Curriculum & Syllabus

of

M.Tech. Nanoscience and Technology

(For the batch admitted in 2010-11 onwards)

K.S.RANGASAMY COLLEGE OF TECHNOLOGY
TIRUCHENGODE – 637 215

(An Autonomous Institution affiliated to Anna University Chennai and approved by AICTE New Delhi)

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<tr><td>Department</td><td colspan="2">Nanoscience and Technology</td></tr>
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K.S. Rangasamy College of Technology, Tiruchengode 637 215								
Curriculum for the programmes under Autonomous Scheme								
Regulation	R 2010							
Department	Department of Nanoscience and Technology							
Programme Code & Name	PNT: M.Tech. Nanoscience and Technology							
Semester I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
THEORY								
10 PNT 101	Applied Numerical Methods	3	1	0	4	50	50	100
10 PNT 102	Quantum Concepts	3	1	0	4	50	50	100
10 PNT 103	Introduction to Nanoscience and Technology	3	0	0	3	50	50	100
10 PNT 104	Advanced Materials Technology	3	1	0	4	50	50	100
10 PNT 105	Introduction to Biomaterials	3	0	0	3	50	50	100
10 PNT 106	Computer Programme in C and C++	3	0	0	3	50	50	100
PRACTICAL								
10 PNT 107	Synthesis of Nanomaterials Laboratory	0	0	3	2	50	50	100
	Total	18	3	3	23	700		
Semester II								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
THEORY								
10 PNT 201	Advanced Characterisation Techniques	3	1	0	4	50	50	100
10 PNT 202	Nanomaterials and Nanomedicine	3	0	0	3	50	50	100
10 PNT 203	Industrial Nanotechnology	3	0	0	3	50	50	100
10 PNT 204	Nanoelectronics	3	1	0	4	50	50	100
10 PNT 205	Nanolithography	3	0	0	3	50	50	100
10 PNT 206	Nanobiotechnology	3	0	0	3	50	50	100
PRACTICAL								
10 PNT 207	Characterisation of Nanomaterials Laboratory	0	0	3	2	50	50	100
10 PNT 208	Technical Report Preparation and Presentation	0	0	2	0	100	00	100
	Total	18	2	5	22	800		

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Semester III								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
THEORY								
10 PNT 301	Nanodevices	3	0	0	3	50	50	100
10 PNT E1*	Elective I	3	0	0	3	50	50	100
10 PNT E2*	Elective II	3	0	0	3	50	50	100
PRACTICAL								
10 PNT 302	Project Work - Phase I	0	0	12	2	100	00	100
	Total	9	0	12	11	400		

Semester IV								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT 401	Project Work - Phase II	0	0	40	10	50	50	100
	Total	0	0	40	10	100		

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Elective I								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT E11	Micro Electro Mechanical System and Nano Electro Mechanical System	3	0	0	3	50	50	100
10 PNT E12	Drug Delivery	3	0	0	3	50	50	100
10 PNT E13	Fundamentals of Batteries	3	0	0	3	50	50	100
10 PNT E14	Nanotechnology in polymers	3	0	0	3	50	50	100
10 PNT E15	Solid state of Nanotechnology	3	0	0	3	50	50	100
10 PNT E16	Nanotechnology in semiconductor devices	3	0	0	3	50	50	100
Elective II								
10 PNT E21	Nanosafety and Environmental Issues	3	0	0	3	50	50	100
10 PNT E22	Intellectual Property Rights	3	0	0	3	50	50	100
10 PNT E23	Research Methodology - Engineering and Management Studies	3	0	0	3	50	50	100
10 PNT E24	Research Methodology - Science and Humanities	3	0	0	3	50	50	100

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Department	Nanoscience and Technology		Programme Code & Name			PNT : M.Tech - Nanoscience and Technology				
Semester I										
Course Code	Course Name		Hours / Week			Credit	Maximum Marks			
			L	T	P	C	CA	ES	Total	
10 PNT 101	APPLIED NUMERICAL METHODS		3	1	0	4	50	50	100	
Objective(s)	With the present development of the computer technology, it is necessary to develop efficient algorithms for solving problems in science, engineering and technology. This course gives a complete procedure for solving different kinds of problems that occur in engineering numerically. At the end of the course the students would be acquainted with the basic concepts in numerical methods and their uses.									
1	SOLUTION OF EQUATION					Total Hrs	09			
Bisection Method – Newton Raphsan method- Method of False Position, Iteration Method, Secant Method and Muller's Method.										
2	SOLUTION OF EQUATION AND EIGEN VALUE PROBLEM					Total Hrs	09			
Solution of Linear Systems: Matrix Inversion Method, Gauss Elimination Method, Gauss-Jordan Method, Gauss - Seidal iteration Method, Solution of Tridiagonal Systems, Eigen value Problems- Eigen values of a symmetric Tridiagonal Matrix, Householder Method, QR Method.										
3	INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS					Total Hrs	09			
Picard's Method of Successive approximations - Eulers Method, Modified Euler's Method -Range-Kutta Methods(Forth order only). Boundary-Value Problems- Finite Difference Method, Shooting Method, Cubic Spline Method.										
4	BOUNDARY VALUE PROBLEMS FOR ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS					Total Hrs	09			
Poisson Equation - Laplace's Equation: Jacobi's Method, Gauss-Seidal Method- ADI method, Parabolic Equations, and Hyperbolic Equations.										
5	NUMERICAL INTEGRATIONS					Total Hrs	09			
Numerical integrations by Trapezoidal and Simpson's 1/3 and 3/8 rules, Two and three point Gaussian quadrature formulas, Romberg's Method- Double intergrades using trapezoidal and Simposon's rules. Finite Element Method-Rayleigh-Ritz Method, Galerkin Method.										
Total hours to be taught							45			
Reference(s) :										
1	S.S. Sastry, "Introductory Methods of Numerical Analysis", Prentice-Hall of India, PVT. LTD,									
2	M.K. Jain, S.R.K. Iyenkar and R.K. Jain, "Numerical Methods Problems and Solutions", New Age International Limited Wiley Eastern Limited, New Delhi, 1995.									
3	P. Kandasamy, K.Thilakavathy and Gunavathy "Numerical Methods" S. Chand & Company Ltd, New Delhi, 2005.									
4	B.S. Grewal, "Numerical Methods in Engineering & Science with Programs in FORTAN 77, C & C++", Khanna Publishers, New Delhi, 2003.									
5	V.N. Vedamurthy and N.Ch.S.N. Iyengar, Vikas Publishing house PVT. LTD, 2000, New Delhi.									
6	S. Arumugam, A. Thangapandian Isacc and A. Somasundram, "Numeric Methods Second Edition", SCITECH Publications (India) PVT.LTD, Chennai, 2001.									

K.S. Rangasamy College of Technology - Autonomous Regulation			**R 2010**
Department	Nanoscience and Technology	Programme Code & Name	PNT : M.Tech - Nanoscience and Technology

Semester I

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT 102	QUANTUM CONCEPTS	3	1	0	4	50	50	100

Objective(s)	Impart the basic knowledge about the Quantum Concepts and understand the various parameters like operator, Eigen function, angular momentum, the variation principles and approximate methods. Understand the quantum concept and apply the nanostructured materials.

1	INTRODUCTION	Total Hrs	9

Limitation of classical mechanics - Plank's quantum hypothesis - Einstein's photoelectric effect - Wave nature of particle - Uncertainty principle - Schrodinger's time dependent and independent wave equations - Particle in a one dimensional box - Harmonic oscillator.

2	WAVE MECHANICS	Total Hrs	9

Linear operator - Hermitian operator - Linear harmonic oscillator - Operator method – Postulates of quantum mechanics - Equations in motion - Ehren fast's theorem - Hydrogen atom - Hydrogen orbitals - Matrix representation of wave functions.

3	OPERATORS AND COMPUTATION LAWS	Total Hrs	9

Linear momentum operator – Properties of Hermition operator – Angular momentum operators – Ladder operators – Parity operator – Commuting and non commuting operators – Commutation relation L_x and L_y - Commutation relation L^2 and L_x – Commutation relation L_+ and L_-.

4	VARIATION PRINCIPLES	Total Hrs	9

Variation principle - Variation method for ground state of hydrogen molecule - Ground state of Helium atom – Perturbation theory in non-degenerate case - First order perturbation – Harmonic perturbation - Transition to continuous states.

5	APPROXIMATION METHODS	Total Hrs	9

Klein-Gordon equation – Charge and current densities – Inadequacies of Klein-Gordon equation – Dirac's equation for a free particle - Dirac's matrices – Properties of Dirac's matrices – Negative energy states – Hatree-Fock equation.

Total hours to be taught	45

Reference(s) :

1. G. Aruldhass, "Quantum Mechanics", Prentice Hall of India pvt. Ltd. New Delhi, 2004.
2. B.M. Mathew and K. Venkateshan, "A Text Book Quantum Mechanics", Tata McGraw Hill publications, New Delhi, 2007.
3. L.I. Schiff, "Quantum Mechanics", McGraw Hill book company 1968.
4. Ghatak and Lokanathan "Quantum Mechanics", The Macmillan Company of India Ltd 1975.
5. Amit Goswami, "Quantum Mechanics", WCB publishers, 1992.

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Semester I									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ES	Total	
10 PNT 103	INTRODUCTION TO NANO SCIENCE AND TECHNOLOGY	3	0	0	3	50	50	100	
Objective(s)	Impart the basic knowledge on nanoscience and technology. Understand the various process techniques available for the processing of nanostructured materials. Impart knowledge on the exotic properties of nanostructured materials at their nanoscale lengths. Acquire the knowledge above the various nanoparticles process methods and their skills. Study the reactive merits of various process techniques.								

1	INTRODUCTION	Total Hrs	9
Introduction to nanoscale materials - atomic & molecular size. Scientific revolutions-nanotechnology application area. Scope of nanoscience and technology.			
2	NANOSTRUCTURES AND DIMENSIONS	Total Hrs	9
Classification of nanostructures-zero, one, two and three dimensional nanostructures. Size Dependency in Nanostructures-quantum size effects in nanostructures. Chemistry of tailored nano shapes.			
3	NANOMATERIAL SYNTHESIS	Total Hrs	9
Synthesis of nanomaterials-top down and bottom up approach. Method of nanomaterials preparation – wet chemical synthesis-mechanical grinding-gas phase synthesis.			
4	NANOMATERIAL PROPERTIES	Total Hrs	9
Surface to volume ratio. Surface properties of nanoparticles. Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. Size dependent properties-size dependent absorption spectra. Shape impact.			
5	PHYSICAL PROPERTIES OF NANOSTRUCTURED MATERIALS	Total Hrs	9
Quantum dots-optical properties and applications. Carbon nano tubes-physical properties and applications. Magnetic behavior of nanomaterials. Electronic transport in quantum wires. Surface chemistry of tailored monolayer.			
Total hours to be taught			45

Reference(s) :	
1	Mick Wilson, Kamali Kannargare., Geoff Smith, “Nano technology: Basic Science and Emerging technologies”, Overseas Press, 2005.
2	Charles P. Poole, Frank J. Owens, “Introduction to Nanotechnology”, Wiley Interscience, 2003.
3	Mark A. Ratner, Daniel Ratner, “Nanotechnology: A gentle introduction to the next Big Idea”, Prentice Hall P7R:1st Edition, 2002.
4	T. Pradeep, “ Nano the Essential Nanoscience and Nanotechnology”, Tata McGraw hill, 2007.
5	J. Dutta, H. Hoffmann, “Nanomaterials”, Topnano-21, 2003.

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Semester I

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT 104	ADVANCED MATERIALS TECHNOLOGY	3	1	0	4	50	50	100

Objective(s)	Understand the basic ideas about the materials and impart the knowledge about the properties and various applications of dielectric materials magnetic, superconducting material.etc. Impart the knowledge about the new materials like smart materials, shape memory alloys and acquire the various physico-chemical properties of various materials.

1	STRUCTURE & BONDS OF SOLIDS	Total Hrs	9
Bonding in solids-Ionic bonding-bond energy of NaCl molecule- Covalent bond-Metallic bond-Intermolecular bonds-Dispersion bonds-dipole bonds-hydrogen bonds – properties - structure of solids-Lattice Points-Space lattice-basis - crystal structure-unit cell-Lattice Parameter- Primitive cell crystal systems - simple cubic - body centered-Face centered -hexagonal-crystal symmetry-Miller indices. Imperfection-Point defect-Vacancy-Schotty defect-Fresnel defect-Line imperfection-Screw dislocation-Burger vector-Reciprocal lattice.			
2	DIELECTRIC MATERIALS	Total Hrs	9
Dielectric Materials: Basic concepts- Langevin's Theory of Polarisation – Clausius - Mossotti Relation-Ferro electricity-Piezoelectricity-Properties of Dielectric in alternating fields- The complex Dielectric Constant and Dielectric Loss - Ionic polarizability as a function of frequency-Complex dielectric constant of Non-polar solids-Dipolar relaxation - Effects of Dielectrics-Multiferroids.			
3	MAGNETIC MATERIALS	Total Hrs	9
Magnetic materials: Dia and Paramagnetic materials-Quantum theory of paramagnetic materials-Paramagnetic susceptibility of conduction electrons-Ferroids.			
4	SEMI CONDUCTING & SUPERCONDUCTING MATERIALS	Total Hrs	9
Semiconducting materials: Semiconductor-Direct and Indirect band gap characteristics-Quantum confinement-quantum dots and wires-organic semiconductors-Polymer semiconductors-Photo conductive polymers-applications.			
5	NEW MATERIALS	Total Hrs	9
New Materials: Smart materials-shape memory alloys-shape memory effects- Martens tic Transformation functional properties-processing-texture applications.			
Total hours to be taught			45

Reference(s) :

1	V. Rajendran, Material Science, Tata McGraw Hill, New Delhi, 2011.
2	A.J. Dekker, Solid state Physics, Macmillan India Ltd, New Delhi, 2012.
3	S.O. Pillai, Solid state Physics,New Age International(p)Ltd, 2007 Revised Edition
4	C. Kittle, Introduction to Solid State Physics 8th Edition, Wiley publishers, 2005.
5	Funakuho, Shape Memory Alloys, Gordon and Breach, New York, 1984.

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Course Code	Course Name		Hours / Week			Credit	Maximum Marks			
			L	T	P	C	CA	ES	Total	
10 PNT 105	INTRODUCTION TO BIOMATERIALS		3	0	0	3	50	50	100	
Objective(s)	Understand the basic properties of biomaterials and the classes of biomaterials implant, knowledge about DNA nanotechnology and nanosensors and understand basic Characterisation techniques related to DNA Nanotechnology. Understand the applications of biomaterials for implant applications.									
1	INTRODUCTION					Total Hrs	9			
Biomaterials and biological materials - examples and use - First generation biomaterials-General characteristics- naturally occurring biomaterials- pure metals-alloys ceramics-polymer-composites.										
2	SECOND GENERATION BIOMATERIALS					Total Hrs	9			
Second generation bio materials and their properties - Bioactive and biodegradable ceramics-biodegradable polymers-hydro gels.										
3	THIRD GENERATION BIOMATERIALS					Total Hrs	9			
Third generation biomaterials - Characteristics-biomaterials in tissue engineering - enzyme conjugate - DNA conjugates-micro array technologies- Micro-nanotechnology – micro fabrication - nanofabrication between biological materials - molecular machines.										
4	TISSUE ENGINEERING					Total Hrs	9			
Nanotechnology and Tissue Engineering and Regeneration– importance of Scaffolds in tissue engineering – structure and function of natural extracellular matrix – Application of nanotechnology in developing scaffolds for tissue engineering – Top-down and bottom-up approaches in developing scaffolds for tissue engineering – Electrospinning – Self-assembly - Future trends.										
5	DNA TECHNOLOGY					Total Hrs	9			
Introduction-DNA nanotechnology-structural DNA assembly – DNA nano pore - arrays- DNA detection, sorting, sequencing- DNA studies by AFM - DNA computer - PCR amplification of DNA fragments-Molecular surgery of DNA - nanoscale organization-characterization-quantum size effects – nano-biosensors.										
Total hours to be taught							45			
Reference(s) :										
1	Raplph et al, “Nanoscale Technology in Biological Systems”, CRC Press, 2005.									
2	C.M. Niemyer & C.A. Mirkin, “Nanobiotechnology: Concepts, Applications and Perspectives”, Wiley VCH Verlag GMBH & Co, 2004.									
3	Joon B. Park, R.S. Lakes, “Bio Materials: An Introduction”, Birkhäuser 2nd Edition 2006									
4	Challa Kumar (Ed.) “Tissue, cell and Organ Engineering”, Nanotechnologies for life sciences,WileyVCH 2009									

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		L	T	P	C	CA	ES	Total	
10 PNT 106	COMPUTER PROGRAMME IN C AND C++	3	0	0	3	50	50	100	
Objective(s)	Impart the basic programming in C & C++.								

1	BASIC CONCEPTS IN C	Total Hrs	9
Identifiers and Keywords - Constant Variables and Data Types- Operators and Expressions- Data Input and Output – Control Structures – if and Switch statements while, do- while and for statements – goto statement – Arrays – Character strings – Simple programs.			
2	FUNCTION & POINTERS	Total Hrs	9
User defined Functions - Defining and accessing functions – Passing arguments – Functions prototypes – Recursion – Pointer Declarations – Passing pointers to functions – Operations on pointers.			
3	STRUCTURE & ARRAYS	Total Hrs	9
User defined data types - Structures – Declaring structures and Accessing members – Array of structures – Unions – files – sequential file processing – random access file processing.			
4	BASIC CONCEPTS IN C++	Total Hrs	9
Object Oriented Programming (OOP) - Basic concepts and applications – Structure of C++ program –variable declaration – Differences between C and C++ - Functions in C++ - Function overloading/polymorphism – Classes and objects – Constructors and destructors – Operator overloading – Simple programs.			
5	TYPES OF CLASSES	Total Hrs	9
Extending classes - Inheritance and its types – Single level, multilevel, multiple and hybrid inheritance – Pointers to Objects and derived classes – Virtual functions.			
Total hours to be taught			45
Reference(s) :			
1	E. Balagurusamy, “Object – Oriented Programming with C++”, Tata McGraw – Hill		
2	Robert Lafore, “Object-Oriented Programming in Turbo C++” , Galgotia Publications,1995		
3	W. Kernighan Brain and M. Ritchie Dennis, “The C Programming Language”, 2nd Edition, Prentice Hall of India.		
4	Bjarne Stroustrup, “Programming: Principles and practice using C++, Addison-Wesley professional.		

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Semester I										
Course Code	Course Name		Hours / Week			Credit	Maximum Marks			
			L	T	P	C	CA	ES	Total	
10 PNT 107	SYNTHESIS OF NANOMATERIALS LABORATORY		0	0	3	2	50	50	100	
Objective(s)	Understand the different methods to prepare the nanoparticles and technical skill on the process method.									

1. Preparation of nanoparticles - chemical reduction
2. Preparation of nanoparticles - sol-gel
3. Preparation of nanoparticles - sonochemical
4. Preparation of nanoparticles - ball milling
5. Preparation of nanoparticles - spray pyrolysis
6. Preparation of nanocomposite materials
7. Nanocrystalline thin film by spin coating
8. Chemical bath deposition by dip coating

Total Hrs	45

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Course Code	Course Name		Hours / Week			Credit	Maximum Marks			
			L	T	P	C	CA	ES	Total	
10 PNT 201	ADVANCED CHARACTERISATION TECHNIQUES		3	1	0	4	50	50	100	
Objective(s)	Understand the relative methods of various characterisation techniques and the basic knowledge about the different characterisation techniques. Impart the knowledge about the characterisation techniques and study each and every technique and acquire the knowledge to use the technique.									

1	MICROSCOPY	Total Hrs	9
Optical absorption and emission spectroscopy – Basics - AAS – ICP OES – Electron Microscopy: Scanning electron microscopy – Transmission electron microscopy – Scanning tunneling electron microscopy – Image collection in electron microscopes – Environmental transmission electron microscopy – Electron energy loss spectroscopy at the nanometer scale – In-situ nano measurements.- Qualitative approach.			
2	SCANNING PROBE MICROSCOPY	Total Hrs	9
Scanning Probe microscopy – Atomic manipulations – Atomic force microscopy – Scanning probe lithography – Optical microscopy – Confocal microscopy – Scanning near field optical microscopy – Secondary ion mass (SIMS) spectrometry – Matrix assisted laser desorption ionization mass spectrometry (MALDIMS).			
3	SPECTROSCOPY	Total Hrs	9
Spectroscopy of semiconductors – Excitons – Infrared surface spectroscopy – Raman spectroscopy – Brillouin spectroscopy – Dynamic Light Scattering (DLS) – NMR Spectroscopy – ESR spectroscopy – Mossbauer spectroscopy – Thermo gravimetric Analysis (TGA) – Differential Scanning Calorimetry (DSC) – Thermo mechanical Analysis (TMA).			
4	MECHANICAL CHARACTERISATION	Total Hrs	9
Mechanical Characterization – Modulus and load carrying capability of nano region/ compression - micro hardness – Fatigue – Abrasion and wear resistance – Super plasticity – Nano indentation – Nano tribology – Nano tribometre – Surface Force apparatus – Quartz crystal microbalance – Friction force microscope.			
5	STRUCTURAL CHARACTERIZATION	Total Hrs	9
Neutron and X- ray diffraction – Scherer formula – Dislocation density – Micro strain macromolecular crystallography using synchrotron radiation – Role for neutron scattering in nano science - Photoluminescence - Thermo luminescence – X-ray absorption Fine Structure (XAFS) – Extended X- ray absorption fine structure (EXAFS) – Electron scattering for chemical Analysis (ESCA).			
Total hours to be taught			45
Reference(s) :			
1	T.Pradeep, “Nano: The Essentials”, Tata McGraw Hill, New Delhi, 2007.		
2	Charles P Poole Jr and Frank J Ownes, “Introduction to Nanotechnology”, John Wiley Sons, 2003.		
3	Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkar Raguse, “Nanotechnology: Basic sciences and emerging technologies”, Overseas Press, 2005.		
4	Willard, Merritt, Dean, Settle “Instrumental Methods of Analysis”, CBS PUBS & DISTS New Delhi 2007.		
5	Ewing. Etal, “Instrumental Methods for Chemical Analysis”, Tata McGraw Hill Pub, New Delhi 2010.		

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Semester II										
Course Code	Course Name	Hours / Week			Credit	Maximum Marks				
		L	T	P	C	CA	ES	Total		
10 PNT 202	NANOMATERIALS AND NANOMEDICINE	3	0	0	3	50	50	100		
Objective(s)	Understand the principle behind nanomedicine and understand the application of Nanomaterials in medicine. Impart knowledge about drug delivery systems and nanosensors. Impart the knowledge to apply the Nanomaterials in different medical applications and gain the knowledge for the solution of right nanomaterials for biomedical applications.									

1	BASIC OF NANOBIOMOLECULES	Total Hrs	9
Structure property relationship of Biological Materials: Nano Structure of proteins and Polysaccharides – Structure property relationship of tissues, bones and teeth - Collagen rich tissues - elastic tissues - Preparation of nano biomaterials – Polymeric scaffolds collagen – Elastins – Mucopolysaccharides – Proteoglycans - Cellulose and derivates – Dextrans – Alginates – Pectins - Chitin.			
2	TYPES OF NANOBIOMOLECULES	Total Hrs	9
. Introduction - Development of nano medicines – Nano Shells – Nano pores – Tectodendrimers – Nano particle drug system for oral administration – Drug system for nasal administration – Drug system for ocular administration – Nanotechnology in diagnostic application.			
3	BIOTECHNOLOGY	Total Hrs	9
Introduction – Antibody conjugated nanoparticles – Conjugated nanoparticles interaction with biological surfaces – Biomedical nanoparticles – Liposome's – Dentrimers – Different types of drug loading – Drug release – Biodegradable polymers – Applications.			
4	BIONANO PARTICLES	Total Hrs	9
Gold and Silver nanoparticles in cancer targeting and treatment – Nanoparticles in treatment of breast cancer – Chemotherapy – Active and Passive cancer tissue targeting – Micro fluidics – Chemotherapeutic agents – Immunotherapy – Vaccine immunotherapy – Radiotherapy – Thermotherapy – Photo dynamic therapy – Nano particulate targeting.			
5	NANOBIOSENSORS	Total Hrs	9
Introduction to Biosensors – Organization techniques – Ion sensing at nano particle surface – Cation sensing – Anion sensing – Surface confined chemical sensors – Nanoparticles sensors – Calorimetric sensing – Vapor phase sensing – Raman sensing at surfaces – Electro analytical sensing – Plasma and optical sensing.			
Total hours to be taught			45
Reference(s) :			
1	J. B Park, "Biomaterials Science and Engineering", Plenum Press, New York, 1984.		
2	T. Pradeep, "Nano: The essentials" , McGrew – Hill, 2007		
3	J.J. Davis, Dekker, "Encyclopedia of Nanoscience and nanotechnology"		
4	Natalie P. Praetories and Tarun K. Mandal, Recent Patents on Drug Delivery& Formulation		
5	Y. Lu, S.C. Chen, Advanced Drug Delivery Reviews.		

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Semester II

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT 203	INDUSTRIAL NANOTECHNOLOGY	3	0	0	3	50	50	100

Objective(s): Understand the applications of nanomaterials in industries and study the relative methods of various principles and their industrial applications

1	SEMICONDUCTOR NANOSTRUCTURES	Total Hrs	9

Semiconductor fabrication techniques. Electronic structure and properties of semiconductor nanostructures. Principles and performance of semiconductor nanostructures based electronic and electro-optical devices.

2	MAGNETIC NANOSTRUCTURES	Total Hrs	9

Magnetism in solids-magnetic domains. Nanomagnetic properties of materials-nanostructure relationships. Fabrication and properties of nanostructured magnets. Photoinduced magnetism and spintronics. Nanomagnetic probes. Electronic magneto transport and micro magnetic modeling.

3	NANOSENSORS AND ACTUATORS	Total Hrs	9

Micro and nano electromechanical systems-fabrication process, choice of materials, calculations, performance of different nanostructures, advantages and limitations of various approaches. Applications-thermal, radiation magnetic, chemical and mechanical nanosensors and micro actuators.

4	MOLECULAR ELECTRONICS	Total Hrs	9

Conducting and semiconducting polymers-hybridization, conjugation and excitations. Molecular crystals. Organic electroluminescent displays-injection, transport, exciton formation and light emission. Influence of supramolecular order- excimers, H and J aggregates. Liquid crystal display.

5	INDUSTRIAL APPLICATIONS	Total Hrs	9

Nanomaterials in bone substitutes & dentistry. Antimicrobial applications of nanomaterials. Food and cosmetic applications of nanomaterials. Application of nanomaterials in textiles, paints, catalysis, lubricants, fuel cells and batteries.

Total hours to be taught	45

Reference(s) :

1	J. Verdeyen, “Laser Electronics”, II Edition, Prentice Hall, 1990.
2	C.W. Turner, T. Van Duzer, “Principles of Superconductive Devices and Circuits”, 1981
3	Reynolds, M.Pomeranty, “Electro responsive molecules and polymeric systems”, Skotheim T. Marcel Dekker New York, 1991.
4	A . Yariv, “Principles of Optical Electronics”, John Wiley, New York, 1984
5	M C Petty, M R Bryce, D Bloor (eds.), ’Introduction to Molecular Electronics’, Edward Arnold, London, 1995 (ISBN 0-340-58009-7)
6	G Hadziioannou, P F van Hutten, ’Semiconducting Polymers: Chemistry, Physics, and Engineering’, Wiley-VCH, 2000 (ISBN 3-527-29507-0)
7	D. D. C Bradley, Current Opinion in Solid State & Materials Science Vol. 1, 789 (1996)

K.S. Rangasamy College of Technology - Autonomous Regulation			R 2010
Department	Nanoscience and Technology	Programme Code & Name	PNT : M.Tech - Nanoscience and Technology
Semester II			

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT 204	NANOELECTRONICS	3	1	0	4	50	50	100

Objective(s)	Understand the basic about the semiconductor & magnetic materials. Impart the knowledge about the nanostructured semiconducting materials. Understand the different applications of nano semiconductor & nano-magnetic particles in different areas.

1	BASICS OF NANOELECTRONICS	Total Hrs	9
Physical concepts – Quantization of action, charge and flux – electrons in potential well – photons interacting with electrons in solids – diffusion processes – basic information theory – data & bits – data processing - Size Effects on structure and Morphology of free or Supported Nanoparticles – Size and confinement Effects – Fraction of surface atoms – Specific surface energy and surface stress.			
2	SIZE DEPENDENT PROPERTIES	Total Hrs	9
Size dependent absorption spectra - Blue shift with smaller sizes - Phonons in nanostructures - Contacts at Nano level – AFM, lSTM tip on a surface - Electronic states in crystal energy bands - Concepts of 2D nanostructures (quantum wells) - 1 D nanostructures (quantum wires) OD nanostructures (quantum dots) - Artificial atomic clusters -			
3	QUANTUM SIZE EFFECTS	Total Hrs	9
Charging of quantum dots - Coulomb blockade - Quantum mechanical treatment of nanostructures - Widening of band gap in quantum dots - Strong and weak confinement - Properties of coupled quantum dots - Optical scattering from nano defects.			
4	NANOELECTRONIC MATERIALS	Total Hrs	9
Nanoelectronic Materials Synthesis - Molecular beam epitaxy – MOCVD - Chemical routes - Nanoparticles on polymers - Pulsed laser deposition - Ion beam assisted techniques including embedded nanoparticles-sputtering - RF sputtering.			
5	NANOCOMPOSITES	Total Hrs	9
Nanocomposites - Electronic and atomic structure of aggregates and nanoparticles - theory and modeling of nanoparticles – functionalization – Nano-electronics with superconducting devices – Microscopic characteristics and modeling – Switching devices.			
Total hours to be taught			45

Reference(s) :

1	Keith Barnham, Dimitri Vvedensky, “Low-dimensional semiconductor structures: fundamentals and device applications”, Cambridge University Book, 2001.
2	L.Banyai and S.W.Koch, “Semiconductor Quantum Dots”, World Scientific, 1994.
3	J.H. Davies, “An introduction to the physics-at low dimensional semiconductors”, Cambridge Press, 1998.
4	Karl Goser, Peter Glosekotter, Jan Dienstuhl, “Nanoelectronics and Nanosystems”, Springer, 2004.

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Semester II									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ES	Total	
10 PNT 205	NANOLITHOGRAPHY	3	0	0	3	50	50	100	
Objective(s)	Understand the basic about nanolithography and impart the knowledge for the different lithography techniques. Impart knowledge about the lithography application of different industries and study the use of AFM in nano lithography								

1	BASICS IN LITHOGRAPHY	Total Hrs	9
Lithography – Printing – Chemical process – Refinements – The modern process – Optical, micro, nanolithography – Lithography in artistic medium – Nanometer design for electronic circuits – Applications of nanolithography.			
2	OPTICAL LITHOGRAPHY	Total Hrs	9
Optical lithography – Light sources – Photo mask and alignment - Resolution in projection systems – Positive and negative photo resists – Ultraviolet lithography – X ray Lithography - Proximity printing – X ray masks – X ray sources – Synchrotron radiation – X ray projection – X ray resists.			
3	ION BEAM LITHOGRAPHY	Total Hrs	9
Ion beam lithography - Focused ion beam – Point sources of ion – Ion column – Beam writing – Masked ion beam lithography – Ion projection lithography - Electron lithography – Electron optics – Raster scan and vector scan – Electron proximity / Projection printing - Electron resists – Electron beam applications.			
4	MICRO-NANO LITHOGRAPHY	Total Hrs	9
Microlithography – Microchips - Immersion lithography – Semiconductor processing – MEMS design - Nanolithography - Nanosphere lithography – Molecular self-assembly – Nanoimprint lithography - Dip-pen nanolithography - Soft lithography - Stereo -lithography - Nanoscale 3D shapes – NEMS design.			
5	NANOLITHOGRAPHY TOOLS	Total Hrs	9
Tools for nanolithography - Molecular manipulation by STM and AFM - Nanopattern synthesis – Nano scratching – Resist and imaging layers.			
Total hours to be taught			45

Reference(s) :	
1	James R. Sheats, Bruce W. Smith, “Microlithography Sciences and Technology”, CRC Press, 1998.
2	M.Gentili, Carlo Giovannella, Stefano Selci, “Nanolithography: A Borderland between STM, EB, IB, and X-Ray Lithographies”, 1st edition, Springer, 1994.
3	P. Rai-Choudhury, “Handbook of microlithography, micromachining, and micro fabrication”, IET, 1997.
4	W.R.Fahrner, “Nanotechnology and Nanoelectronics – Materials, Devices, Measurement Techniques”, Springer, 2006.
5	David G.Bucknall, ”Nanolithography and Patterning techniques in microelectronics”, CRC Press, 2005.

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Semester II								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT 206	NANOBIOTECHNOLOGY	3	0	0	3	50	50	100
Objective(s)	Understand the basic knowledge of Nanobiotechnology and DNA structures. Understand the application of nanomaterials in biotechnology and acquire the knowledge about the DNA, proteins, amino acids, drug delivery, biomedicine etc.,							

1	INTRODUCTION	Total Hrs	9
Interdisciplinary areas of Biotech and Nanoscience - Biological systems – Cells – Cellular components - Nucleis acids and proteins refinement and application of instruments – To generate and manipulate nanostructured materials to basic and applied studies.			
2	INTERPHASE SYSTEMS	Total Hrs	9
Interphase systems of devices for medical implants – Microfluidic systems – Microelectronic silicon substrates – Nano-biometrics – Introduction – Lipids as nano-bricks and mortar: self assembled nanolayers.			
3	PROTEIN BASED NANOSTRUCTURES	Total Hrs	9
Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events – Nanobioelectronic devices and polymer nanocontainers – Microbial production of inorganic nanoparticles – Magnetosomes.			
4	DNA BASED NANOSTRUCTURES	Total Hrs	9
DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers – Use of DNA molecules in nanomechanics and Computing.			
5	APPLICATION OF NANOBIOTECHNOLOGY	Total Hrs	9
Semiconductor (metal) nanoparticles and nuclic acid and protein based recognition groups – Application in optical detection methods – Nanoparticles as carrier for genetic material – Nanotechnology in agriculture – Fertiliser and pesticides.			
Total hours to be taught			45
Reference(s) :			
1	CM, Niemeyer, C.A. Mirkin, “Nanobiotechnology: Concepts, Applications and Perspectives”, Wiley – VCH, 2004.		
2	T. Pradeep, “Nano: The Essentials”, McGraw – Hill education, 2007.		
3	Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer,”Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact”, Wiley – VCH, 2005.		
4	Nicholas A. Kotov, “Nanoparticle Assemblies and Superstructures”, CRC, 2006.		

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Semester II									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ES	Total	
10 PNT 207	CHARACTERISATION OF NANOMATERIALS LABORATORY	0	0	3	2	50	50	100	
Objective(s)	Understand the different characterisation techniques and acquire knowledge on the various characterisations of nanostructured materials.								

- Particle size determination – XRD
- Elemental analysais – XRF
- Determination of surface area – porosity - nanoparticles
- Morphological study of nano particles – SEM/ TEM*
- Surface Topographic study of Nanoparticles - AFM
- Identification of functional group of nanoparticles – FTIR
- Thermal analysis TGA/ DTA
- Contact angle measurements
- Imaging of Nano particles – AFM
- Nano Indentation

Total Hrs	45

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Department	Nanoscience and Technology		Programme Code & Name			PNT : M.Tech - Nanoscience and Technology			
Semester II									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ES	Total	
10 PNT 208	TECHNICAL REPORT PREPARATION AND PRESENTATION	0	0	2	0	100	00	100	
Objective(s)	To provide exposure to the students to refer, read and review the research articles in referred journals and conference proceedings. To improve the technical report writing and presentation skills of the students.								

Methodology

- Each student is allotted to a faculty of the department by the HOD
- By mutual discussions, the faculty guide will assign a topic in the general / subject area to the student.
- The students have to refer the Journals and conference proceedings and collect the published literature.
- The student is exposed to collect at least 20 such Research papers published in the last 5 years.
- Using OHP/Power point, the student has to make presentation for 15-20 minutes followed by 10 minutes discussion.
- The student has make two presentations, one at the middle and the other near the end of the semester.
- The student has to write a Technical report for about 30-50 pages (Title page, One page Abstract, review of research paper under various subheading, Concluding remarks and List of References). The technical report has to b submitted to the HOD one week before the final presentation, after the approval of the faculty guide.

Execution

Week	Activity
I	Allotment of Faculty Guide by the HOD
II	Finalizing the topic with the approval of Faculty Guide
III-IV	Collection of Technical papers
V – VI	Mid semester presentation
VII – VIII	Report writing
IX	Report Submission
X-XI	Final presentation

Evaluation

- 100 % Continuous Assessment
- 2 Hrs/week

Component	Weightage
Phase – I Presentation	25 %
Phase – II Presentation	25 %
Report preparation and Submission	30 %
Final presentation	20 %
Total	100%

K.S. Rangasamy College of Technology - Autonomous Regulation									R 2010
Department	Nanoscience and Technology		Programme Code & Name			PNT : M.Tech - Nanoscience and Technology			
Semester III									
Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
10 PNT 301	NANODEVICES		3	0	0	3	50	50	100
Objective(s)	To understand the development of nanoelectronics. To study the principle behind the nanodevices. To explore the application of nanodevices. To understand and study the molecular and bioelectronics on nano application.								
1	QUANTUM DEVICES					Total Hrs	9		
Quantum electronic devices – Electrons in mesocopic structures – Short-channel MOS transistor – Split gate transistor – Electron wave transistor – Electron spin transistor – Quantum cellular automata – Quantum dot array – Quantum computer- Bit and Qubit – Coherence and Entanglement – Quantum parallelism.									
2	TUNNELING DEVICES					Total Hrs	9		
Tunneling element – Tunnel effect and tunneling elements -Tunneling diode – Resonant tunneling diode – Three-terminal resonate tunneling devices -Technology of RTD - Memory applications – Basics logic circuits – Dynamic logic gates - Digital circuits design based on RTBT – Single electron transistor (SET).									
3	SUPERCONDUCTING DEVICES					Total Hrs	9		
Basics - Macroscopic characteristics – Macroscopic model - Super conducting switching devices – Cryotron - Josephson tunneling devices - Elementary circuits – Associative or Content – Addressable memory - SQUID – Flux quantum device – LC - Gate – Magnetic flux quantum – Quantum cellular automata - Quantum computer with single flux devices – SFQD - RSFQD – Application of superconducting devices.									
4	Challenges IN NANODEVICES					Total Hrs	9		
Limitations of integrated electronics - Survey of limits – Replacement of technologies – Energy supply and Heat dissipation – Parameter spread as limiting effect – Limits due to thermal particle motion - Debye length – Thermal noise - Reliability as limiting factor – Physical limits – Thermodynamic limits - Relativistic limits – Equal failure rates by tunneling and thermal noise.									
5	BIOELECTRONICS					Total Hrs	9		
Bioelectronics – Molecular processor – DNA analyser molecular electronics – Switches based on fullerenes and nanotubes – Polymer electronic – Self assembling circuits – Optical molecular memories – DNA computer – Information processing with chemical reaction – Nanomachines – Parallel processing.									
Total hours to be taught							45		
Reference(s) :									
1	K. Goser, P. Glosekotter and J. Dienstuhl, “Nanoelectronics and Nanosystems-From Transistors to Molecular Quantum Devices”, Springer, 2004.								
2	Herve Rigneault, Jean-Michel Lourtioz, Claude Delalande, Ariel Levenson, “Nanophotonics”, ISTE.								
3	W.R.Fahrner, “Nanotechnology and Nanoelectronics – Materials, Devices and Measurement Techniques” Springer, 2006.								

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Semester III

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT 302	PROJECT WORK - PHASE I	0	0	12	2	100	00	100

Objective(s): To exposure the students with Innovative Ideas. To provide exposure to the students to new areas of nanotechnology Introduction to solve a scientific problem in both practically and theoretically.

Methodology:

- Each student is allotted to a faculty of the department by the HOD
- By mutual discussions, the faculty guide will assign a topic in the general / subject area to the student.
- The students have to refer the Journals and conference proceedings and collect the published literature.
- The student is exposed to collect at least 25 such Research papers published in the last 5 years.
- Using Power point, the student has to make presentation for 15-20 minutes followed by 10 minutes discussion.
- The student has make two presentations, one at the middle and the other near the end of the semester.
- The student has to write a mini project report for about 30-50 pages (Title page, One page Abstract, review of research paper under various subheading, Concluding remarks and List of References). The project report has to be submitted to the HOD one week before the final presentation, after the approval of the faculty guide.

Execution:

Week	Activity
I	Allotment of Faculty Guide by the HOD
II	Finalizing the topic with the approval of Faculty Guide
III-IV	Collection of Scientific papers
V – VI	Mid semester presentation
VII – VIII	Report writing
IX	Report Submission
X-XI	Final presentation

Evaluation:

- 100 % Continuous Assessment
- 3 hrs/week and 2 credits

Component	Weightage
Phase – I Presentation	25 %
Phase – II Presentation	25 %
Report preparation and Submission	30 %
Final presentation	20 %
Total	100%

<table>
<tr><td colspan="5">K.S. Rangasamy College of Technology - Autonomous Regulation</td><td colspan="4">R 2010</td></tr>
<tr><td>Department</td><td>Nanoscience and Technology</td><td colspan="2">Programme Code & Name</td><td colspan="5">PNT : M.Tech - Nanoscience and Technology</td></tr>
<tr><td colspan="9">Semester IV</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>10 PNT 401</td><td>PROJECT WORK - PHASE II</td><td>0</td><td>0</td><td>40</td><td>10</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="8">To make the students with Innovative Ideas. To provide exposure to the students to new areas of nanotechnology. To solve a scientific problem in both practically and theoretically</td></tr>
<tr><td>Methodology</td><td colspan="8">
Each student is allotted to a faculty of the department by the HOD
By mutual discussions, the faculty guide will assign a topic in the general / subject area to the student.
The students have to refer the Journals and conference proceedings and collect the published literature.
The student is exposed to collect at least 50 such Research papers published in the last 5 years.
Using Power point, the student has to make presentation for 15-20 minutes followed by 10 minutes discussion.
The student has make two presentations, one at the middle and the other near the end of the semester.
The student has to write a project report for about 30-50 pages (Title page, One page Abstract, review of research paper under various subheading, Concluding remarks and List of References). The project report has to be submitted to the HOD one week before the final presentation, after the approval of the faculty guide.
</td></tr>
</table>

Execution	Week	Activity
	I	Allotment of Faculty Guide by the HOD
	II	Finalizing the topic with the approval of Faculty Guide
	III-IV	Collection of Scientific papers
	V – VI	Mid semester presentation
	VII – VIII	Report writing
	IX	Report Submission
	X-XI	Final presentation

Evaluation

- 50 % Continuous Assessment and 50 % End semester exam
- 30 hrs/week and 20 credits

Component	Weightage
Phase – I Presentation	15 %
Phase – II Presentation	15 %
Report preparation and Submission	20 %
Viva - Voce	50 %
Total	100%

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Department	Nanoscience and Technology	Programme Code & Name	PNT : M.Tech - Nanoscience and Technology	

Elective I

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT E11	MICRO ELECTRO MECHANICAL SYSTEM AND NANO ELECTRO MECHANICAL SYSTEM	3	0	0	3	50	50	100

Objective(s)	To explore the knowledge on Silicon Technology. To understand the principle, architecture, fabrication and application of MEMS. To study the properties of materials used for MEMS design. To explore the basic principle and fabrication and application of NEMS. To explore the application of NEMS & MEMS

1	SILICON TECHNOLOGY	Total Hrs	9
Development of microelectronics – nanostructure region – complexity problem – challenges in nanoelctronics - Semiconductor materials – band diagram of semiconductor – inhomogeneous semiconductor - different types of transistor integration -microminiaturization process-methods and limitation- scaling – milestone of silicon technology – microelectronic and mechanical systems (MEMS) – micromechanics technology – micromechanics for nanoelctronics – integrated optoelectronics.			
2	MICRO ELECTRO MECHANICAL SYSTEMS	Total Hrs	9
Silicon micromachining – bulk micromachining – surface micromachining - Microsystems fabrication techniques – photolithography – ion implantation – diffusion – oxidation – CVD – PVD – sputtering – single crystal reactive etching – LIGA – x-ray based fabrication – packaging of MEMS devices–microsystem packaging–packaging technology – sealing – 3D packaging – assembly of micro system - selection of packaging materials.			
3	DESIGN OF MEMS	Total Hrs	9
Design considerations – selection of materials – selection of manufacturing processes – process design – photolithography – thin film fabrication – geometry shaping – mechanical design – thermo mechanical- loading thermo mechanical stress analysis – dynamic analysis – interfacial fracture analysis – mechanical designing methods – computer aided designing.			
4	APPLICATIONS OF MEMS AND NEMS	Total Hrs	9
Micromechanical pressure sensors -Inertial sensors – accelerometer – gyroscope - piezo resistive – capacitive - micro robotics – micro channel heat sinks – optical MEMS – visual display – precision optical platform – optical data switching – RF MEMS – MEMS variable capacitors – MEMS switches – Resonators.			
5	NANO ELECTROMECHANICAL SYSTEMS	Total Hrs	9
Introduction – nano machining of NEMS - electron beam lithography – Nano electromechanical systems fabrication – nano imprint lithography – polymeric nano fiber templates – focused ion beam - wet chemical etching – stencil lithography and sacrificial etching – large scale integration – future challenges - applications.			
Total hours to be taught			45

Reference(s) :

1	K. Goser, P. Glosekotter and J. Dienstuhl, “Nanoelectronics and Nanosystems - From Transistors to Molecular Quantum Devices” Springer, 2004.
2	Tai –Ran Hsu, “MEMS & Microsystems Design and Manufacture”, Tata McGraw-Hill publication, 2001.
3	P. Rai-Choudhury, “MEMS and MOEMS technology and applications”, PHI learning private Ltd, 2009.
4	Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC Press, 2002.

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Elective I									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ES	Total	
10 PNT E12	DRUG DELIVERY	3	0	0	3	50	50	100	
Objective(s)	To provide exposure to the students on biophysics in nanotechnology. To explore the cancer therapy and drug delivery system. To study the various devices used for nanotechnology								
1	IMAGING TECHNIQUES				Total Hrs	9			
Medical diagnostics – Imaging – MRI – Principle, Instrumentation, Operation and Imaging - NMR – Principle, Instrumentation, Operation and imaging - Nanotechnology based diagnostics including imaging - Applications.									
2	NANO BIOACTIVE GLASSES				Total Hrs	9			
Introduction - Nano Bioactive glasses – Preparation – Methods - Nanobioactive glass powders – Properties – Mechanical-measurement of bioactivity – *In vitro* studies - coating on metallic implant – Characterisation - Implant applications.									
3	CANCER TREATMENT				Total Hrs	9			
Gold and Silver nanoparticles in cancer targeting and treatment - Nanoparticles in treatment of breast cancer – Chemotherapy: Active and Passive cancer tissue targeting – micro fluidics – Chemotherapeutic agents – Immunotherapy – Vaccine immunotherapy – Radiotherapy – Thermotherapy – Photo dynamic therapy – Nano particulate targeting.									
4	DELIVERY MECHANISM				Total Hrs	9			
Introduction, Antibody conjugated nanoparticles – Conjugated nanoparticles interaction with biological surfaces – Biomedical nanoparticles – Liposomes - Dentrimers - Different types of drug loading, drug release and Biodegradable polymers – Applications.									
5	TARGETTED DRUG DELIVERY				Total Hrs	9			
Basic and special pharmacology – strategies for targeted delivery – in nature – Bacteria – virus – prion - strategies for targeted delivery – by human – oral delivery – transdermal – transmucosal – invasive – Targetted delivery to brain – macrophage targeting -									
Total hours to be taught						45			
Reference(s) :									
1	Challa Kumar, Nanomaterials for medical diagnosis and therapy , Wiley VCH 2005								
2	James A. Schwarz, Cristian I. Contescu, Karol Putyera, “Dekker encyclopedia of nanoscience and nanotechnology” CRC Press, 2004.								
3	Natalie P. Praetorius and Tarun K. Mandal, *Recent Patents on Drug Delivery & Formulation*								
4	Maksym V Yezhelyev, Xiaohu Gao, Yun Xing, Ahmad Al-Hajj, Shuming Nie, Ruth M O’Regan, *Lancet Oncol*								
5	Y. Lu, S.C. Chen, “Micro and nano-fabrication of biodegradable polymers for drug delivery” Advanced Drug Delivery Reviews, 56 (1621-1633) 2004.								
6	Wei Xia and Jiang Chang, Preparation and characterization of nano-bioactive-glasses (NBG) by a quick alkali-mediated sol–gel method, Materials letters, 61 (3251-3253) 2007.								

<table>
<tr><td colspan="7">K.S. Rangasamy College of Technology - Autonomous Regulation</td><td colspan="2">R 2010</td></tr>
<tr><td>Department</td><td>Nanoscience and Technology</td><td colspan="3">Programme Code & Name</td><td colspan="4">PNT : M.Tech - Nanoscience and Technology</td></tr>
<tr><td colspan="9">Elective</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>10 PNT E13</td><td>FUNDAMENTALS OF BATTERIES</td><td>3</td><td>0</td><td>0</td><td>3</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="8">With the present development of battery technology, it is necessary to develop efficient energy storage system for the future trends. This course gives fundamental concepts for solving different kinds of problems that occur in energy storage system technology. At the end of the course the students would be acquainted with the basic concepts in all kind of batteries and their uses.</td></tr>
</table>

1	PRINCIPLES OF OPERATION	Total Hrs	9

Basic concepts-Components & Classification of Cells and Batteries-Operation of a Cell- Theoretical Cell Voltage, Capacity, and Energy-Specific Energy and Energy Density of Practical Batteries-Factors affecting Battery Performance-Battery standardization-Battery design-General Characteristics-Selection and Application of Batteries.

2	PRIMARY BATTERIES	Total Hrs	9

Primary batteries-Introduction-Classification of primary batteries-Cell components-Cell design-Performance characteristics of primary batteries-Zinc/carbon batteries-Magnesium and aluminium batteries -Zinc alkaline batteries-Zinc air batteries-Button configuration-Mercuric oxide batteries-silver oxide batteries-lithium primary batteries-Solid electrolyte batteries.

3	RESERVE BATTERIES & SODIUM BETA BATTERIES	Total Hrs	9

Reserve batteries-Introduction-Classification of reserve batteries-characteristics of reserve batteries-Magnesium water activated batteries-Zinc/silver oxide reserve batteries-Spin dependent reserve batteries-Ambient temperature lithium anode reserve batteries-Thermal batteries-Sodium-beta batteries-Battery design and application.

4	SECONDARY BATTERIES	Total Hrs	9

Secondary batteries-Introduction-General characterisation and application of secondary batteries-Types and characteristics of secondary batteries-Lead acid batteries-Valve regulated lead-acid batteries-Iron electrode batteries-Nickel cadmium batteries and its types-Nickel/zinc batteries-Zinc/carbon rechargeable batteries-Nickel metal hydride batteries-Lithium-Ion batteries-

5	METAL-AIR BATTERIES & PORTABLE FUEL CELLS	Total Hrs	9

General characteristics-Chemistry-Zinc-Aluminium-Magnesium-Lithium-air batteries-Fuel cells-Introduction-General characteristics and Operation of the fuel cell-Innovative designs for low wattage fuel cells. Applicable fuel cell technologies-System requirements-Fuel processing & storage technologies-Hardware & performance

Total hours to be taught	45

Reference(s) :

1	Thomas Reddy, “Linden’s Handbook of Batteries”, McGraw Hill Professional, USA, 2010.
2	Ogumi Z, “Battery/Energy technology (General)”, The Electrochemical Society, USA 2010
3	Dudney N, “Metal/Air and Metal/Water Batteries”, The Electrochemical Society, USA 2010
4	Ronald M. Dell David A. J. Rand, “Understanding Batteries”, RSC, UK, 2001.

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Elective								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT E14	NANOTECHNOLOGY IN POLYMERS	3	0	0	3	50	50	100

Objective(s)	With the present development of nanotechnology in organic material, it is necessary to develop effective performance for the future trends. This course gives fundamental concepts and application for solving different kinds of problems that polymers involving technologically. At the end of the course the students would be acquainted with the basic concepts in several kinds of polymers in nanotechnology and their uses.

1	INTRODUCTION TO POLYMERIC MATERIAL	Total Hrs	9
Introduction – polymers in top – down and bottom – up nanotechnology, origin, classification and formation of polymers, micro structures in polymers – polymer length, molecular weight, amorphous and crystalline, challenges of polymers in nanotechnology – polymers in top – down and bottom – up nanotechnology.			
2	CONDUCTING POLYMERS	Total Hrs	9
General description – band theory metals, insulators, semiconductors, poly(acetylene)s – synthesis , structure and morphology- theory of conductivity, Conduction mechanism, uses – poly(pyrrole)s- poly(aniline)s, poly(phenylene)s - polymers with metals in the side group structure.			
3	POLYMER FUNCTIONALITY	Total Hrs	9
Nanostructuring polymers - polymer nanofibers - multifunctional polymer nanocomposite from polymerization - nanofilled polymeric fibers, polymers/clay nanocomposites.			
4	TEXTILE APPLICATIONS	Total Hrs	9
Introduction – electrospinning- production of non woven mat from electrospinning - controlling the parameter and morphology of nanofibers - electro static self assembled nanolayer films for cotton fibers – synthetic nanocomposite fibers – Nanofibers in mask and tissue engineering Applications.			
5	ORGANIC ELECTRONIC APPLICATIONS	Total Hrs	9
Printing and patterning techniques - Nanoscale behavior in organic transistors - transition of sensing response by organic transistor from micro to nanoscale - organic field effect transistor sensor - flexible organic light emitting diode.			
Total hours to be taught			45

Reference(s) :	
1	Harry R allcock, Frederick W lampe and James E Mark,” Contemporary polymer chemistry”, person education, 2003
2	K cousins, keith cousins,” polymers in electronics” smithers Rapra technology publishers, 2006
3	P J Brown and K Stevens,” nanofibers and nanotechnology in textiles” CRC press, 2007
4	Frances Gardiner, Eleanor carter,: polymer electronics – a flexible technology”, ismithers, 2009

K.S. Rangasamy College of Technology - Autonomous Regulation								R 2010
Department	Nanoscience and Technology	Programme Code & Name			PNT : M.Tech - Nanoscience and Technology			
Elective								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT E15	SOLID STATE OF NANOTECHNOLOGY	3	0	0	3	50	50	100

1	PHYSICAL PROPERTIES	Total Hrs	9
Melting point and phase transition processes, Physics of Amorphous Material: preparation of amorphous materials, Size-induced metal-insulator-transition (SIMIT)- nano-scale magnets-order and magnetic structure, chemical physics of atomic and molecular clusters.			
2	PHYSICAL CHEMISTRY OF SOLID SURFACES	Total Hrs	9
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.			
3	CHEMISTRY ASPECTS	Total Hrs	9
Photochemistry- Photoconductivity-Electrochemistry of Nanomaterials Nanoscale Heat Transfer-Transport in Semiconductor Nanostructures- Transition Metal Atoms on Nanocarbon Surfaces- Nanodeposition of Soft Materials-Nanocatalysis.			
4	NANOSTRUCTURES	Total Hrs	9
Electronic Structure of Nanoparticles, Zero dimensional, one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors, nanowires, Size dependent properties-phonons in nanostructures.			
5	PROCESSING OF METALS AND CERAMIC POWDERS	Total Hrs	9
Selection and characterization of powders, compacting and sintering; mechanical working. Production of Porous and Dense Composites : Metal- polymer- and ceramic- based composites.			
Total hours to be taught			45

Reference(s) :

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	K. A. Padmanabhan, “Mechanical Properties of Nanostructured Materials”, Materials Science and Engineering, A 304-306 (2001) 200-205.

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Elective									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ES	Total	
10 PNT E16	NANOTECHNOLOGY IN SEMICONDUCTOR DEVICES	3	0	0	3	50	50	100	

1	SEMICONDUCTOR FUNDAMENTALS	Total Hrs	9
Introduction to Semiconductor physics – Semiconductor nanostructures – Electronic structure and physical process – Principles of semiconductor nanostructures based electronic and electro-optical devices			
2	QUANTUM CONFINED MATERIALS	Total Hrs	9
Quantum dots – optical transitions – absorption-inter-band transitions-quantum confinement intraband transitions-fluorescence/ luminescence–photoluminescence /fluorescence optically excited emission – electroluminescence emission.			
3	SEMICONDUCTOR NANOPARTICLES – APPLICATIONS	Total Hrs	9
Optical luminescence and fluorescence from direct band gap semiconductor nanoparticles, surface-trap passivation in core-shell nanoparticles, carrier injection, polymer-nanoparticle, LED and solar cells, electroluminescence, barriers to nanoparticle lasers, doping nanoparticles, Mn-Zn-Se phosphors, light emission from indirect semiconductors, light emission form Si nanodots.			
4	SEMICONDUCTOR NANOWIRES	Total Hrs	9
Fabrication strategies, quantum conductance effects in semiconductor nanowires, porous Silicon, nanobelts, nanoribbons, nanosprings.			
5	SEMICONDUCTOR NANODEVICES	Total Hrs	9
Single-Electron Devices; Nano scale MOSFET – Resonant Tunneling Transistor - Single-Electron Transistors; Single-Electron Dynamics; Nanorobotics and Nanomanipulation; Mechanical Molecular Nanodevices; Nanocomputers: Theoretical Models; Optical Fibers for Nanodevices; Photochemical Molecular Devices; DNA-Based Nanodevices; Gas-Based Nanodevices; Micro and Nanomechanics			
Total hours to be taught			45

Reference(s) :

1	Hari Singh Nalwa, “Encyclopedia of Nanotechnology”, USA 2011
2	Bharat Bhusan, “Springer Handbook of Nanotechnology”, springer, Newyork, 2007
3	Herve Rigneault, Jean-Michel Lourtioz, Claude Delalande, Ariel Levenson, “Nanophotonics”, john wiley & sons, 2010
4	K. Goser, P. Glosekotter and J. Dienstuhl, “Nanoelectronics and Nanosystems-From Transistors to Molecular Quantum Devices”, Springer, 2004.

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Elective II

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
10 PNT E21	NANOSAFETY AND ENVIRONMENTAL ISSUES	3	0	0	3	50	50	100

Objective(s)	To provide exposure to the students on safety and environmental issues of nano science and technology. To explore the toxic effects of nanotechnology on human health and life, analyze the various issues on environmental effects and explore suitable remedial measures.

1	INTRODUCTION	Total Hrs	9
Identification of Nano - Specific Risks- Responding to the Challenge -Human health hazard – Risk reduction – Standards – Safety – transportation of NP– Emergency responders. Risk assessment –Environmental Impact – Predicting hazard – Materials Characterization. Risk Assessment related to nanotechnology – Environmental and policy making- Ecotoxicity measurement of Polychlirinated biphenyl and intermediates in their degradation			
2	NANOTOXICOLOGY	Total Hrs	9
Inhalation of nanomaterials – Overview. Introduction- Inhalation deposition and Pulmonary clearance of Insoluble Solids – Bio –persistence of Inhaled solid material. Systemic Trenslocation of inhaled Particles. Pulmonary effects of SWCNT- Pulmonary Inflammatory Responses to SWCNTs *In Vivo* - Interactions of pulmonary Inflammation with oxidative stress – Interactions of SWCNTs with Macrophages			
3	EXPERIMENTAL ISSUES	Total Hrs	9
Nanoparticle exposure and systematic cardiovascular effects – experimental data – respiratory particulate matter exposure and cardiovascular toxicity, Nanoparticles – Hypothesis and research approaches. SWCNT – Experimental data. Toxicity of polymeric nanoparticles with respect to their application as drug carriers. Particle exposure through the indoor air environment –Measurement of indoor of PM and experimental study.			
4	ETHICS	Total Hrs	9
Needs for regulations, training and education for health protection and environmental security of nanotechnologies – definitions and essence – general benefits – benefits for health and medical practice – potential risks – The approaches to assessment of exposure to the nanotechnology. Bioethics and legal aspects of potential health and environmental risks in nanotechnology – Legal regulatory considerations of nanotechnology.			
5	CHALLENGES AND FUTURES	Total Hrs	9
Nanotechnology – the frame of worker training, public education, and participation – Introduction – Nanotoxicity – Workers protection – International documents – protection of medical staff – Nurses education – Public information. Occupational risk assessment and management – focus on Nanomaterials.			
Total hours to be taught			45

Reference(s) :

1	P.P. Simeonova, N. Opopol and M.I. Luster, “Nanotechnology - Toxicological Issues and Environmental Safety”, Springer 2006.
2	Vinod Labhasetwar and Diandra L. Leslie, “Biomedical Applications of nanotechnology”, A John Willy & son Inc,NJ, USA, 2007 .
3	Miyawaki, J.; *et.al* Toxicity of Single-Walled Carbon Nanohorns. *ACS Nano 2* (213–226) 2008.
4	Hutchison, J. E. Green Nanoscience: A Proactive Approach to Advancing Applications and Reducing Implications of Nanotechnology. *ACS Nano 2*, (395–402) 2008.
5	Mo-Tao Zhu *et.al* Comparative study of pulmonary responses to nano- and submicron-sized ferric oxide in rats Toxicology, 21 (102-111) 2008.
6	Dracy J. Gentleman, Nano and Environment: Boon or Bane? Environmental Science and technology, *43* (5), P1239, 2009.

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Elective II									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ES	Total	
10 PNT E22	INTELLECTUAL PROPERTY RIGHTS	3	0	0	3	50	50	100	
Objective(s)	To provide awareness about IP Rights. To provide exposure to protect the Intellectual property.								
1	INTRODUCTION			Total Hrs		9			
Introduction - Invention and Creativity - Intellectual Property (IP) - Importance - Protection of IPR - Basic types of property (i. Movable Property ii. Immovable Property and iii. Intellectual Property).									
2	PATENTS REGISTRATION			Total Hrs		9			
IP - Patents - Copyrights and related rights - Trade Marks and rights arising from Trademark registration - Definitions - Industrial Designs and Integrated circuits - Protection of Geographical Indications at national and International levels - Application Procedures.									
3	INTELLECTUAL PROPERTY			Total Hrs		9			
International convention relating to Intellectual Property - Establishment of WIPO - Mission and Activities - History - General Agreement on Trade and Tariff (GATT).									
4	STRATEGIES			Total Hrs		9			
Indian Position Vs WTO and Strategies - Indian IPR legislations - commitments to WTO-Patent Ordinance and the Bill - Draft of a national Intellectual Property Policy - Present against unfair competition.									
5	CASE STUDIES			Total Hrs		9			
Case Studies on - Patents (Basumati rice, turmeric and Neem) - Copyright and related rights - Trade Marks - Industrial design and Integrated circuits - Geographic indications - Protection against unfair competition.									
Total hours to be taught						45			
Reference(s) :									
1	N.R. Subbaram," Handbook of Indian Patent Law and Practice ", S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.								
2	Eli Whitney, United States Patent Number: 72X, Cotton Gin, March 14, 1794.								
3	Intellectual Property Today: Volume 8, No. 5, May 2001, [www.iptoday.com].								

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Elective II									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ES	Total	
10 PNT E23	RESEARCH METHODOLOGY - ENGINEERING AND MANAGEMENT STUDIES	3	0	0	3	50	50	100	

1	RESEARCH METHODOLOGY	Total Hrs.	9
Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process- steps. Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.			
2	SCALES AND MEASUREMENTS	Total Hrs.	9
Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non-probability sampling method – convenience sampling, judgment sampling, quota sampling.			
3	HYPOTHESES TESTING	Total Hrs.	9
Hypotheses testing – Testing of hypotheses concerning means (one mean and difference between two means - one tailed and two tailed tests), Concerning variance – one tailed Chi-square test.			
4	SAMPLE TESTS	Total Hrs.	9
Nonparametric tests- One sample tests – one sample sign test, Kolmogorov-Smirnov test, run test for randomness, Two sample tests – Two sample sign test, Mann-Whitney U test, K-sample test – Kruskal Wallis test (H-Test)			
5	ANALYSIS AND REPORT	Total Hrs.	9
Introduction to Discriminant analysis, Factor analysis, cluster analysis, multidimensional scaling, conjoint analysis. Report writing- Types of report, guidelines to review report, typing instructions, oral presentation			
Total hours to be taught			45
Reference(s):			
1.	Kothari, C.R., Research Methodology –Methods and techniques, New Age Publications, New Delhi, 2009.		
2.	Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.		

<table>
<tr><td colspan="5">K.S.Rangasamy College of Technology - Autonomous Regulation</td><td colspan="4">R 2010</td></tr>
<tr><td>Department</td><td>Nanoscience and Technology</td><td colspan="2">Programme Code & Name</td><td colspan="5">PNT : M.Tech - Nanoscience and Technology</td></tr>
<tr><td colspan="9">Elective II</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>10 PNT E24</td><td>RESEARCH METHODOLOGY - SCIENCE AND HUMANITIES</td><td>3</td><td>0</td><td>0</td><td>3</td><td>50</td><td>50</td><td>100</td></tr>
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1.	RESEARCH METHODOLOGY	Total Hrs	9
Research Methods Versus Methodology-Objectives of Research-Types of Research-Research Approaches-Criteria of Good Research- Hypothesisation-Selection of Topic			
2.	DATA COLLECTION & COMPILING	Total Hrs	9
Collection of Primary Data-Collection of Secondary Data-Interview method-Compiling a Working Bibliography-Evaluating Sources			
3.	MECHANICS OF WRITING	Total Hrs	9
Spelling-Punctuation-Abbreviations-Margins and Spacing – Heading and Title-Page Numbers-Corrections and Insertions			
4.	DOCUMENTATION	Total Hrs	9
Preparing the list of works cited - Citing Sources in the text- Endnotes and footnotes-Parenthetical References.			
5.	PLAGIARISM	Total Hrs	9
Definition – Forms of Plagiarism – Consequences of Plagiarism- Unintentional Plagiarism-Copyright Infringement-Collaborative work			
Total hours to be taught			45
Reference(s):			
1.	Joseph Gibaldi, “MLA Handbook for Writers of Research Papers’, Modern Language Association of America, 2009		
2.	Wayne Goddard and Stuart Melville, “Research Methodology – An Introduction’, Juta and Company Ltd, 2004		
3.	Ranjit Kumar, “Research Methodology”, Sage Publications, 1999.		