M. Sc. in Materials Science

Brief Description:

The Department of Metallurgical and Materials Engineering aims to develop a core competence in teaching and research in the areas of materials Science/Engineering and its applications to Defence technologies and products. Being in Defence University, the Department offers M. Tech and Ph. D. programs on materials engineering and also engaged in conducting various short-term courses to DRDO and Defence Officers. The main focus of our research is to investigate the structure-property-performance relationship of various materials for Defence applications. To cater the defence need further, department would like to offer M.Sc. program in Materials Science for B.Sc. graduates.

This programme is offered for DRDO employees and Officers from Tri-services, Defence public sector undertaking, ISRO/DAE personal, industry personal, faculties from institutes/universities and civilian students. This program is also open to friendly foreign countries.

At present, the Department is equipped with major characterization facilities such as:

- High Resolution Transmission electron microscope (TEM) with STEM, Lorentz, HAADF and EDAX facilities
- Field emission scanning electron microscope (FESEM) with EDS
- Small angle x-ray scattering (SAXS)
- Physical Property Measuring System (PPMS)
- Wear and friction measurement equipment
- Micro-Hardness Tester
- Brinnel and Rockwell Hardness Tester
- Automatic grinding and polishing machines
- Optical polarizable microscope with image analyzer
- Surface Area Analyzer
- Impedance Analyzer and Electrochemical workstation
- Piezometer
- Corona Poling Unit
- UV-Visible Spectroscopy
- Contact Angle measurement unit

and many materials synthesis facilities also available in the Department such as:

- Spray Pyrolysis set-up
- High-Temperature Furnace
- Centrifuge
- Autoclave
- Vacuum Oven
- Orbital Shaker
- Twin screw extruder
- Plastography

- Two roll mill
- Hydraulic press
- Electro spinning unit
- Homogenizer
- Sonicator

The development of know-how and manufacturing technologies of many strategic and advanced materials like intelligent textiles, biosensors, electrospinning, magnetic materials, engineering adhesives, structural composites, hybrid supercapacitors, functional materials, biomaterials for prosthetics, tissue engineering, plastics processing, piezoelectric materials, super critical foaming technology are taken up by the faculties and students. The Department is working on many sponsored research projects and the researchers have developed a range of products, including propellers for fuel cells, encapsulated drugs on fibers, magnetic alloys, inorganic oxides for drug delivery, encapsulation and sustained release of anti-cholesterol drugs, polymeric beads and membranes for toxic and heavy metal adsorption (effluent treatment), carbon foams for high-temperature applications and open cell polyurethane foams for automobile applications. Moreover, the Department participates extensively in R&D activities in collaboration with Defence Labs and Establishments of India. International collaborative work is being carried out with Naval Post-graduate School (NPS), California, Crainfield University, UK, Loughborough University, UK, National Ding Hwa University, Taiwan, Weizmann Institute of Science, Israel etc.

Eligibility:

The eligibility for the M.Sc. postgraduate programme is B.Sc. or equivalent in any branch of science/mathematics or BE/B.Tech in any branch of Engineering. Also, student should have mathematics subject in 12^{th} standard.

Organization:

The programme is of four-semester duration. In each semester (first, second and third semester), students have to undergo 5 courses excluding the last semester. In fourth semester students will have to perform project work. In the third semester, students have the option to choose elective courses. In first, second and third semester, there will be continuous evaluation which may comprise several tests/quizzes (decided by the concerned instructor/s) and a final examination for theory subjects. At the end of the final (fourth) semester, students will submit their thesis before going for final evaluation and present their project work before the expert committee (consists of External / Internal members from various R&D organisations/Institutions / Universities etc.). No credits are counted for attending an audit course.

Course structure for M.Sc. in Materials Science

Semester I

Sr. No.	Course Code	Subjects (Theory/Practical)	Contact Hours			Credits
			L	T	P	
1	MS501	**Structure and Properties of Materials (HSP)**	3	0	2	4
2	MS502	**Materials Characterization Techniques (TUP)**	3	0	2	4
3	MS503	**Thermodynamics, Kinetics, and Phase Transformations (BM)**	3	1	0	4
4	MS504	**Polymer Synthesis, Manufacturing and Technology (BK)**	3	0	2	4
5	MS505	**Computational Mathematics (FK)**	3	1	0	4

Total credit --20

Semester II

Sr. No.	Course Code	Subjects (Theory/Practical)	Contact Hours			Credits
			L	T	P	
1	MS506	**Processing of Metals and Ceramics (VDH)**	3	0	2	4
2	MS507	**Principles of Metallurgy (ST)**	3	1	0	4
3	MS508	**Non-destructive Testing (HSP)**	3	0	2	4
4	MS509	**Polymer Processing and Rheology (BK)**	3	1	0	4
5	MS510	**Computational Materials Science (FK)**	3	1	0	4

Total credit --20

Semester III

Sr. No.	Course Code	Subjects (Theory/Practical)	Contact Hours			Credits
			L	T	P	
1	MS511	**Additive Manufacturing of Materials (VDH)**	0	0	5	4
2	MS512	**Composite Materials and Polymer Blends (TUP)**	3	1	0	4
3	MS513	**Mini Project**	3	1	0	4
4		**Elective I (Polymer Characterization and Testing**	3	1	2	4
5		**Elective II**	3	1	2	4

Total credit -- 20

Semester IV

Sr. No.	Course Code	Subjects (Theory/Practical)	Contact Hours		Credits
			L	T/P	
1	MS541	**Dissertation**		40	20

Total credit – 20

List of Electives

Sr. No.	Course Code	Name of the Course
Electives from the Department		
1	MS 514	Polymer characterization and Testing
2	MS515	Nanoscience and Nanotechnology
3	MS516	Chemistry of Polymer
4	MS517	Biomaterials
5	MS518	Functional Materials

Since, DIAT adopted choice-based credit system, student can choose any subject from the institute as well as from online platforms (MOOC, SWAYAM etc.) as an elective subject.

Course Name: Structure and properties of Materials
Course Code: MS501

Unit I: Introduction, classification of materials; atomic structure, bonding in solids, bonding forces and energies; crystal structure, unit cells, crystal systems, crystallographic points, directions, and planes,
Unit II: Crystalline and non-crystalline materials, anisotropy; Structure of crystalline solids: metallic crystal structure
Unit III: Ceramic materials, Basic properties, classification of ceramic materials– conventional and advanced, ceramic crystal structure, Defects in ceramics: types of defects, origin of point defects, defects and electron energy levels, defect equllibria in ceramic crystals
Unit IV: Electronic and Magnetic Properties: Free electron theory, Fermi energy, density of states, elements of band theory, semiconductors, Hall effect, dielectric behavior, piezo and ferro-electric behaviour Origin of magnetism in materials, para-, dia-, ferro- and ferri-magnetism
Unit V: Thermal and optical properties: Specific heat, heat conduction, thermal diffusivity, thermal expansion, and thermoelectricity, Refractive index, absorption and transmission of

electromagnetic radiation, Examples of materials exhibiting the above properties, and their typical/common applications.

Text Book(s):
- Materials Science and Engineering by William D. Callister, JohnWiley& Sons, Inc.
- Elements of Materials Science and Engineering by Lawrence H. van Vlack.

Reference Book(s):
- Elements of Ceramics: F.H Norton
- Fundamentals of Ceramics: Barsoum
- Introduction to Ceramics: W.D.Kingery
- Physical Ceramics for Engineers: VanVlack
- Handbook of Ceramics: Editor S. Kumar Ceramic
- Materials for Electronics: R.C. Buchanon

Course Name: Materials Characterization Techniques
Course code: MS502

Unit I

Microscopy: Optical microscopy, concepts of magnification, resolution and depth of focus, types of optical microscopy, sample preparation, SEM: imaging modes, image contrast, illustrative applications, EDS, Basic principle and components of TEM: Contrast mechanisms, bright field, dark field, TEM application in crystal defect analysis, Electron diffraction in TEM

Unit II

Diffraction Techniques- Concepts of diffraction, scattering and radiation-matter interactions, X-ray diffraction: phase identification, strain and grain size determination

Unit III

Spectroscopic Techniques- Fundamental basis of Spectroscopic analysis, UV-Vis, IR and Raman, X-ray Photon Spectroscopy and Auger electron spectroscopy

Unit IV

Thermal Analysis Techniques- DSC, DTA and TGA

Unit V: Tensile test, hardness measurement, electrical conductivity, carrier mobility and concentrations.

Text Book(s):

- Elements of X-ray Diffraction, B. D. Cullity, Prentice Hall, 2001
- Solid State Chemistry and its Applications, Anthony R. West, Wiley.

Reference Book(s):

- Materials Characterization, ASM Handbook Vol 10.

- Characterization of Materials, Vol 1, Elton N. Kaufmann

Course Name: Thermodynamics, Kinetics, and Phase Transformations
Course code: MS503

Unit I: Simple and composite systems, phases, Internal energy, Enthalpy, Entropy, Gibbs Free energy, Specific heat, Laws of thermodynamics, Reversible and Irreversible processes. Generation of Auxiliary Functions: Legendre transforms, Coefficient relations, Maxwells relations, Thermodynamic relations among state functions variables and its application to solids.
Unit II: Free energy of single component system: Free energy as a function of temperature, Clausius-Clapeyron Equation, Driving force for solidification.
Unit III: Solution thermodynamics: Entropy of mixing, Enthalpy of mixing, Free energy of ideal, regular and real solutions, Chemical potential, Unary and binary phase diagrams and Gibbs free energy.
Unit IV: Diffusion: Phenomenology, First and Second law of diffusion, Solution to diffusion equations and error function, Types of diffusion
Unit V: Solidification of pure metals and alloys, nucleation and growth, diffusional solid-state phase transformations (precipitation and eutectoid), martensitic transformation

Text/References

- *M. Modell and R.C. Reid, Thermodynamics and its Applications, Prentice-Hall, Englewood Cliffs, New Jersey, 1983.*
- *H.B. Callen, Thermodynamics and an Introduction to Thermostatics, Jonh Wiley & Sons, New York, 1985.*
- *R.T. DeHoff, Thermodynamics in Materials Science, McGraw-Hill, Singapore, 1993*
- *Richard E. Dickerson, Molecular Thermodynamics, W. A. Benjamin, 1969*

Course Name: Polymer Synthesis, Manufacturing and Technology

Course Code: MS504

Unit I: Commodity and general purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, PBT, PSU, PPO, ABS, Fluoropolymers Thermosetting polymers: Polyurethane, PF, MF, UF, Epoxy, Unsaturated polyester, Alkyds.

Unit II: Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex; SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE,

Unit III: Speciality plastics: PEK, PEEK, PPS, PSU, PES etc.

Unit IV: Biopolymers such as PLA, PHA/PHB.

Unit V: Polymer compounding-need and significance, different compounding ingredients for rubber and plastics (Antioxidants, Light stabilizers, UV stabilizers, Lubricants, Processing aids, Impact modifiers, Flame retardant, antistatic agents. PVC stabilizers and Plasticizers) and

their function, use of carbon black, polymer mixing equipments, cross-linking and vulcanization, vulcanization kinetics

Reference Books:

- Textbook of Polymer Science, Fred W. Billmeyer (Wiley)
- Polymer alloys and blends by L A Utracki
- Polymer nanocomposites: processing, characterization, and applications by Josheph H. Koo (McGraw-Hill Nanoscience and Technology)

Course Name: Computational mathematics
Course Code: MS505

Unit I: Linear Algebra:

- Algebra of real matrices: Determinant, inverse and rank of a matrix; System of linear equations (conditions for unique solution, no solution and infinite number of solutions); Eigenvalues and eigenvectors of matrices; Properties of eigenvalues and eigenvectors of symmetric matrices, diagonalization of matrices; Cayley-Hamilton Theorem.

Unit II: Calculus of single and multiple variables:

- Limit, Continuity and differentiability; Maxima and minima; Partial derivatives; Total derivative.

Unit III: Vector Calculus:

- Gradient, divergence and curl; Line integrals, and Green's theorem.

Unit IV: Numerical Solution of Differential Equations:

- Concepts of discretization in space/time, implicit, explicit; Taylor's series; Solution to ODEs; Classification of second order linear partial differential equations; Method of separation of variables: One dimensional heat equation and two-dimensional Laplace equation.

Text Book(s)

- Advanced engineering mathematics: Kreyszig; Wiley.
- Advanced engineering mathematics: Jain/Iyenger; Narosa

Reference Book(s)

- Advanced engineering mathematics: Peter V. O'Neil Cengage Learning
- Advanced engineering mathematics: Alan Jeffery; Academic Press
- Calculus and analytic geometry: Thomas/Finney; Narosa
- Numerical methods for Engineers: Steven C. Chapra and Paymond P. Canale

Course Name: Processing of Metals and Ceramics
Course Code: MS506

Unit 1: Metallic processing: Casting and forming processes, rolling, forging, extrusion, Heat treatment of Ferrous and Aluminium alloys, Mechanical properties of metals
Unit 2: Processing of ceramics- Preparation of ceramic powder, Compaction, moulding, sintering, refractory manufacturing processes, Mechanical properties of ceramics
Unit 3: Thin film deposition: evaporation and sputtering techniques, chemical vapour deposition, thin film growth phenomena
Unit 4: Practical: Metal processing- rolling and annealing, solgel, co-precipitation

Text Book(s):
- Mechanical Metallurgy, 3rd Ed, George E Dieter, Mc-Graw Hill, New York, 1986.
- Manufacturing Processes and Materials for Engineers, L. E. Doyle, 1975. Powder 436

Reference Book(s)
- Metallurgy, Applications, Advantages and Limitations, Klar, Erhard, ASM, 1983, Ohio.
- Extrusion: the definitive processing guide and handbook, Giles, Harold F.; Wagner, John R.; Mount, Eldridge M, 2005.

Course Name: Principle of Metallurgy
Course Code: MS507

Unit I: Phase diagrams, Phase Transformation and Microstructures of Al alloys and steel

Unit II: Heat Treatment of steel and Al alloys, TTT and CCT diagram.

Unit III: Defects and plastic deformation phenomenon

Unit IV: Recovery, Recrystallization and Grain growth

Unit V: Strengthening of metals and alloys

Text/Reference Books:

1. Introduction to Physical Metallurgy, S H Avner, TATA Mc-Graw Hill, New Delhi, 2001.
2. Morden Physical Metallurgy, 8th Ed, R.E. Smallman, A.H.W. NGAN, Butterworth Heinemann publications, 2014 417
3. Mechanical Metallurgy, 3rd Ed, George E Dieter, Mc-Graw Hill, New York, 1986
4. Physical Metallurgy, Vijendra Singh, Standard Publishers Distributors

Course Name: Non-Destructive Testing
Course Code: MS508

Unit I: Visual Inspection, Liquid Penetrant Testing, Magnetic Particle Testing,
Unit II:Eddy Current Testing, Ultrasonic Testing,
Unit III:Acoustic Emission Technique, Radiography Technique,

Unit IV: Residual Stress Analysis, In-situ Metallography, Automation and Robot in NDT,
Unit V: Case study: Grain Size, Weldment and other Structural Components.

Test Book(s)

1. Non-destructive Testing of welds, Baldev Raj, C.V. Subramanian and T. Jayakumar, Narosa Publishing House, 2000, Delhi.

Reference book(s)

2. International Advances in non-destructive testing, (Ed.) W. J. Mcgonnagle, Gordon and Breach Science Publishers, 1981, NY.
3. Non-destructive Testing, Views, Reviews, Previews, (Ed.) L.L.Alston, Oxford University Press, 1970
4. Nondestructive Evaluation and quality control, ASM handbook, Volume 17,ASM International

Course Name: Polymer Processing and Rheology

Course Code: MS509

Unit I: Polymer Processing Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, filament winding, SMC, BMC, DMC, extrusion, pultrusion, calendaring, rotational molding, thermoforming, powder coating,

Unit II: Rubber processing in two-roll mill, internal mixer.

Unit III: Flow of Newtonian and non-Newtonian fluids, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions.

Unit IV: Measurements of rheological parameters by capillary rotating, parallel plate, cone-plate rheometer. Visco-elasticity- creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR.

Reference Books:

- Commercial Polymer blends by L.A. Utracki
- Textbook of Polymer Science, Fred W. Billmeyer (Wiley)
- Polymer alloys and blends by L A Utracki
- Polymer nanocomposites: processing, characterization, and applications by Josheph H. Koo (McGraw-Hill Nanoscience and Technology)

Course Name: Computational Materials Science
Course Code: MS510

Unit I: Review of programming in high-level and low-level languages

Unit II: Lotka-Volterra Model: Analytical and Numerical Solution; Solving Fick's laws of Diffusion numerically in 1D using low-level language; Diffusion in 3D using advanced solvers; Random Walker model

Unit III: Monte Carlo method; Ising Model; Sharp and Diffuse interface models; Phase field method for evolution of microstructure: Cahn-Hilliard and Allen-Cahn model

Unit IV: Introduction to Machine Learning: Supervised and Unsupervised models, Fitting and visualization of multidimensional data; Data analytics using principal component analysis

Text Book(s):

- Introduction to Computational Science: Modeling and Simulation for the Sciences, Princeton University Press, A. B. Shiflet and G. W. Shiflet
- Introduction to Computational Materials Science – Richard LeSar, Cambridge University Press

Reference Book(s):

- Computational Materials Engineering: An Introduction to Microstructure Evolution, Elsevier Academic press, K. G. F. Janssens, D. Raabe, E. Kozeschnik, M. A. Miodownik, B. Nestler
- David V. Hutton, Fundamentals of Finite Element Analysis
- Mathematic physics (V. Balakrishnan)
- Numerical Recipes in C(William H. Press, Vetterling, Teutolsky, Flannery)

Course Name: Composite Materials and Polymer Blends
Course Code: MS511

Unit I
Matrix, reinforcement, types of reinforcing fillers, continuous and discontinuous fibers, carbon, glass, aramid and other fibers, preparation methods and properties, particulate fillers, dispersion and interfacial phenomena, nanofillers, functional fillers.

Unit II
Polymer Matrix Composites: Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings -woven fabrics – non woven random mats – various types of fibres. PMC processes – hand lay up processes – spray up processes – compression moulding – reinforced reaction injection moulding – resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass Fibre Reinforced Plastics (GFRP). Mechanics of Composites, basic constitutive equations, rule of mixture, Halpin-Tsai equations etc. Applications of PMC in aerospace, automotive industries

Unit III
Metal Matrix Composites: Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding -stir casting – squeeze casting, a spray

process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties-applications of MMC in aerospace, automotive industries

Unit IV
Ceramic matrix composites, carbon-carbon composites, processing, manufacturing, properties and applications in aerospace and automotive components

Unit V
Introduction to polymer blends, nanostructured materials and nanocomposites, Thermodynamics of polymer blends, mixing, factors governing miscibility, immiscible polymers and phase separation. Influence of interface on property of blends and nanocomposites. Compatibilizers and compatibilization. Blends of amorphous & semi-crystalline polymers, inter-penetrating networks, thermoplastic and thermoset blends, rubber toughened polymers, particulate and fiber reinforced composites.

Text Books:

1. Mathews F. L. and Rawlings R. D., Composite Materials: Engineering and Science, 1st Edition, Chapman and Hall, London, England, 1994.
2. Chawla K. K., Composite materials, Second Edition, Springer – Verlag, 1998.
3. Introduction to Materials Engineering, William Callister
4. Polymer alloys and blends by L A Utracki

References:

1. Clyne, T. W. and Withers, P. J., Introduction to Metal Matrix Composites, Cambridge University Press, 1993.
2. Strong, A.B., Fundamentals of Composite Manufacturing, SME, 1989.
3. Sharma, S.C., Composite materials, Narosa Publications, 2000.
4. Broutman, L.J. and Krock,R.M., Modern Composite Materials, Addison-Wesley, 1967.

ASM Hand Book, Composites, Vol.21, ASM International, 2001.

Course Name: Additive Manufacturing of Materials
Course Code: MS 512

UNIT I- Basic Introduction
Overview- History- Need classification- Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology- Tooling- Applications

UNIT II- Solid and liquid based additive manufacturing
Classification – Liquid based system- Stereolithography Apparatus (SLA)- Principle, process, advantages and applications – Solid based system- Fused Deposition Modeling- Principle, process, advantages and applications, Laminated object Manufacturing.

UNIT III- Powder based additive manufacturing

Selective Laser Sintering- Principles of SLS process- Process, advantages and applications, Three-Dimensional Printing – Principle, Process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting.

UNIT IV- CASE STUDIES
Case studies for metals and alloys, Ceramics and Polymers

Test Books:

1. Chua C.K., Leong K.F., and Lim C.C., "Rapid prototyping: Principles and applications". Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.

Reference Books:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nase E.A., "Rapid Prototyping: Theory and practice: Springer, 2006.
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.
4. Dougles Bryden, "CAD and Prototyping for Product Design", 2014

Course Name: Mini Project
Course Code: MS513

Small project on selected Topic.

Course Name: Polymer Characterization and Testing

Course Code: MS 514

Unit I: Concept of molecular weight distribution and its significance, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques, Molecular wt. distribution: Broad and Narrow, GPC, mooney viscosity. Polymer solubility and swelling

Unit II: Mechanical-static and dynamic, tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness.

Unit III: Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity,

Unit IV: swelling, aging resistance, environmental stress cracking resistance, limiting oxygen index. Heat deflection temperature –Vicat softening temperature, Brittleness temperature, Glass transition temperature, Coefficient of thermal expansion, Shrinkage, Flammability, dielectric constant, dissipation factor, power factor.

Unit V: Optical Properties - Refractive Index, Luminous Transmittance and Haze, Melt flow index

Reference Books:

- Textbook of Polymer Science, Fred W. Billmeyer (Wiley)
- Polymer alloys and blends by L A Utracki
- Polymer nanocomposites: processing, characterization, and applications by Josheph H. Koo (McGraw-Hill Nanoscience and Technology)

Course Name: Nanoscience and Nanotechnology
Course Code: MS 515

Unit 1: Overview of Nanostructures and Nanomaterials; Synthesis of Nanomaterials: Types and strategies for synthesis of nanomaterials;
Unit 2: Crystalline nanomaterials and defects therein; Hybrid nanomaterials; Multiscale hierarchical structures built out of nanosized building blocks (nano to macro); Nanomaterials in Nature: Nacre, Gecko, Teeth; Nanostructures: Carbon Nanotubes, Fullerenes, Nanowires, Quantum Dots.
Unit 3: Cells response to Nanostructures; Surfaces and interfaces in nanostructures, Ceramic interfaces, Superhydrophobic surfaces, Grain boundaries in Nanocrystalline materials,

Unit 4: Thermodynamics of Nanomaterials; Overview of properties of nanostructures and nanomaterials; Overview of characterization of nanostructures and nanomaterials

Unit 5: Applications of Nanotechnology in various fields

Text Book(s)
• T. Pradeep, NANO: The Essentials,Tata McGraw-Hill Publisher, 2007. ISBN-13:978-0-07-061788-9.
Reference Book(s)
• K. Haghi, G. E. Zaikov, Advanced Nanotube and Nanofiber Materials, Nova Science Publishers Inc, 2012
• Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications, Cambridge University Press, 2008

Course Name: Chemistry of Polymers

Course Code: MS516

Unit I: Chemistry of High Polymers Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness.

Unit II: Polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer methods of polymerization, copolymerization, monomer reactivity ratios, and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization.

Unit III: Block and graft copolymers, techniques for polymerization-bulk, solution, suspension, emulsion.

Unit IV: Concept of intermolecular order (morphology) – amorphous, crystalline, orientation states. Factor affecting crystallinity. Crystalline transition. Effect of morphology on polymer properties.

Reference Books:

- Textbook of Polymer Science, Fred W. Billmeyer (Wiley)
- Polymer alloys and blends by L A Utracki
- Polymer nanocomposites: processing, characterization, and applications by Josheph H. Koo (McGraw-Hill Nanoscience and Technology)

Course Name: Biomaterials
Course Code: MS517

Unit I: Introduction to biomaterials, Tissue Engineering, Biocompatibility, Biodegradation Biofluids and medical devices, Biostructures
Unit II: Ceramic based biomaterials, metallic biomaterials, polymer based biomaterials, Biofluidici, medical devices, Biostructures
Unit III: Nano-biomaterials: Self assembly of nanomaterials, hydrophilic, hydrophobic and surfaces, biomimicking
Unit IV: Medical imaging, electrospinning of scaffold structures, Additive manufacturing of medical devices, biofluidics and biostructure
Unit V: Case studies: Lotusleaf, Gecko feet, Nacre/Bone. Application of nanocomposite biomaterials: artificial biomaterials, antidragcoatings,self-cleaning surfaces,sensors, Riboswitches

Text Book(s):

- Biomaterials- An Introduction, Joon Park- Publisher Springer 423

Reference Book(s):

- Biomaterials- Principals and Applications- Joon Park- CRC Press
- Handbook of Biomaterial Properties- Garth Hastings- Springer
- Handbook of Biomaterials Properties- William Murphy- Springer
- Handbook of Biomaterial Properties- Jonathan Black- Chapman and Hal

Course Name: Functional Materials
Course Code: MS 518

Unit I: Shape memory and Superelastic alloys: shape memory effect, thermodynamics of martensitic transformation, Stress induced martensite and superelasticity, Ni-Ti and Ni-Al based alloys and their applications.

Unit II Magnetic materials: Soft and hard magnetic materials, remnant magnetic material, rare earth magnets, Finemet alloys.
Unit III Opto-electronic Materials: Optical properties of semiconductors, absorption and emission processes, Electronic materials such as GaAs and GaN.
Unit IV Sensor: Metal oxide based sensors, Principles of operation

Text/References

Shape memory Materials: K. Otsuka and C. M. Wayman; Cambridge University Press
Principles of Electronic Materials and Devices: S. O. Kasap; McGraw Hill Publications