Scheme of Examination and Syllabi for

M. Tech (Material Science and Technology)

1st to 4th Semesters for Academic Year 2019-2020

Year: First **Semester: First**

S. No.	Course Code	Course Name	Scheme of Teaching			Scheme of Examination			
			L-T-P	Contact hrs/week	Credits	Theory			Practical*
						Internal Assessment	University Assessment	Total	
1.	MST-101	Materials and their properties	4-0-3	7	4+1	50	50	100	50
2.	MST-102	Material Characterization	4-0-3	4	4	50	50	100	
3.	MST-103	Physics of Nano-materials	4-0-0	7	4+1	50	50	100	50
4.	MST-104	Thermodynamics	4-0-0	4	4	50	50	100	
5.	MST-105	Research Methodology	3-0-0	3	3	50	50	100	
Total			**19-0-6**	**25**	**21**	**250**	**250**	**500**	**100**

Year: First **Semester: Second**

S.No.	Course Code	Course Name	Scheme of teaching			Scheme of Examination			
			L-T-P	Contact hrs/week	Credits	Theory			Practical*
						Internal Assessment	University Assessment	Total	
1.	MST-201	Advanced Material Characterization	4-0-3	7	4+1	50	50	100	100
2.	MST-202	Ceramics and Biomaterials	4-0-0	4	4	50	50	100	-
3	MST-203	Solid State Phase Transformations	4-0-0	4	4	50	50	100	-
4.	MST-204	Semiconductors and Optoelectronics	4-0-0	4	4	50	50	100	-
5.	MST-205	Polymers	4-0-0	4	4	50	50	100	-
Total			**20-0-3**	**23**	**21**	**250**	**250**	**500**	**100**

Year: Second **Semester: Third**

S. No.	Course Code	Course Name	Scheme of Teaching			Scheme of Examination			
			L-T-P	Contact hrs/week	Credits	Theory			Practical*
						Internal Assessment	University Assessment	Total	
1.	MST-301	Magnetism and Superconductivity	4-0-0	4	4	50	50	100	-
2.	MST-302	Nanomaterials	4-0-0	4	4	50	50	100	-
3.	MST-303	Preliminary Thesis Work	5-0-0	20	10	100	--	100	-
Total			**13-0-0**	**28**	**18**	**200**	**100**	**300**	**-**

Year: First **Semester: Fourth**

S.No.	Course Code	Course Name	Scheme of teaching			Scheme of Examination			
			L-T-P	Contact hrs/week	Credits	Theory			Practical*
						Internal Assessment	University Assessment	Total	
1.	MST-401	Thesis	-	30	15	-	100	100	
Total			**-**	**30**	**15**	**-**	**100**	**100**	

Sr. No.	Grade	Requirement
1.	**A+**	**Publication in SCI/SCIE Indexed Journal**
2.	**A**	**Scopus/ESCI Indexed Journal**
3.	**B+**	**Paper presented in International/National conference**

***** Practical marks are for continuous and end semester evaluation

FIRST SEMESTER

Course Code	**MST-101**
Course Title	**Materials and their Properties**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz) Practical (Continuous and end semester evaluation)	 50 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner: *Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION-A

Crystal Structure: Bonding forces and energies, Primary and Secondary bonds. Space Lattices, Symmetries in a cubic lattice, close packed morphology (Hexagonal and cubic close packing), interstitial spaces (trigonal, tetrahedral and octahedral voids in closest and other close packings) Assignment of coordinates, directions and planes in crystals, Linear, Planar and Space densities in crystals, Single and polycrystalline structures, structure of ceramics (NaCl, Zinc blende, silica and silicates, diamond crystal, Graphite, Fullerenes and carbon nanotubes) Structure of polymers, crystallinity of long chain polymers Crystal Defects (Point, line, surface and volume imperfections).

Diffusion: Diffusion mechanisms, steady state diffusion, non-steady state diffusion, factors affecting diffusion, applications based on diffusion (corrosion resistance of Duralumin, carburization of steel, decarburization of steel, doping of semiconductors)

Elastic, Anelastic and Viscoelastic Behaviour: Elastic behaviour and its atomic model, rubber like elasticity, anelastic behaviour, relaxation processes, viscoelastic behaviour, spring-dashpot model.

SECTION-B

Plastic Deformations and Strengthening Mechanisms: Tensile properties (Yield strength, Tensile Strength, Ductility, Resilience, Toughness), dislocations and plastic deformation, characteristics of dislocations, slip systems, slip in single crystals, plastic deformation of polycrystalline materials, mechanisms of strengthening in metals (grain size reduction, solid-solution strengthening, strain hardening), recovery, recrystallization and grain growth.

Fracture, Fatigue and Creep: Fracture (Ductile and brittle fractures), principles of fracture mechanics, fracture toughness, ductile to brittle transitions cyclic stresses, S-N curve, crack initiation and propagation, factors that affect fatigue life, environmental effects, generalized creep behavior, stress and temperature effects.

Thermal Properties: Lattice vibrations, vibrations of simple lattice, optical and acoustic phonons, heat capacity, thermal expansion, thermal conductivity, thermal stresses in materials.

Optical Properties: Interaction of radiation with matter (metals and non-metals), Refraction, reflection, absorption, transmission, color, opacity and translucency in insulators, phosphorescence, luminescence, photoconductivity.

RECOMMENDED BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1.	Elements of material Science & Engg.	Lawrence H.Van Vlack	Addison Wesley
2.	Material science and Engineering – A First Course	V.Raghvan	Fourth Edition, Eastern Economy Edition
3.	Materials and Engineering- An Introduction	W.D. Callister	Wiley and Sons
4.	Principles of Material Science and Engineering	W. Smith	McGraw Hill
5.	Introduction to Solid State Physics	C. Kittel	

List of Experiments

Course Duration: There will one laboratory session of 3 hours per week.

1. To measure the resistivity of a semiconductor using four probe method.
2. To measure the magneto-resistance of a semiconductor specimen.
3. To measure the g-factor of electron using ESR spectrometer.

4. To study the dependence of the Hall Coefficient on temperature.
5. To determine dielectric constant of a material as a function of temperature and measure the Curie temperature of material.
6. To measure the susceptibility of paramagnetic solids by Gouy's method.
7. To determine the thermionic work-function of tungsten using a directly heated diode.

Course Code	**MST-102**
Course Title	**Material Characterization**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION-A

Vacuum Technology and Materials Deposition: Basics of vacuum technology, Rotary Pump, Diffusion pump, Turbo Molecular Pump, Cryopumps and ionization pumps Gauges for measuring high vacuum (pirani, penning and ionization gauge).
Physical vapor deposition, sputtering, chemical vapour deposition, molecular beam epitaxy

Crystallography: X-Ray, Bragg's Law, Structure Factor, Powder diffraction, Reitveld Refinement**,** Examples of X-Ray diffraction in applications, Determination of particle size, influence of particle size on XRD peaks.

Thermal Analytical Techniques: Principles of differential thermal analysis, differential scanning calorimetry and thermo-gravimetric analysis (Instrumentation, determination of transition temperature, heats of transition of plastics, metals and alloys and other materials).

SECTION-B

Optical and X-Ray Spectroscopy: Overview of electron and photon sources, Electron and Photon interactions with matter.
Optical Spectroscopy: Fourier Transform Infra-Red and Raman spectroscopy and Luminescence spectroscopy.

Principles, methods and applications of particle analysis: Basic measurements (grain size, particle morphology, particle size, and size distribution) and applications.

X-ray Fluorescence: X-ray absorption in materials, Basic principles, Instrumentation, elemental identification and quantification.

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Thermal Analysis	W. W. Wendlandt	John Wiley and sons (1986)
2.	Practical non destructive testing	B. Raj, T. Jayakumar, M. Thavasimuthu,	Narosa Publishers 2002
3.	Characterisation of Materials	John B. Wachtman, Z. H. Kalman	Butterworth-Heinmann, Boston 2993
4.	Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Film	C. R. Brundle, Charles A. Evans, Shaun Wilson	Gulf Professional Publishing, 1992
5.	Concise Encyclopedia of Materials Characterization	W. Cahn, E.M. Lifshitz	Elsevier 2013
6.	A guide to material characterization and chemical analysis	John P. Sibilia	Publishers Inc. NY, 1988
7.	Analytical Techniques for Thin Films	Treatise on Materials Science and Technology	Academic Press, Inc. New York

Course Code	**MST-103**
Course Title	**Physics of Nanomaterials**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz) Practical (Continuous and end semester evaluation)	 50 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION-A

Quantum Physics of Nano-Scale Materials

Foundations of Quantum Physics: Transition from classical to quantum realm (Black Body Radiation, Compton Scattering, Photoelectric Effect), idea of wave matter duality and Davison-Germer experiment, uncertainty principle and correspondence principle, Ehernferst theorem.

Schrodinger's Equation: Time dependent and steady state form, wave function-interpretation and its properties, operators formalism, commutator relations.

Application of Schrodinger's Equation: Infinitely deep one-, two- and three- dimensional potential well (idea of nano-wires, nano-sheets and nano-dots), excitons and quantum confinement, finite potential barrier and well, harmonic oscillator, tunneling effect.

Statistical Physics: Maxwell-Boltzmann statistics, Bose-Einstein statistics and Fermi-Dirac Statistics, Fermi energy, specific heat of crystalline solids, photon gas.

SECTION-B

Theory of Solids: free electron gas, density of states, Kronig Penny model, zone theory, effective

mass.Overview of Density Functional Theory (DFT).

Introduction to Nanomaterials: Features of nanosystems: characteristic length scales of materials and their properties; fundamental behaviour of 0-D(nanoclusters, Quantum dots), 1-D(nanowires), 2-D(thin film multilayers), and 3-D(bulk nanostructures) materials, Conduction electrons and dimensionality, density of states, properties dependent on density of states, top down and bottom up approaches of generation nanoparticles.

Properties of Nanomaterials: Size and shape dependent properties, color, melting point, magnetism, conductivity and band gap, Mechanical properties of nano-materials; Magnetic and electronic transport properties of nano-structured materials.

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Nano-materials	A. K. Bandopadhyay	New Age International
2.	Wires & Dots: Theoretical & Computational Physics of Semiconductors Nanostuructures,	Paul Harrison,	Wiley International
3.	Nanostructures and Nanomaterials - Synthesis, Properties and Applications	Cao Guozhong	

List of Experiments

Course Duration: There will one laboratory session of 3 hours per week.

1. To synthesize metal nanoparticles by chemical route.
2. Synthesis of nanoparticles of different sizes using sol-gel technique.
3. Preparation of nano-composites using chemical method.
4. To deposit a thin film of metal using thermal evaporation technique and measure its thickness.
5. To deposit a thin film of metal using electron beam gun and determine its thickness.
6. To synthesize semiconductor nanoparticles by chemical route.
7. To synthesize a polymer material.
8. To prepare and isolate and characterize of a biomaterial.

Course Code	**MST-104**
Course Title	**Thermodynamics**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION-A

Recapitulation of Equilibrium: Thermodynamic Systems and Variables, First, second and third laws of thermodynamics. Maxwell Relations. Statistical interpretation of entropy. Free energy functions and criteria for equilibrium.

Thermodynamics of Solutions: Partial molar quantities, Gibbs-Duhem equation, ideal and regular solutions, partial and excess properties, quasi-chemical model, polynomial expressions for excess Gibbs energy of mixing for binary and higher order solutions. multi-component dilute solutions and interaction parameters.

Chemical Equilibrium : Direction of spontaneous change in a chemical reaction, extent of reaction, stoichiometric coefficients, equilibrium constant in terms of G. Temperature and pressure dependence of equilibrium constant, homogeneous and heterogeneous equilibria.

SECTION-B

Physical Transformation of Pure Materials (Change of State): Stability of phases, Clapeyron equation, Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-

vapour equilibria, First and Second Order Phase Transitions, Attainment of low temperature and energetics of refrigeration, adiabatic demagnetization.

Phase Equilibria: Phase rule and binary phase diagrams Free energy composition diagrams. Phase equilibrium calculations. Introduction to ternary phase diagrams, chemical reactions involving gases and solids- Ellingham diagrams, eutectics, freezing mixture, zone refining.

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1.	Introduction to the Thermodynamics of Materials	David R. Gaskell	4th ed., Taylor & Francis, New York, 2002.
2.	Thermodynamics of Solids	R. A. Swalin	John Wiley and Sons, 1972
3.	Chemical Thermodynamics of Materials	C. H. P. Lupis	Elsevier Science Publishing Co., New York, 2001.
4.	Thermodynamics in Material Science	T. Dettoff	McGraw Hill, Singapore, 1993
5.	Thermodynamics and an Introduction to Thermostatics	H. B. Callen	John Wiley and sons, NY, 1985. .

Course Code	**MST-105**
Course Title	**Research Methodology**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION-A

Basics of Research Methodology: Definition of Research, Need of Research, Concept and steps of Research Methodology, Uses of Research Methodology, Research Techniques, Identifying and Defining Research Problem, Generating different types of hypotheses and evaluating them, Descriptive research design-survey, case study, content analysis, Ex-post Facto Research, Correlation and Experimental Research, Basic Sampling Techniques, aspects of data collection, techniques of data collection.

Review of Literature: Need, Sources-Primary and Secondary, Purposes of Review, Scope of Review, Journal searching keywords, Citations, impact factors, various citation and indexing sites, , PACS numbers of APS, letters/articles/reviews.

Writing research proposals/papers for journals/papers for conferences, referencing, figures, style etc, authorship, patents and plagiarism.

SECTION-B

Statistical Methods of Analysis: Descriptive statistics: Meaning, graphical representations, mean, range and standard deviation, characteristics and uses of normal curve.

Measures of Central tendency, Dispersion, Skewness, Kurtosis, Correlation and Regression analysis.

Testing of Hypotheses for mean, proportion and variance: t-test, Chi-square tests, ANOVA (one way).

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1.	*Research Methodology* Methods and Techniques	C.R. Kothari	Wiley Eastern Ltd2009.
2.	Educational Research	L. R . Gay	Ohio: Charles E. Merril Publishing Company 2000
3.	Statistics for Management	R.I. Levin and D.S. Rubin	Pearson Education.
4.	Marketing Research- An AppliedOrientation Science	N.K. Malhotra	Pearson Education

SECOND SEMESTER

Course Code	**MST-201**
Course Title	**Advanced Materials Characterization**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz) Practical (Continuous and end semester evaluation)	 50 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION-A

Ion Interactions with Matter: Overview of ion sources, Rutherford Backscattering Spectroscopy, Secondary Ion Mass Spectroscopy (SIMS).

Surface Structure and Surface Structure Analysis: Introduction to surface studies, Surface chemical composition: The extension of bulk techniques to surface studies - Unit meshes of five types of surface nets, surface reconstructions - diffraction from di-periodic structures. Surface methods using electron, low energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED), Ellipsometry.

SECTION-B

Determination of Surface Properties:

Scanning Tunneling Microscopy: Basic principle of tunneling spectroscopy, instrumentation and applications, Atomic Force Microscopy, tip-surface interaction, contact and non-contact modes, different imaging modes of AFM, Force sensor, Deflection detection, working with biological samples.

Electron Microscopy Based Methods: Scanning electron microscope: performance of SEM; Transmission electron microscopy: construction and operation of TEM, electron diffraction, image interpretation, Comparison with optical microscopy.

Qualitative Treatment: Electron spectroscopy for chemical analysis (ESCA), ultraviolet photo electron spectroscopy (UPS), X-ray Photoelectron Spectroscopy/UV Photoelectron Spectroscopy, Auger electron spectroscopy (AES), Electron energy analyzers, X-ray absorption spectroscopy.

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1.	An Introduction to Surface Analysis	John F. Watts, John Wolstenholme	XPS and AES, willey (2003)
2.	Introduction to Surface Physics	M. Prutton	Clarendon Press, 1994
3.	Solid Surfaces, Interfaces and Thin Films	Hans L	Springer Science & Business Media, 01-Jan-2001
4.	Scanning Probe Microscopy and Spectroscopy: Methods and Applications	Roland Wiesendanger	Cambridge University Press., 1994
5.	Charaterisation of Materials	John B. Wachtman, Z. H. Kalman	Butterworth-Heinmann, Boston 2993
6.	Metals and Material Science, Processes, Applications	R. E. Smallman and R. J. Bishop	Bterworth-Heinmann 1995
7.	X-ray Diffraction	B. D. Cullity	
8.	A guide to material characterization and chemical analysis	John P. Sibilia	VCH Publishers Inc. NY, 1988
9.	Treatise on Materials Science and Technology “Analytical Techniques for Thin Films"		Volume 27, Academic Press, Inc.Newyork

List of Experiments

Course Duration: Two laboratory sessions of 3 hours per week.

1. Introduction to working of rotary and diffusion vacuum pumps.
2. Determination of crystal structure and grain size by X-ray powder diffraction.
3. Distinction between SEM and TEM images by analyzing the micrographs.

4. Spectrophotometer: band gap determination.
5. FTIR spectrum and its interpretation.
6. Thermographic Analysis.

Course Code	**MST-202**
Course Title	**Ceramics and Biomaterials**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION-A

Introduction, bonding and structures of ceramics, types of ceramics

Structural Ceramics: Carbides, nitrides, oxides, borides, composites. Synthesis, bonding: structures and applications.

Electronic Ceramics: Ferro electrics, electrical insulators, smart ceramics, peizo electrics, PLZT sensors, metallized ceramics and superconducting ceramics

Magnetic Ceramics: Spinel Ferrites, Hexagonal Ferrites, Garnet processing and applications.

Special Glasses and Glass Ceramics: High-Purity silica glasses, Laser Glasses, optical; glasses, fiber glasses, oxide and non-oxide glasses, oxy-nitride glasses, photosensitive glasses, conducting glasses, glass ceramics, application of glass ceramics, glass for satellite application.

SECTION-B

Introduction to Biomaterials, Characterization of biomaterials bulk and surface characterization including degradation, mechanical, electrical, thermal and tribiological properties

Hard Biomaterials: Metals (Steel, cobalt-chromium, titanium, new titanium alloys, shape memory alloys, niobium alloys, tantalum alloys). alumina, zirconia, diamond like carbon, hydroxyapatite, bioglass, refractory nitrides (TiN), and refractory carbides (TiC).

Soft Biomaterials: Biopolymers (collagen, proteoglycans, cellulose-their structure properties and applications). Surface modification of biomaterials, Rapid prototyping of biomaterials. Biocompatibility & tissue response to implanted biomaterials. Applications of polymers in tissue engineering and drug delivery.

Bio-Ceramics: Introduction, composition, interaction with biological systems, properties, applications.

RECOMMENDED BOOKS

S.No.	NAME	AUTHORS	PUBLISHER
1.	Introduction to Ceramics	W. D. Kingery	Wiley NY
2.	Modern Ceramics Engineering properties, processing and use in design	D. W. Richerson,	Marcel Dekker, Inc. N. Y.
3.	Ceramic Materials for Advanced Heat Engines	Larsen ,D.C., C.W. Adams., L.R. Johnson, A.P.S. Teotia and L.G.Hill	1985,Noyes Pub., New Jersey, USA.
4.	Alumina Processing, Properties and Applications	Dorre, E., and H.Hibner	1984, Springer-Verlag, NY Stevens, R.,Zirconia and Zirconia Ceramics, 1986,Magnesium Elektron Ltd
5.	Advanced Ceramics 3	Somiya, S.	1990, Elseivr Applied Science, NY
6.	High-Tech. Ceramics	Gernot Kostorz	1989, Academic Press, NY
7.	Concise Encyclopedia of Advanced Ceramic Materials	Brook, R.J.(Ed)	1991,Pergamon Press, NY. Noboru Ichinose, Introduction to Fine Ceramics, 1987, John Wiley & Sons.
8.	Advanced Ceramics	P.Ramakrishnan and Mohan Primlani	1992, Oxford ISH.
9.	Biomaterials	Sujata V Bhat	2nd Edition Alpha Science International. .

10.	Biomaterials Science: An Introduction to Materials in Medicine	Buddy D Ratner et al	Academic Press 3rd Edition.
11.	Biomaterials: An Introduction, Springer Science , An introduction	Joon Park and R.S. Lakes	3rd edition.

Course Code	**MST-203**
Course Title	**Solid State Phase Transformations**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION- A

Solidification: Solidification from liquid and vapor phase, Nucleation, growth of homogeneous and heterogeneous nucleation, Interface stability, development of microstructure, super cooling, equilibrium phase diagrams, eutectic and peritectic solidification and their microstructures.

Thermodynamics: Equilibrium conditions, statistical thermodynamics of ideal and regular binary solution, energy of mixing and activity, derivation of phase diagrams from the model of solutions, free energy and binary phase diagrams.

Ordering: Ordered and disordered transformation, intermediate phases and compounds, super-lattices, degree of order, ordered domains and their boundaries.

SECTION-B

Heat treatment for steel: Transformation in steel, effect of alloying elements, various heat treatment processes, transformation in alloy steel, super-alloys

Cast Iron: Heat treatment of cast irons, thermo-mechanical treatments

Non-ferrous alloys: Ti alloys, Al alloys, Cu alloys and their transformation behaviour

Non-Metallic Systems: Overview of properties of ceramics and polymers

Foundry Techniques: Sand casting, permanent mould casting, investment casting and die casting, casting defects and their inspection.

Forming Processes: Fundamentals of metal forming, hot working processes (rolling, forging, extrusion), cold working processes (bending, shearing, squeezing etc).

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Phase Transformations in metals and alloys	D.A. Porter and K. Easterling	
2.	Principles of solidification	Bruce Chalmner.	Willy
3.	Solidification Processing	M. C. Fleming	McGraw Hill
4.	Materials and processing in manufacturing	E. Paul. Degarmo, J. T. Black, Ronald A Kosher	Prentice Hall of India Ltd.
5.	Eutectic Solidification Processing	R. Elliott	Butterworthd
6.	Materials and Engineering- An Introduction	W.D. Callister,	Wiley and Sons
7.	Heat treatment	Rajan and Sharma	New Delhi
8.	light Alloys	I. J. Polmear	Arnold New Delhi
9.	Physical metallurgy Cambridge Press	Peter Haasan	Cambridge
10.	Phase transformation	A K Jena, MC Chaturvedi	McGraw Hill New York
11.	Phase transformation	V. Raghavan	New Delhi

Course Code	**MST-204**
Course Title	**Semiconductors and Optoelectronic Materials**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION- A

Preparation and Characterization of Semiconductors: Types of semiconductors, charge carrier statistics, crystal growth, preparation and doping techniques of elemental and compound semiconductors, Metallization, Lithography and Etching, Bipolar and MOS device fabrication characterization (electrical, thermoelectric, magnetic and optical properties) of semiconductor materials.

Optical Properties of Semiconductors: Dipolar elements in direct gap semiconductors, optical susceptibility of a semiconductor, absorption and spontaneous emission, bimolecular recombination coefficient, condition for optical amplification in semiconductors.

SECTION- B

Electronic and Electric Properties of Semiconductors: Boltzmann equation, scattering mechanisms, hot electrons, recombination, transport equation in a semiconductor.
Electronic and ionic conductivity, solid oxide fuel cells, ceramic semiconductors, linear dielectrics, dielectric properties.

Ferroelectric materials, piezoelectrics, ferro-piezoceramics, actuators and electrostrictions, pyroelectrics, electro-optics photorefractives, thin film capacitors.

Ferroic crystals, primary and secondary ferroics, proper ferroics, magnetoferroelectricity

Application in Semiconductor Devices:

Ge, Si, GaAs, Semiconductor device: metal-semiconductor and semiconductor heterojunctions, physics of bipolar devices, fundamentals of MOS and field effect devices, basics of solar cell, photodiodes, photodetectors.

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Physics of Semiconductor devices	S. M. Sze	2nd Edition Wiley, NY
2.	Optoelectronics	J. Wilson and JFB Hawkes	PHI New Delhi
3.	Semiconductors	R. A. Smith	Academic Publishers, Calcutta(1989)
4.	Physics of Semiconductor Devices	M Shur	Prentice Hall(1990)
5.	Chemistry of Glasses	A. Paul	Champman, Chapman hall, London.
6.	Fundamentals of Fibre Optics in Telecommunication and Sensor systems	Bishnu P. Pal	Wiley Eastern Ltd., New Delhi
7.	Dielectric Phenomena in solids	Kwan Chi Kao	Elsevier Publications
8.	Optoelectronics: An introduction	Wilson Hawkes	
9.	The Physics and Applications of Photoreferactive Materials	Laszlo Solymar David J. Webb	Clarendon Press
10.	Introduction to Ferroic materials	Vinod K. Vadhawan	Gordan and Breach 2000
11.	Optoelectronics	Emmanuel Rosencher and Broge Vinter	Cambridge University Press

Course Code	**MST-205**
Course Title	**Polymers**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION- A

Basics: Basic concepts, classification of polymers, nomenclature of polymers, concepts such as monomers, oligomers, polymers, dendrimers: physical state (amorphous and crystalline) and functionality, stereo-regular polymers, copolymers, block and graft polymers, molecular forces and chemical bonding in polymers, polymerization mechanisms, addition and condensation including co-ordination, cationic, anionic, ring opening redox polymerization, living radical polymerization-atom transfer radical polymerization.

Methods of Polymerization: Bulk solution, precipitation polymerization, suspensions, emulsions, melts, polycondensation, solid phase, gas phase and (formulation, mechanism, properties of polymers produced, advantages and disadvantages of each technique), criteria of polymer solubility, solubility parameter, thermodynamics and phase equation of polymers solutions, fractionation of polymer by solubility.

Structure Property Relationship in Polymers: Configuration of polymer chains, crystallinity in polymers, crystallization and melting, strain inducing morphology, crystalline temperature, glass transition temperature, factors influencing T_g and T_m, polymer rheology, viscous, kinetic theory of rubber elasticity, viscoelasticity.

SECTION- B

Molecular Weight and Size: Importance of weight, molecular weight distribution, concept of average molecular weights, measurement of molecular weight by end group analysis, colligative properties, light scattering, ultracentrifugation, dilute solution viscosity, gel permeating chromatography.

Polymer Manufacturing: Unit operations, polymer reactors, polymer isolation, handling and storage.

Polymer Structure and Properties: Polymer characterization, polymer modification, compounding and fabrication, testing, product design, applications and processing.

Frontiers of Polymer Materials: Conducting polymers like polypyrrole, polythiophene, polyaniline, biomedical polymers, magnetic polymers, non linear optical polymers, liquid crystal polymers.

Problems with the Polymers: Thermoxidative degradation, fire hazards, toxicity, effluent disposal, feedstock scarcity.

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	A textbook of Polymers	Ferd W Billmeyer	John Wiley and Sons, New York (1990)
2.	Polymer Science	V.R. Gowariker, N.V. Vishwanathan and Jayadev Shereedhar	Wiley Eastern Ltd, New Delhi (1986).
3.	Analysis of Polymers-An Introduction	T.R. Cromton	Smithers Rapra Pvt. Ltd. SY4 4NR, UK (2008)
4.	Experimental Methods in polymer chemistry	J F Rabek	John Wiley and Sons New York (1980)
5.	Polymer Science	P L Nayak	Kalyani Publishers, New Delhi (2005)
6.	Analysis and characterization of polymers	Sukumar Malti	Anusandhan Prakashan, Midhapur (1978).
7.	Principles of Polymerization	George Odian	Wiley-Interscience; 4th

			edition 2004
8.	Textbook of Polymer Science	F W Billmeyer	Wiley Interscience 1994
9.	Low environmental impact polymers	Nick Tucker and Mark Johnson	Rapra technology ltd, UK

THIRD SEMESTER

Course Code	**MST-301**
Course Title	**Magnetism and Superconductivity**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION-A

Magnetism and Magnetic Materials

Origin of magnetism in materials, Phenomenon and mechanism of dia-, para-, ferro, antiferro-magnetism. Magnetostatics, magnetostriction, demagnetization effect, magnetic anisotropy and exchange energies. Magnetic anisotropy, Magnetic domains and domain walls, single domain particles, Reversible and irreversible magnetization processes, experimental techniques in magnetic characterization, magnetism in low-dimensional systems, nuclear magnetism, magnetic force microscopy. Eddy current and loss mechanism, Magnetic materials for high frequency applications, Giant and colossal magnetoresistance, Spintronic devices and their applications, Hard and soft magnetic materials. Magnetic storage, spin glasses, Super-paramagnetism.

SECTION-B

Superconductivity

Type-I Superconductivity: London theory, Specific Heat and Thermal Conductivity, Intermediate State, Measurements of Critical currents and Magnetic Properties, Critical State Models, Ginzberg-Landau and BCS Theory, Josephson effects, SQUIDs.

Type-II Superconductivity: Pinning of Vortices, High Temperature Superconductors, Flux Flow, Flux Creep, Fluctuation effects, Levitation and Electrical Power Applications of HTSC.

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Introduction to Magnetic Materials	B. D. Cullity	Addison-Wesley Publications, California, London, 1972
2.	Magnetism and Magnetic Materials	J. P. Jakubovics	Institute of Materials, London, 1994
3.	Introduction to Magnetism and Magnetic Materials	D. Jiles	Chapman & Hall, 1991
4.	Introduction to Superconductivity	A. C. Rose-Innes and E. H. Rhoderick	Pergamon Press, Oxford, 1969
5.	Superconductivity	C. P. Pool, Jr., H. A. Farach and R. J. Creswick	Academic Press, 1995
6.	High Temperature Superconductivity	J. W. Lynn	Springer-Verlag, 1990

Course Code	**MST-302**
Course Title	**Nanomaterials**
Type of Course	Core
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note for Examiner*: Total of 7 questions will be set with first question compulsory, three questions from part A and three questions from part B. Candidate will be required to attempt 5 questions in all, with first question compulsory and selecting two from each of the part A and part B.*

SECTION-A

Recapitulation of Nanomaterials.

Synthesis Methods: Specific production techniques like chemical vapor deposition, arc ignition, Ion beam deposition, Formation of clusters and nanoparticles from supersaturated vapor and selected properties (Vapour-liquid-Solid method, Template based synthesis), sputtering and thermal evaporation and laser methods, ball milling, chemical bath deposition, Synthesis of nanoparticles by chemical routes, cluster beam evaporation.

Effect of Chemistry of Nanostructured Materials:

Modification of nanoparticles, Langmuir Blodgett films, Self assembled surface films, binding of molecules on solid substrate surfaces, Electrostatic Stabilization, Steric Stabilization

SECTION-B

Nanostructured Materials: Organic Nanoparticles, Fullerenes, nanotubes and nano structured carbon coatings, Core-Shell Structures, nanocomponent thin film chemical sensors- gas sensors, vapour sensors and biosensors.

Applications: Biomedical imaging, nanofluidics, photonic crystals and optoelectronics. Nanoelectronics, nanobiometrics, Nanomechanics, band gap engineered quantum devices, nanobots.

Potential adverse effects of nanomaterials on environment and human health, Environmental fate and behavior of nanomaterials

RECOMMENDED BOOKS			
S. No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Quantum Dot Heterostructures	D. Bimerg, M. Grandmann and N. N. Ledentsov	John Wiley and Sons
2.	Physics of Semiconductor Nanostructures	K. P. Jain	Narosa Publication
3.	Nano Particles and Nano structured films	J. H. Fendler	John Wiley and sons
4.	Nanotechnology	G. Timp	Springer- Verlag 1999
5.	Nanomaterials, synthesis, Properties and applications	A. S. Edlestein and R. C. Cammaratx	Inst of Physics Publishing Bristol
6.	Introduction to Solid State Physics	C. Kittel	VIIIth Ed.
7.	Introduction to Nanotechnology	Owen and Poole	Wiley
8.	Nano-materials	A. K. Bandopadhyay	New Age International
9.	Theoretical & Computational Physics of Semiconductors Nanostureuctures	Paul Harrison, Quantum Wells, Wires & Dots	Wiley International
10.	Nanostructures and Nanomaterials - Synthesis, Properties and Applications	Cao, Guozhong	
11.	Environmental and human health impacts of nanotechnology	Jamie R Lead and Emma Smith	John Wiley Publications

Course Code	**MST-303**
Course Title	**PRELIMINARY THESIS WORK (LITERATURE SURVEY)**
Type of Course	Core
Course Assessment Methods Internal Assessment : 100	100
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Each student will be allotted supervisors for his/her thesis work and in consultancy with supervisor the literature survey of the topic chosen will be undertaken to define his/her thesis problem. The student will spend a minimum of six hours per week on literature survey work. This progress of this work will be monitored by internal committee.

FOURTH SEMESTER

Course Code	**MST-401**
Course Title	**Major Project (Thesis)**
Type of Course	Core
Course Assessment Methods Internal Assessment : 100	100
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Each student will be required to work on major project approved by department faculty that will span fourth semester during which periodic progress reports will be monitored. At the end of fourth semester the student will submit the thesis based upon his/her project work and project progress will be evaluated by department faculty.