalate Chemistry for Nano- Composite Design
5. Rheology and processing of polymer nanocomposites by Sabu Thomas, JiJi Abraham-Wiley Publications
6. Nano Composites by K. K. Chawla,

Reference books:

1. Encyclopedia of Nanotechnology by H.S.Nalwa
2. Encyclopaedia of Nano Technology by M.Balakrishnarao and K.Krishna Reddy, Vol I to X Campus books.

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2NTPE04 SCIENCE AND TECHNOLOGY OF THIN FILMS

Objective:

The course covers the importance of thin film technology and nanofabrication, vacuum technology, various physical and chemical methods of thin film a fabrication and various applications of thin films including sensors.

Outcome of the study:

1. To develop deep understanding on Vacuum Technology.
2. To compile all the Conditions for formation of thin films
3. To know the importance of Physical Vapor Deposition techniques.
4. To prioritize the role of Electrical discharges used in Thin Film Deposition
5. To improve the understanding of deposition using CVD.

Pre-requisite:

1. Vacuum pump technology
2. Basics of vacuum pump technology Perini and gauge technology

Unit-I: Vacuum technology: principles of vacuum pumps in range of 10^{-2} torr to 10^{-11}torr, principle of different vacuum pumps: roots pump, rotary, diffusion, turbo molecular pump, cryogenic-pump, ion pump, Ti-sublimation pump, importance of measurement of vacuum, Concept of different gauges: Bayet- Albert gauge, Pirani, Penning and pressure control.

Unit–II: Conditions for the formation of thin films: Environment for thin film deposition, deposition parameters and their effects on film growth, formation of thin films (sticking coefficient, formation of thermodynamically stable cluster – theory of nucleation), Zone model and Thornton model for thin film growth, capillarity theory, microstructure in thin films, adhesion, properties of thin films: Mechanical, electrical, and optical properties of thin films.

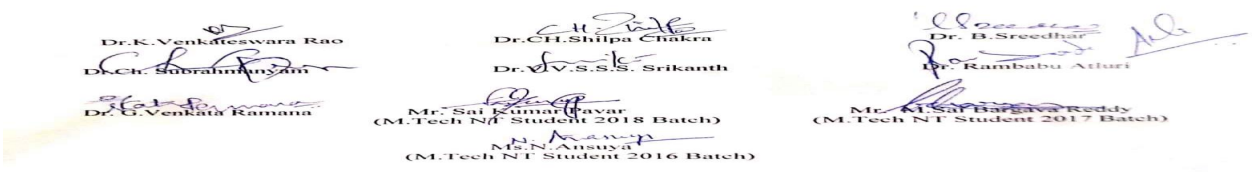
Unit-III: Physical Vapor Deposition techniques: Thermal evaporation, resistive evaporation, Electron beam evaporation, Laser ablation, Flash and Cathodic arc deposition, Electron beam and Ion beam lithography techniques

Unit-IV: Electrical discharges used in thin film deposition: Sputtering, Glow discharge sputtering, Magnetron sputtering, Ion beam sputtering, Ion plating, difference between thin films and coating,

Unit-V: Electro deposition, molecular beam epitaxy and laser pyrolysis. Chemical vapor deposition techniques: Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types, boundaries and flow, Different kinds of CVD techniques: Metallorganic CVD (MOCVD), Plasma Enhanced CVD (PECVD), thermally activated CVD, CVD, Spray pyrolysis, etc.

Text Books & References:

1. Thin Film Phenomenon by K.L. Chopra, McGraw-Hill
2. Methods of Experimental Physics (Vol 14) by G.L.Weissler and R.W. Carlson "Vacuum Physics and Technology"
3. A User's Guide to vacuum Technology by J.F.O'Hanlon, John Wiley and Sons
4. Vacuum Physics and Techniques by T.A. Delchar, Chapman and Hall
5. Evaporation: Nucleation and Growth Kinetics" by J.P. Hirth and G.M.Pound, Pergamon Press
6. Handbook of Vacuum Science and Technology by Dorothy M. Hoffman, Bawa Singh, John H. Thomas, III, Academic Press-Elsevier



2NTPE04 LITHOGRAPHIC TECHNIQUES

Objective: The course is intended to cover deep understanding of basics and different types of lithographic techniques useful for Nanofabrication.

Outcome of the study:

1. To discuss about Lithography and Optical Lithography
2. To formulate the role of Electron Lithography
3. To construct the idea of X-ray Lithography
4. To improve our knowledge in Ion Lithography
5. To understand the importance of Lithography based on Surface Instabilities

Pre-requisite:

1. Clean room technology, thin films coating techniques

Unit–I:Introduction to lithography and Optical lithography: Introduction to lithography- Contact, proximity printing and Projection Printing, Resolution Enhancement techniques, overlay-accuracies, Mask-Error enhancement factor (MEEF), Positive and negative photoresists.

Unit–II:Electron Lithography: Electron optics, Raster scan and Vector scan, Electron proximity / Projection Printing, Direct writing, Electron resists, Electron Beam Applications.

Unit–III:X-ray Lithography: X-ray Proximity and projection printing X-ray masks, X-ray sources, X-ray resists.

Unit–IV:IonLithography: Focussed ion beam – Point sources of Ion, Ion Column, Beam writing, Focused Ion Beam Lithography, Masked Ion Beam Lithography, Ion Projection Lithography.

Unit–V:Lithography based on Surface Instabilities: Wetting, De-wetting, Adhesion, Limitations, Resolution and Achievable / line widths of each of the above techniques

Reference books:

1. K.L. Chopra, "Thin Film Phenomenon", McGraw-Hill, 1968
2. JohnN.Helbert, "Handbook of VLSI Microlithography", Noyes Publication, USA, 2001.
3. James R Sheats and Bruce w.Smith, "Microlithography Science and Technology", Marcel Dekker Inc., New York, 1998.
4. S. Wolf "Silicon processing for the VLSI era", Vol-1 to 4, Lattice Press.
5. J.P. Hirth and G.M.Pound "Evaporation: Nucleation and Growth Kinetics" (Pergamon Press, Oxford, 1963
6. Hand book of Microscopy for Nanotechnology- Nan Yao &Zhong ling wang Kluwer Academic publishers
7. Nanofabrication. Principles, Capabilities and Limits Zheng Cui Springer publications
8. Scanning Microscopy for Nanotechnology Techniques and Applicationsedited by Weilie Zhou and Zhong Lin Wang springer publications

Journals references:

1. R.F.Bunshah and C.V.Deshpandey "Evaporation Processes" MRS Bulletin p.33, Dec.1988.
2. W.D.Westwood "Sputter Deposition Processes" MRS Bulletin p.46, Dec.1988.
3. P.Harris "Taking the Lead in Electron-bemDeposition"Vacuum& Thin Film, Feb.1999,p.26.
4. B.Heinz Sputter Target and Thin Film Defects" Vacuum & Thin Film, October 1999,p.22.
5. G.S.Bales et al., "Growth and Erosion of Thin Splid Films", Science, 249, 264 (1990).
6. C.R.M. Grovenor, H.T.G. Hentzell and D.A. Smith, "The Development of Grain Structure during Growth of Metallic Films" ActaMetallurgica 32, 773 (1984).
7. L.A.Stelmack, C.T.Thurman and G.R. Thompson "Review of Ion-assisted Deposition:
8. Research to Production", Nuclear Instruments and Methods in Physics Research B, 37/38,787 (1989).

2NTPE04 MEMS/NEMS DESIGN AND APPLICATIONS

Objective: The course is intended to cover deep understanding of micro and nano electromechanical systems their design and various applications as well as micro and nano fabrication techniques.

Outcome of the study:

1. To provide understanding of MEMS/NEMS applications specially sensors, Micro machining tools etc.,
2. To provide silicon micro fabrication techniques etc.,
3. To bring out scaling and packaging issues of physical system

Pre visit Request:

1.Machano- elctronic properties , fabrication techniques.

Unit-I: Introduction to MEMS : MEMS and NEMS – working principles- MEMS processes & features, various components of MEMS, applications and standards, micromachining, basic process tools- epitaxy, sputtering, chemical vapor deposition and spin on methods, oxidation, evaporation, lithography and etching, advanced process tools, sol gel process, EFAB

Unit-II: Materials for MEMS and Engineering aspects: Silicon, Silicon oxide and nitride, Thin metal films, Polymers, Other materials and substrates, polycrystalline materials, mechanics of Microsystems, static bending, mechanical vibrations, thermo mechanics, fracture mechanism, fatigue, stress and strain, young's modulus and modulus of rigidity, scaling laws in miniaturization.

Unit-III: MEMS Sensors, Design and processing: Micro sensors (acoustic wave sensors, biomedical sensors, chemical sensors, optical sensors, capacitive sensors, pressure sensors, thermal sensors), microactuators (thermal, piezoelectric, electrostatic actuators, micrometers, microvalves& pumps, accelerometer, microfluidics and devices), design consideration, process design and mechanical design.

Unit-IV: MEMS/NEMS Scaling issues and Packaging: Introduction – Scaling of physical systems – Mechanical system scaling, Thermal system scaling, Fluidic system scaling, Electrical system scaling, Packaging- mechanical and microsystem package, design considerations, Process steps, Diepreparation-interconnects, surface and Wafer bonding, wire bonding and scaling, 3D packaging and assembly signal Thermal management, Hermetic packaging, Electrical//Micro fluidic/and optical interconnects, Signal mapping transduction, Microfluidic technology - MEMS and NEMS technology for microfluidic devices.

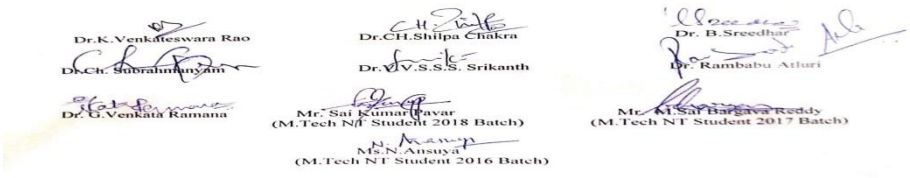
Unit-V: MEMS/NEMS applications: Applications in automotive industry – health care – aerospace – industrial product consumer products – lab on chip – molecular machines – data storage devices – micro reactor – telecommunications, Servo systems.

Text Books:

1. "An introduction to Micro electro mechanical systems Engineering" by NadimMalut and Kirt Williams – Second edition – Artech House, Inc, Boston
2. "Micro electro mechanical systems Design". / By James J Allen- CRC Press – Taylor and Francis Group
3. "Mechanics of micro electro mechanical systems "by NicolaeLobontiu and Ephrahim Garcia Kluwer. Academic Publishers – Boston
4. The Physics of Micro/Nano- Fabrication by Ivor Brodie and Julius J.Muray
5. Nano- and Micromaterials by Kaoru Ohno, Masatoshi Tanaka, Jun Takeda and Yoshijuki Kawazoe

References Books

1. "Springer Hand Book of Nano Technology " byBharathBhushan – Springer
2. "Nano and Micro electro Mechanical systems" by Sergey Edward Lysherski – CRC Press.



2NT07 NANOSTRUCTURED MATERIAL APPLICATION LAB

Objective: The course is intended to cover understanding of nanomaterial synthesis, fabrication and characterization technique.

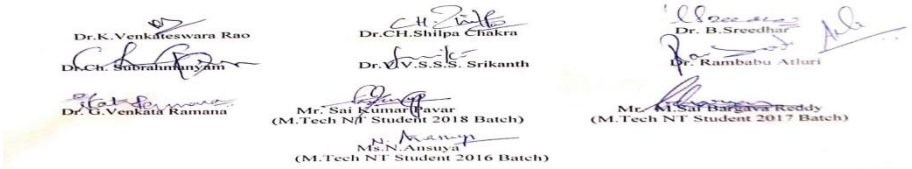
The outcome of the study is:

1. To gain overall knowledge on synthesis, characterization and application of nanomaterials.
2. Students can acquire knowledge on equipment handling like Cyclic voltammetry, Anti bacterial applications, gas sensor etc.
3. To construct a theoretical knowledge on the experiment.
4. The ability to write and present the laboratory reports.
5. To maximize knowledge regarding synthesis, characterization and applications of nanomaterials.

Pre-requisite: Synthesis, Fabrication and Characterization Techniques

Experiments:

1. Synthesis and Characterization of Metal oxide nanostructured material for Humidity Sensing Application
2. Synthesis and Characterization of Metal oxide nanostructured material for Gas Sensing Application
3. Synthesis and Characterization of Metal oxide nanostructured material for Glucose Sensing Application
4. Synthesis and Characterization of Metal oxide nanocomposite material for Humidity Sensing Application
5. Synthesis and Characterization of Metal oxide nanocomposite material for Gas Sensing Application
6. Synthesis and Characterization of Metal oxide nanocomposite material for Glucose Sensing Application
7. Fabrication (Dip coating) and Characterization of Thin film for Humidity Sensing Application
8. Fabrication (Spin coating) and Characterization of Thin film for Gas Sensing Application
9. Fabrication (Spray pyrolysis) and Characterization of Thin film for Glucose Sensing Application
10. Synthesis and Characterization of Nanostructured material for Seed Germination Application
11. Synthesis and Characterization of Nanostructured material for Anti-bacterial Application
12. Synthesis and Characterization of Nanostructured material for Energy Application



2NT08 SIMULATION (NANOHUB+QUANTUM WISE) LAB-II

Objective:Objective: The course is intended to cover understanding of nanomaterial fabrication technique and modeling.

The outcome of the study is:

1. To familiarize students about applying various material design and data analysis.
2. To help in understanding the theoretical modeling of semiconductor devices and quantum structures using online in- browser simulation tools.
3. To construct a theoretical knowledge on the experiment.
4. The ability to write and present the laboratory reports.
5. To maximize knowledge regarding simulation tools.

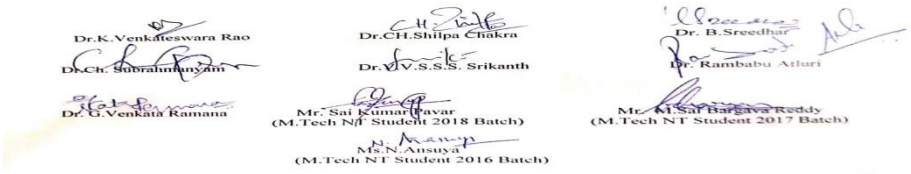
Pre-requisite: Strategies to simplify the process of implementation

I. QUANTUM WISE (ATK & VNL)

1. Geometry for Transport Calculations (ATK)
2. Setting up a transport calculation with the script generator (ATK)
3. I-V Curve (ATK)
4. Building and optimizing the geometry (ATK)
5. Calculating the band structure of a SiC crystal (VNL)
6. Transmission spectrum of a graphenenanoribbon with a distortion (VNL)
7. Building a graphenenanoribbon device (VNL)

II. NANOHUB

1. BJT Lab (ABACUS)
2. Carrier Statistics Lab (ABACUS)
3. Drift-Diffusion Lab(ABACUS)
4. MOSFET (ABACUS)
5. PN Junction Lab (ABACUS)



3NTPE05 NANOTOXICOLOGY

Objective:

To learn and understand social impact and health issues of environmental pollution caused due nanoindustries

The outcome of the study is:

. 1. To provide knowledge on social impact of nanoindustry
2. To design and conduct experiments, as well as to analyze the results
3. To enhance the various analytical techniques and to identify and solve problems
4. To understand the socio-ethical responsibility

Pre-requisite:

UNIT I - POSSIBLE HEALTH IMPACT OF NANOMATERIALS

Sources of Nanoparticles; Epidemiological Evidence; Entry Routes into the Human Body – Lung, Intestinal Tract, Skin*;* Nano particle Size - Surface and Body Distribution; Effect of Size and Surface Charges; Nanoparticles, Thrombosis and Lung Inflammation ;Nanoparticles and Cellular Uptake; Nanoparticles and the Blood-Brain Barrier.

UNIT II - NANOMATERIALS FOR ENVIRONMENTAL REMEDIATION (9 hours)

Introduction- Nanoparticle-based Remediation Materials - Acid-Base Chemistry - Redox Chemistry- Field Deployments of ZVI - Absorption Chemistry - Hybrid Nanostructured Remediation Materials- Self-assembled Monolayers on Mesoporous Supports (SAMMS) - Functional CNTs .

UNIT III - BIOTOXICITY OF METAL OXIDE NANOPARTICLES AND CARBON NANOTUBES

Introduction; Nanoparticles in the Environment; Nanoparticles in Mammalian Systems; Health Threats; Nanomaterials and Biotoxicity; Iron Oxide; Titanium Dioxide; Dark Studies; UV Irradiation Studies;Other Metal Oxides; Toxicological Studies and Toxicity of Manufactured CNTs- case study; Toxicity of CNTs and Occupational Exposure Risk; Toxicity of MWCNTs/SWCNTs and Impact on Environmental Health.

UNIT IV - TOXICOLOGY OF NANOPARTILES IN ENVIRONMENTAL POLLUTION

Air Pollution; Introduction to Air Pollution Particles; Adverse Effects of PM in Epidemiological Studies; Role of Nanopartides in Mediating the Adverse Pulmonary Effects of PM; Effects of Nanopartides on the Cardiovascular System; Nanopartide Translocation and Direct Vascular Effects; Endothelial Dysfunction and Endogenous Fibrinolysis; Coagulation and Thrombosis; Cardiac Autonomie Dysfunction; Effects of Nanopartides on the Liver and Gastrointestinal Tract; Effects of NP on the Nervous System.

UNIT V - DOSIMETRY, EPIDEMIOLOGY AND TOXICOLOGY OF NANOPARTICLES

Epidemiological Evidence for Health Effect Associations with Ambient Particulate Matter; Toxicological Evidence for Ambient Particulate Matter Induced Adverse Health Effects; Inhaled Nanoparticle Dosimetry; Toxicological Plausibility of Health Effects Caused by Nanoparticles; Integrated Concept of Risk Assessment of Nanoparticles.

REFERENCES

1. Challa. S. S. R, Kumar, “Nanomaterials - Toxicity, Health and Environmental Issues”, Wiley-VCH publisher, 2006.
2. Nancy. A, Monteiro-Riviere, Lang Tran. C, “Nanotoxicology: Characterization, Dosing and Health Effects”, Informa healthcare, 2007.
3. Drobne. D, “Nanotoxicology for safe and Sustainable Nanotechnology”, Dominant publisher, 2007.
4. ZafarNyamadzi. M, “A Reference handbook of nanotoxicology”, Dominant publisher, 2008.

3NTPE05 SOCIETAL IMPACTS OF NANOTECHNOLOGY

Objective: To provide an adequate basic knowledge on social impact of NanoScience and Nanotechnology

The outcome of the study is:

1. To provide awareness to the engineering students about socio economic impact of nanotechnology and to handle the techniques effectively .
2. Understand the various social impacts of nanotechnology trend and research
3. To enhance the nanotechnology research by taking ethics and public opinion into consideration.
4. To understand of professional and ethical responsibility

Pre-requisite:

UNIT I - PROTECTION & REGULATION FOR NANOTECHNOLOGY

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

UNIT II – LIABILITY LEGAL ASPECTS OF NANOTECHNOLOGY

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

UNIT III – ECONOMIC IMPACTS AND COMMERCIALIZATION OF NANOTECHNOLOGY & SOCIAL SCENARIOS

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

UNIT IV - ETHICS, LAW & GOVERNANCE

Ethics and Law-Ethical Issues in Nanoscience and Nanotechnology: Reflections and Suggestions-Ethics and Nano: A Survey-Law in a New Frontier- An Exploration of Patent Matters Associated with Nanotechnology -The Ethics of Ethics -Negotiations over Quality of Life in the Nanotechnology Initiative. Governance-Problems of Governance of Nanotechnology -Societal Implications of Emerging Science and Technologies: A Research Agenda for Science and Technology Studies (STS)-Institutional Impacts of Government Science Initiatives -Nanotechnology for National Security.

UNIT V - PUBLIC PERCEPTIONS & EDUCATION

Public Perceptions-Societal Implications of Nanoscience: An Agenda for Public Interaction Research -Communicating Nanotechnological Risks- A Proposal to Advance Understanding of Nanotechnology's Social Impacts - Nanotechnology in the Media: A Preliminary Analysis-Public Engagement with Nanoscale Science and Engineering - Nanotechnology: Moving Beyond Risk-Communication Streams and Nanotechnology: The (Re)Interpretation of a New Technology- Nanotechnology: Societal Implications — Individual Perspectives-Historical Comparisons for Anticipating Public Reactions to Nanotechnology.

REFERENCES

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

3NTOE INTRODUCTION TO NANOSCIENCE & NANO TECHNOLOGY

Objective:

To familiarize students with basics of nanoscience and technology, Nanobiotechnologies and Nanomaterials for environmental and toxicology.

Outcome of the study:

1. To discuss the basic concepts of nano technology.
2. To understand the importance of nano biotechnology
3. To study the influence of nanotechnology in the field of environment and toxicology.
4. To evaluate the concepts of nano electronics.
5. To classify the applications of nano materials.

Pre-requisite:

1. Basic chemistry fundamentals
2. Basic material science

Unit-I: Background of Nanotechnology

Scientific Revolutions, Nanotechnology and Nanomachines,The Periodic Table, Atomic Structure, Molecules and Phases, Energy, Molecular and Atomic size, Surfaces and Dimensional Space, Top down and Bottom up approach.

Unit-II:Nanobiotechnologies: Concept-Structural principle of Bionanotechnology-Classification of Nanobiotechnologies -Micro- and Nanoelectromechanical Systems- Function of Biological Nanomolecules-DNA computers and DNA microprocessors- Biotechnology based genetic engineering -Function of Biological Nanomolecules- Bionanomachines in Action. Drug deliveries -Targeting Ligands based Drug Delivery- Cancer Treatment- Mediated Delivery - Tissue Regeneration, Growth and Repair,Tissue Bioengineering.

Unit-III: Nano Materials For Environment And Toxicology : Green nanotechnology and its principles, Nano-convergence and Environmental Engineering, different environmental systems, Potential impacts of nanomaterials on organisms and ecosystems, Environmental applications, Nanotechnology and Our Energy Challenge of nanomaterials, Nanotechnology and Renewable Energy, Introduction to toxicology, principles of toxicology,Nanotoxicology, dosage-Response curve, classification of toxicity, factors affecting toxicity, LC50, LD 50, Air borne Particles,

Unit-IV: Nanoelectronics

Approaches to nanoelectronics, Fabrication of integrated circuits, MEMS, NEMS, Nano circuits, Quantum wire, Quantum well, DNA-directed assembly and application in electronics.

Unit-V: Applications

Coatings, Optoelectronic Devices, Environmental Applications, Nanomedicine, Biomedical applications, Energy storage

Text Books

1. Introduction to Nanotechnology by Charles P. Poole Jr and Frank J.Owens Wiley India
2. Introduction to Nanoscience and Nanotechnology, Chatopadhyaya.K.K, and Banerjee A.N,
3. Introduction to nano tech by phanikumar
4. Nanotechnology and the Environment, Kathleen Sellers,Christopher Mackay, Lynn L. Bergeson, Stephen R. Clough, Marilyn Hoyt, Julie Chen, Kim Henry, Jane Hamblen, crc press, 2009

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(M.Tech NT Student 2017 Batch)

AUDIT COURSE: **ENGLISH FOR RESEARCH PAPER WRITING**

Outcome of the study:
Students will be able to:

1. Understand that how to improve your writing skills and level of readability

2. Learn about what to write in each section

3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first- time submission

Pre-requisite:

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

Unit II: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

Unit III: Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check

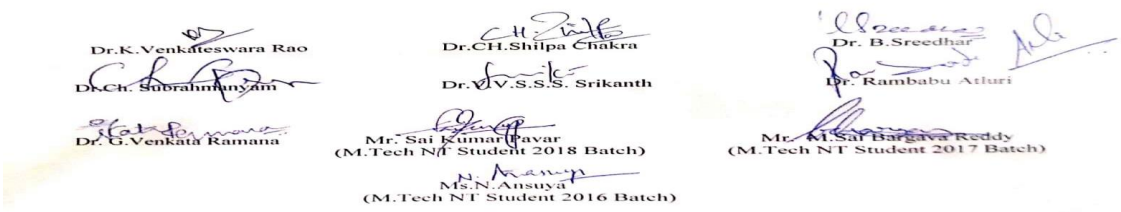
Unit IV: Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Unit V: 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 VI: useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

References:

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



AUDIT COURSE: **Disaster Management**

Course Objectives: -Students will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical Relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches,planning and programming in different countries, particularly their home country or the countries they work in..

Unit I: Introduction

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

Unit II: Repercussions Of Disasters And Hazards:

Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, LandslidesAnd 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

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

Unit IV: Disaster Preparedness And Management

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, MediaReports: Governmental And Community Preparedness.

Unit V: Risk Assessment

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

Unit VI: Disaster Mitigation

Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation,Programs Of Disaster Mitigation In India.

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep &Deep PublicationPvt.Ltd.,NewDelhi.

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AUDIT COURSE: **SANSKRIT FOR TECHNICAL KNOWLEDGE**

Course Objectives: -

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects
4. Enhancing the memory power
5. The engineering scholars equipped with Sanskrit will be able to explore the
6. Huge knowledge from ancient literature

Unit I: Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

Unit II: Order, Introduction of roots, Technical information about Sanskrit Literature

Unit III: Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

.

Suggested reading

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

Course Output:

Students will be able to

1. Understanding basic Sanskrit language.
2. Ancient Sanskrit literature about science & technology can be understood.
3. Being a logical language will help to develop logic in students.

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AUDIT COURSE: # VALUE EDUCATION

Course Objectives

Students will be able to

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

Unit I: Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. 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 for nature, 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. Universa brotherhood 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.

Suggested reading

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

Course outcomes

Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

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Mr. Sai Kumar Pavar (M.Tech NT Student 2018 Batch)
Ms.N.Anusya (M.Tech NT Student 2016 Batch)
Dr. B.Sreedhar
Dr. Rambabu Atluri
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AUDIT COURSE: **CONSTITUTION OF INDIA**

Course Objectives: -

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a Civil rights perspective.
2. 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 of nationhood in the early years of Indian nationalism.
3. 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

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. 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.
4. Discuss the passage of the Hindu Code Bill of 1956.

Unit I: History of Making of the Indian Constitution:

HistoryDrafting Committee, (Composition & Working)

Unit II: Philosophy of the Indian Constitution:

Preamble Salient Features

Unit III: Contours of Constitutional Rights & 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, Qualification, Powers and Functions

Unit V: Local Administration:

District's Administration head: Role and Importance,Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: 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. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women

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, 201
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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AUDIT COURSE: **PEDAGOGY STUDIES**

Course Objectives:

Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Outcomes

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, And with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and Guidance materials best support effective pedagogy?

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 of pedagogical practices 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.

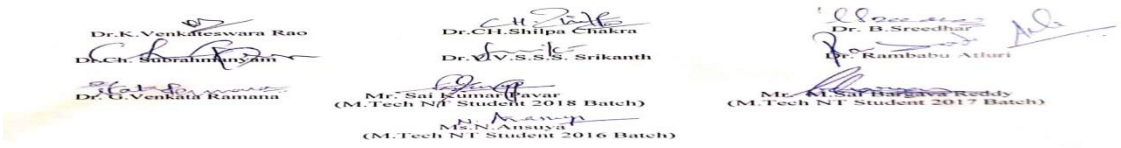
Unit IV: Professional development: alignment with classroom practices and follow-up Support Peer support,Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes

Unit V: Research gaps and future directions

Research design**,**Contexts, Pedagogy,Teacher education, Curriculum and Assessment, Dissemination and research impact.

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher Education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (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. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.



AUDIT COURSE: **STRESS MANAGEMENT BY YOGA**

Course Objectives

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Unit I: Definitions of Eight parts of yog. (Ashtanga)

Unit II: Yam and Niyam. Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha

ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Unit III: Asan and Pranayam

i) Various yog poses and their benefits for mind & body

ii)Regularization of breathing techniques and its effects-Types of pranayama

Suggested reading

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

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AUDIT COURSE: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Course Outcomes

Students will be able to

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

Unit I: Neetisatakam-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. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

Suggested reading

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication
2. Department), Kolkata
3. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,
4. Rashtriya Sanskrit Sansthanam, New Delhi