VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

SCHEME OF TEACHING AND EXAMINATION FOR
M.TECH. Material Science & Technology .

I SEMESTER **CREDIT BASED**

Subject Code	Name of the Subject	Teaching hours/week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work / Assignment/ Tutorials		I.A.	Exam		
16MDE11	Applied Mathematics	4	2	3	20	80	100	4
16MST12	Finite Element Method	4	2	3	20	80	100	4
16MST13	Materials for Cryogenic and High Temperature Applications	4	2	3	20	80	100	4
16MST14	Nano science and Nano materials	4	2	3	20	80	100	4
16MST15X	Elective - I	4	2	3	20	80	100	4
16MST 16	Material Characterization Lab 1	--	3	-	20	80	100	2
16 MST 17	SEMINAR	--	-	--	100	--	100	1
	Total	**20**	**13**	**15**	**220**	**480**	**700**	**23**

ELECTIVE-I

16MST151	Advances in Materials and Processing	16 MST 153	Non Destructive Testing
16MST152	Advanced Foundry Technology	16 MST 154	Selection of Material in Engineering

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

SCHEME OF TEACHING AND EXAMINATION FOR

M.TECH. Material Science & Technology .

II SEMESTER **CREDIT BASED**

Subject Code	Name of the Subject	Teaching hours/week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work / Assignment/ Tutorials		I.A.	Exam		
16MST21	Composite Materials Technology	4	2	3	20	80	100	4
16MST22	Smart Materials and Structures	4	2	3	20	80	100	4
16MST 23	Testing of Materials	4	2	3	20	80	100	4
16MST24	Non –Traditional Machining	4	2	3	20	80	100	4
16MST245X	Elective - II	4	2	3	20	80	100	4
16 MST 26	Advanced Material Processing LAB 2		3	3	20	80	100	2
16 MST 27	SEMINAR	--		--	100	--	100	1
	**PROJECT WORK PHASE-I COMMENCEMENT (6 WEEKS DURATION)	--	--	--	--	--	--	--
	Total	**20**	**13**	**18**	**220**	**480**	**700**	**23**

ELECTIVE-II

16 MST 251	Surface Treatment And Finishing	16MST 253	Advanced Moulding Techniques
16MST 252	Agile Manufacturing	16MST 254	Manufacturing of Electronics Components

**** Between the II Semester and III Semester, after availing a vacation of 2 weeks.**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

SCHEME OF TEACHING AND EXAMINATION FOR

M.TECH. Material Science & Technology .

III SEMESTER : INTERNSHIP **CREDIT BASED**

Subject Code	Subject	No. of Hrs./Week		Duration of the Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work		I.A.	Exam		
16MST31	Seminar Presentation on Internship (After 8 weeks from the date of commencement)	-	-	-	25	-	25	20
16MST32	Report on Internship	-	-	-	25	-	25	
16MST 33	Evaluation and Viva-Voce of Internship		-	-	-	50	50	
16MST 34	Project Work Phase 1				50	-	50	1
	Total	**-**	**-**	**-**	**100**	**50**	**150**	**21**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

SCHEME OF TEACHING AND EXAMINATION FOR

M.TECH. Material Science & Technology

IV SEMESTER **CREDIT BASED**

Subject Code	Subject	No. of Hrs./Week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Field Work / Assignment / Practical		I.A.	Exam		
16MST 41	Plastic Processing	4	2	3	20	80	100	4
16MST42X	ELECTIVE-III	4	2	3	20	80	100	3
16MST 43	EVALUATION OF PROJECT WORK PHASE-II	-	-	-	50	-	50	3
16MST 44	EVALUATION OF PROJECT WORK AND VIVA-VOCE	-	-	3	-	100+100	200	10
Total		**8**	**04**	**09**	**90**	**360**	**450**	**20**
Grand Total (I to IV Sem.) : 2000 Marks; 87 Credits								

ELECTIVE-III

16 MST421	Modeling ,Simulation and Analysis of Manufacturing Systems	16 MST 423	Mechanical Behavior of Materials
16 MST 422	Bio Materials & Technology	16 MST 424	Experimental Methods in Engineering

NOTE:

1	Project Phase – I:6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carryout literature survey / visit to Industries to finalize the topic of dissertation
2	Project Phase – II:16 weeks duration. 3 days for project work in a week during III Semester. Evaluation shall be taken during the first two weeks of the IV Semester. Total Marks shall be 25.
3	Project Phase – III :24 weeks duration in IV Semester. Evaluation shall be taken up during the middle of IV Semester. At the end of the Semester Project Work Evaluation and Viva-Voce Examinations shall be conducted. Total Marks shall be 250 (Phase I Evaluation:25 Marks, Phase –II Evaluation: 25 Marks, Project Evaluation marks by Internal Examiner(guide): 50, Project Evaluation marks by External Examiner: 50, marks for external and 100 for viva-voce). Marks of Evaluation of Project: I.A. Marks of Project Phase – II & III shall be sent to the University along with Project Work report at the end of the Semester. During the final viva, students have to submit all the reports.
4	The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following: a) Head of the Department (Chairman) (b) Guide (c) Two Examiners appointed by the university. (out of two external examiners at least one should be present).

APPLIED MATHEMATICS

(Common to MDE,MMD,MEA,CAE,MCM,MAR,IAE,MTP,MTH,MTE,MST,MTR)

Sub Code	:	16MDE11	IA Marks	:	20
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	80

Course Objectives:

The main objectives of the course are to enhance the knowledge of various methods in finding the roots of an algebraic, transcendental or simultaneous system of equations and also to evaluate integrals numerically and differentiation of complex functions with a greater accuracy. These concepts occur frequently in their subjects like finite element method and other design application oriented subjects.

Course Content:

1) Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering. **06 Hours**

2) Roots of Equations: Bracketing methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed point iteration.
   Roots of polynomial-Polynomials in Engineering and Science, Muller's method, Bairstow's Method Graeffe 's Roots Squaring Method. **12 Hours**

3) Numerical Differentiation and Numerical Integration: Newton –Cotes and Guass Quadrature Integration fo rmulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae **06 Hours**

4) System of Linear Algebraic Equations And Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods.
   Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method . **14 Hours**

5) Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering

   Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets, Orthogonal projections, The Gram-schmidt process, Least Square problems, Inner product spaces**.** **12 Hours**

Text Books:

1. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
2. Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata Mcgraw Hill, 4th Ed, 2002.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.

Reference Books:

1. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.
2. David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.

Course Outcomes:

The Student will be able to

1) Model some simple mathematical models of physical Applications.
2) Find the roots of polynomials in Science and Engineering problems.
3) Differentiate and integrate a function for a given set of tabulated data, for Engineering Applications

FINITE ELEMENT METHOD

(Common to MTE,MST)

Sub Code	:	16 MST12	IA Marks	:	20
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	80

Course Objectives

1. Introduce the various aspects of FEM as applied to engineering problems .
2. Apply the fundamental concepts of mathematical methods and theory of elasticity to solve simple continuum mechanics problems.

Course Content:

1. Introduction to Finite Element Method : Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design., Mathematical Preliminaries, Differential equations formulations, Variational formulations, weighted residual methods

   6 Hours

2. One-Dimensional Elements-Analysis of Bars and Trusses, Basic Equations and Potential Energy Functional,1D Bar Element, Admissible displacement function, Strain matrix, Stress recovery, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, Boundary and Constraint Conditions, Single point constraint, Multi-point constraint, Truss Element, Shape functions for Higher Order Elements, C^o, C^1 elements

   Two-Dimensional Elements-Analysis of Plane Elasticity Problems: Three- Triangular Element, Four-Noded Quadrilateral Element (QUAD 4), Shape functions for Higher Order Elements (LST, QUAD 8), Lagrange element, Strain-Displacement [B] matrix, Stiffness[K] matrix and Jacobian of CST and QUAD4 elements.

   13 Hours

3. Axi-symmetric Solid Elements-Analysis of Bodies of Revolution under axi-symmetric loading: Axisymmetric Triangular and Quadrilateral Ring Elements. Strain-Displacement [B] matrix, Stiffness[K] matrix.

Three-Dimensional Elements-Applications to Solid Mechanics Problems: Basic Equations and Potential Energy Functional, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Shape functions for Higher Order Elements

14 Hours

4. Beam Elements-Analysis of Beams and Frames: 1–D Bea m Element, Problems.
   Heat Transfer /Fluid Flow: Steady state heat transfer, 1 D heat conduction governing equation, boundary conditions, One dimensional element, Functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, 1 D heat transfer in thin fins. Basic differential equation for fluid flow in pipes, around solid bodies, porous media.

   11 Hours

5. Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, beam element. Lumped mass matrix, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

   6 Hours

Text Books:

1. Chandrupatla T. R., “Finite Elements in engineering ”- 2nd Edition, PHI, 2007.
2. Lakshminarayana H. V., “Finite Elements Analysis”– Procedures in Engineering, Universities Press, 2004

Reference Books:

1. Rao S. S. “Finite Elements Method in Engineering”- 4th Edition, Elsevier, 2006
2. P.Seshu, “Textbook of Finite Element Analysis”-PHI, 2004.
3. J.N.Reddy, “Finite Element Method”- McGraw -Hill In ternational Edition.
4. Bathe K. J. Finite Elements Procedures, PHI.
5. Cook R. D., et al. “Conceptsand Application of Fini te Elements Analysis”- 4 th Edition, Wiley & Sons, 2003.

Course Outcome:

Students will be able to

1. Define the element properties such as shape function and stiffness matrix for the various elements.
2. Formulate element properties for 1D and 2D elements.
3. Develop skill to solve simple beam problems using the steps of FEM.

MATERIALS FOR CRYOGENIC AND HIGH TEMPRATURE APPLICATIONS

Sub Code	: 16 MST13	*IA Marks*	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:

The course provides fundamental knowledge on materials for cryogenic and high temperature applications.

Course Content:

1. Introduction: Historical Background – Introduction to Cryogenic p ropellants – Liquid hydrogen, Liquid helium, Liquid nitrogen and Liquid oxygen and their properties.

Production of low Temperature: Theory behind the production of low temperature – E xpansion engine heat exchangers – Cascade process Joule Thompson Effect – Magnetic effect – O rtho and Para H2 – Helium4 and Helium3.

12 Hours

2. Efficiency of Cryogenic Systems: Types of losses and efficiency cycles – Specific am ount of cooling – The fraction liquefied – Cooling coefficient of performance – Thermodynamic efficiency – The energy balance Methods.

Cycles Of Cryogenic Plant: Classification of cryogenic cycles – The structure of cycle – Throttle expansion cycles – Expander cyc les – Thermodynamic analysis – Numerical problems. **13 Hours**

3. Cryogenic Fluid Storage And Transfer Systems: Basic storage vessels, insulations, un insulated and porous insulated lines, vacuum insulated lines, cryogenic valves, cool down process.

Measurement Systems For Low Temperatures : Introduction, Temperature scales and fixed points, Metallic resistance thermometers, thermo couples, constant volume gas thermometers, magnetic thermometers, vapour pressure thermometers.

12Hours

4. Vacuum Technology : Importance flowregimes in vacuum system, components of vacuum system, mechanical vacuum pumps, diffusion pumps, vacuum gaugs and valves. **6 Hours**

5. Cryogenic In Aerospace Applications: Cryogenic liquids in missile launching and space simulation – storage of cryogenic liquids- Effect of cryogenic liquids on properties of Aerospace materials – Cryogenic loading problems – Zero g ravity problems associated with cryogenic propellants – Phenomenon of tank collapse – Elimination of Geysering effect in missiles.

7 Hours

TEXT BOOKS:

1. Barron.R.F. Cryogenic Systems, Oxford University, 1985.
2. DURHAm, T.F, MCCLINTOCK, R.M. and REED, R.P.(1962). Cryogenic Materials, Washington, D.C

REFERENCE BOOKS:

1. Haseldom .G. Cryogenic Fundamentals, Academic Press, 1971.
2. Parner S.F. Propellant Chemistry, Reinhold publishing Corpn., NewYork 1985.
3. Wigley D.A.(1971) Mechanical Properties of Materials at Low Temperatures. Plenum Press, New York.

Course Outcome:

Students will be able to understand the concept of materials for cryogenic and high temperature applications.

NANOSCIENCE AND NANOMATERIALS
(Common to MST,MTE)

Sub Code	: 16 MST16	*IA Marks*	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:
To provide exposure to principles of nanotechnology; characterization of nanostructured materials; and its applications

Course Content:
1. Introduction To Nanoscience And Nanotehnology : History, background scope and interdisciplinary nature of nanoscience and nanotechnology, scientific revolutions, nano sized effects surface to volume ratio, atomic structure, molecules and phases, energy at the nanoscale molecular and atomic size, quantum effects ,types of nanotechnology and nano machines.

Classification Of Nanostructures: Zero dimensional, one-dimensional and two dimensional nanostructure materials-clusters of metals, semiconductors, ceramics and nano composites, size dependent phenomena, quantum dots nano wires ,tubes ,nano sheets ,nano and mespores, top down and bottom ups approach, misnomers and misconception of nano techonology, importance of nanoscale materials and their devices. **12 Hours**

2. Properties Of Nanomaterials: Mechanical properties-Thermo physical properties - Electrical properties Electric properties – Electro chemical properties Magnetic properties - optical properties-Catalytic property – properties of gas pe rmeation and separation membranes.

Nanostructure Design: Functionality of nanostructures and their characteristics evaluation, size effect in semiconductor nanoparticles – particle size, shape density – Melting point, surfa ce tension, wettability – specific surface area and pore – Assembly of nanoparticles and fictionalization – nanoparticles arranged structure s as nanipores and nanocomposites – Structure contr ol of nanoparticle collectives by sintering and bounding – Self – assembly. Nanoparti cle dispersion and aggression behaviour – Single na noparticle motion in fluid – Brownian diffusion – Adsorption properties – intera ctions between particles – Aggregation and dispersi on, characterization and control – Rheology of slurry – Simlation of colloidal dispers ion system.

12Hours

3. Melting Point And Phase Transition Processes : quantum-size-effect (QSE) Size-induced metal-insulator-transition (SIMIT) nano-scale magnets, transparent magnetic materials and ultrahigh-density magnetic recording materials – chemical physical of atomic and molecular clusters. Surface energy – chemical poten tial as a function of surface curvature – Electrostatic stabilization – surface charge density-electric potential at the proximity of solid surface-van der Waals attraction potential. Photochemistry, Photoconductivity, Electrochemistry of nanomaterials – Diffusion in Na nomaterials , Nanoscale Heat transfer, Catalysis by Gold Nanoparticles, Transport in semiconductor Nanostructures, Transition Metal Atoms on Nanocarbon Surfaces, Nano deposition of soft materials, Nanocatalysis.

Surface Modification Of Nanoparticles: Surface modification of inorganic nanoparticles by organic functional groups Instantaneous nano foaming method for fabrication of closed –poro sity silica particle- Development of photo catalyst inserted into surface of porous alumina silicate- Fabrication technique of organic nano crystals and their optical properties and matetialization, Dispersion control of nanoparticles in solvents – Development of new cosm etics based on nanoparticles – Development of funct ional skincare cosmetics using biodegradable PLGA nano spheres**.** **14 Hours**

4. Application Of Quantum Dots For Bio-Medical Engineering: Bio- imaging with quantum dots – Pinpoint drug and gene delivery-delivery to the brain – Development of the thermo r esponsive magnetic nanoparticle and its deployment in the biotechnology field, Addressing of nanoparticles by using DNA molecules, Nanoparticle formation of DNA (globule transformation) – Development and multi-functionalization of high – functional separ ation membranes – Design of nanoparticles for oral delivery of peptide drugs.

6Hours

5. Smart Materials And Systems : Thermoresponsive materials, piezoelectric materials, electrostrictive and magnetostrictive materials, ferrofluids, ER and MR fluids, biomimetic materials, smart gel, shape memory alloys and polymers, actuation methods, measurements. **6 Hours**

TEXT BOOKS:

1. Edward L. Wolf. “Nanophysics and Nanotechnology” – An Introduction to Modern Concepts in Nanoscience “ Second Edition, John Wiley & Sons, 2006.
2. K.W. Kolasinski, “Surface Science Foundation of Cat alysis and Nanoscience “, – Wiley, 2002
3. G.A. Ozin and A.C. Arsenault, “Nanochemistry: A che mical approach to Nanomaterials” , 2005.
4. Nanostructues and Nanomaterials Synthesis, Properties and applications, G.Cao Imperial Collage Press 2004.

REFERENCEBOOKS :

1. Valdimir P, Torchilin (2006) Nanoparticulates as Drug Carriers imperial college press.
2. M Reza Mozafari (2007) Nanomaterials and Nanosystems for Bio-Medical Applications springer.
3. Nanotechnology – Basicscience and emerging technolo gies Chapman and Hall/CRC(2002).
4. Nanomaterials and Nanotechnologies and design on introduction for engineers and architects, Micheal F. Ashby, P.J. Ferreria, D.L. Sehodek.

Course Outcome:

Students will be able to understand the synthesis, properties and industrial applications of nanostructures and nanomaterials

Elective-I

ADVANCED MATERIALS AND PROCESSING

Sub Code	: 16 MST151	*IA Marks*	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:

This course provides a comprehensive knowledge of production, structure, property, function relation and application of a number of advanced materials used in industrial applications.

Course Content:

1. Classification and Characteristics: Metals, Non ferrous Metals and Ferrous Metals, classification of Ferrous Metals and Non Ferrous Metals, Types of Ceramics, Polymers and composites and classification of composites.

General Properties and Structure: Atoms, molecules bonds in solids, Crystalline - Defects in Metallic structure, Dislocations and plastic deformation - Strengthening mechanism - grain size, dislocation - Cold work, precipitation hardening, dispersion hardening - phase reactions, fatigue and Creep behaviour. **12 Hours**

2. Ferrous Alloys: iron carbon equilibrium diagrams - Steels and cast irons - properties, structure, composition and applications transformation hardening in steels - TIT diagrams - Heat treatment processes - Effect of alloying elements - High alloy steels, Stainless steel types, tool Steels, Manganese steels, heat resistant steels, HSLA, Managing steels.
Non Ferrous Alloys: Alloys of copper, Aluminium, nickel, magnesium, titanium, lead, tin, Zinc - composition, heat treatment, structure, properties and applications. **12 Hours**

3. Polymers and Polymerizations: Structure and properties of thermoplastics and thermo sets – Engineering Applications - property modifications - Mechanical and thermal behaviour – processing methods.
Ceramics : Nature and structure of Ceramics - Refractory Abrasives glasses - glass ceramics - Advanced ceramics processing methods.
13 Hours

4. Composites : Definition - classification and characteristics of composite materials - Volume fraction - laminated composites particulate composites, fibrous composites - Types of reinforcements, their shape and size - production and properties of fiber reinforced plastics, Metal Matrix composites and ceramic matrix composites - Applications.
7Hours

5. Processing of Polymers: composites, ceramics - thermal spraying - Ion beam machining diamond coating techniques-tribological 14

Applications. **6 Hours**

TEXT BOOKS:

1. Engineering Metallurgy - Raymond and Higgens - ELBS/EA
2. Introduction to Material Science and Engineering James.F.Shackleford - Mc Millan, NY - 7th edition.

REFERENCE BOOKS:

1. Powder Metallurgy-Metals Hand Book -ASM, USA - Vol.7, 1974.
2. Composite Materials - Science and Engineering - Chawla K.K. , - Springer - Verlag, Newyork - 2nd edition, 1998.
3. Cast Metal Matrix Composites ASM Metals Hand Book - P.K. Rohagti - VI5.
4. Elements of Material Science and Engineering - Van Vlack L.H. - Addison Wesley, NY - 1989.
5. Material science and metallurgy - by Calliester, John Willey & Sons.

Course Outcome:

Students will be able to understand various properties of advanced materials and associated technologies and make sensible choice of the appropriate material/technology for a given industrial application

ADVANCED FOUNDRY TECHNOLOGY

Sub Code	: **16MST152**	*IA Marks*	: **20**
Hrs/ Week	: **04**	**Exam Hours**	: **03**
Total Hrs.	: **50**	**Exam Marks**	: **80**

Course Objective:

Advanced foundry technology gives students insight into various principles, gating system design, die / pattern design and practices used in foundries.

Course Content:

1. Solidification of Casting: Concept of solidification of metals. Homogenous and heterogeneous nucleation. Growth mechanism. Solidification of pure metals and alloys. Mechanism of columnar and dendritic growth. Coring or Segregation. Solidification time and Chvorinov's rule. Concept of progressive and directional solidifications.

Principles of Gating and Risering: Purpose of the gating system. Components of the gating System and its functions. Design of the gating System. Different types of gates. Gating ratio and its functions. Definition and functions of the riser. Types of risers and their application. Design of the riser - its shape. Size and location. Use of insulating material and exothermic compounds in risers.

12Hours

2. Design of Casting and Quality Control:: Factors to be considered in casting design. Design consideration in pattern making, moulding techniques and core making and assembly. Cooling stresses and hot spots in casting and modification in casting geometry to overcome them. Casting defects and factors responsible for them. Different inspection and testing methods to evaluate the casting. Quality control activities in a foundry. Salvaging methods of defective casting.

Furnace Technology: Study of various furnaces used in foundry, construction and operation of crucible and hearth furnaces. Resistance, Arc and Induction furnaces-their construction. Operation and application. Heat treatment furnaces and drying ovens used in foundry.

12Hours

3. Gray Cast - Iron Foundry Practice Malleable Cast Iron: Chemical Composition and structure of gray cast iron. Moulding, gating and risering techniques. Melting of gray cast iron in Cupola and induction furnace. Inoculation of gray cast iron. Application of gray cast iron castings. Chemical composition and structure of White-heart and black-heart malleable cast iron. Melting malleabilisation heat treatment and application of malleable cast iron. **8 Hours**

4. **Aluminium Foundry Practice**: Composition, properties and application of common aluminum alloy casting. Melting and casting of 16

AI-alloys. Gating and risering of AI-alloy casting.

Copper Alloy Foundry Practice: General characteristics of common cast copper alloys. Melting and casting of copper alloys. Gating and risering of cu-alloy castings. **12 Hours**

5. Foundry Mechanization and Modernization: Introduction to modernization. Mechanization of foundry and its advantages. Mechanization of sand plant, moulding and core making mechanization in melting, pouring and shakeout units. Material handling equipments and conveyor systems. Brief sketches and description of layouts of job. Captive and mechanized foundries.

6 Hours

TEXT BOOKS:

1. A Test Book of FoundryTechnology - Lal, M. Khanna, P.O - DhanpatRai & Sons Publication.

REFERENCE BOOKS:

1. Principle of Metal Casting - Heine, et. al - Tata-McGraw-HiII Publication - 2003.
2. Foundry Technology - Beelely, P.R. – Butterworth.

Course Outcome:

Students will able to learn basic principles and advanced foundry concepts which enable them to realize its ap

NON DESTRUCTIVE TESTING
(Common to MST,MTE)

Sub Code	:	16 MST153	***IA Marks***	:	20
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	80

Course Objective:

Exposure to various non destructive testing methods which is essential in advanced manufacturing applications, the course aims at giving an insight into various Non Destructive Testing methods used in practice.

Course Content:

1. **Introduction to ND Testing:** selection of ND methods, visual inspection, leak testing, Liquid penetration inspection, its advantages and limitation.
Magnetic Particle Inspection: Methods of generating magnetic field, types of magnetic particles and suspension liquids steps in inspection – application and limitations **.** **12 Hours**

2. **Eddy Current Inspection:** principles, operation variables, procedure, inspection coils, and detectable discounts by the method.

Microwave Inspection: Microwave holography, applications and limitations.

Ultrasonic Inspection: Basic equipment characteristics of ultrasonic waves, variables inspection, inspection methods pulse echo A,B,C scans transmission, resonance techniques, transducer elements couplets, search units, contact types and immersion types inspection standards-standard reference blocks. **18 Hours**

3. **Radiography Inspection:** principles, radiation source X-rays and gamma rays, X-ray-tube, radio graphic films, neutron radiography, Thermal inspection principles, equipment inspection methods applications.
7Hours

4. **Optical Holography:** Basics of Holography, recording and reconstruction - Acoustical Holography: systems and techniques applications. Indian standards for NDT. **7 Hours**

5. **Visual Inspection and Thermographic methods :** Acoustic emission, Total acoustic emission, felicity ratio, Generation of Acoustic Emission**.** **6 Hours.**

TEXT BOOKS:

1. The Testing Instruction of Engineering Materials - Davis H.E Troxel G.E wiskovil C.T - McGraw hill.

REFERENCE BOOKS:

1. Non Destructive Testing - Mc Gonnagle JJ – Garden a nd reach New York.
2. Non Destructive Evolution and Quality Control - volume 17 of metals hand book 9 edition Asia internal 1989.

Course Outcome:

Students will be able to understand significance and suitability of various non destructive testing methods in industrial applications.

SELECTIONS OF MATERIALS IN ENGINEERING

Sub Code	**: 16 MST154**	*IA Marks*	**: 20**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 80**

Course Objective:

Course aims at providing students information about various aspects of material testing, selection of mechanical properties and suitability of materials to different industrial applications.

Course Content:

1. Introduction to Selection of Mechanical Properties: Types of materials Static strength, Toughness, Stiffness, Fatigue Creep, Fatigue & Thermal Properties. **6 Hours**

2. Selection for corrosion resistance The nature of the corrosion process , selection of materials for resistance to atmospheric corrosion , selection of materials for resistance to oxidation at elevated temperatures , selection of materials for resistance to corrosion in the soil , selection of materials for resistance to corrosion in water , selection of materials for chemical plant , degradation of polymeric materials.

Selection of materials for resistance to wear: The mechanisms of wear, The effect of environment on wear Surface treatment to reduce wear , Erosive wear , Selection of materials for resistance to erosive wear.

12Hours

3. The relationship between materials selection and materials processing: The purpose of materials processing, the background to process selection. The casting of metals and alloys, wrought products, the manufacture of plastics. Fabrication from powder, Fastening and joining. **7 Hours**

4. Materials for Aerospace Application: Principal characteristics of aircraft structures, Property requirements of aircraft structures, Requirements for high-speed flight, Candidate materials for aircraft structures.

Materials for ship structures & automotive application: The ship girder, Factors influencing materials selection for ship hulls, Materials of construction. **13 Hours**

5. **Materials for engines and power generation:** Internal combustion, External combustion.

Materials for bearings &High Temperature Application: Rolling bearings, Plain bearings.

12 Hours

TEXT BOOKS:

1. F A A Crane and J A Charles.

REFERENCE BOOKS:

1. Engineering Materials by O.P.Khanna.
2. Applied Materials W.D. Callister.

Course Outcome:

Students will be able to demonstrate their knowledge in selection of engineering materials for various engineering applications.

Material Characterization Lab – 1

Subject Code:16MST16	IA Marks : 20
Hours/Week : 6	Exam Hours : 03
Total Hours : 84	Exam Marks : 80

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Contents:

1. Determine the effect of heat treatment on formability limits of automotive steels.
2. Establish relationship between microhardness and grain size of aluminum alloy castings.
3. Construct the hardanability curves on automotive / structural steels.
4. Asses the defects of castings / welding by ultrasonic or eddy current test.
5. Correlate microstructure with hardness of rolled /extruded/forged steels.
6. Establish relationship between hardness and microstructure of forged/rolled/extruded popular aerospace / light alloys.
7. Study the effect of quenching media on microstructure and hardness of high speed steels.
8. Heat treatment of super alloys (Titanium/nickel/iron based)
9. Microstructure studies on electroplated components (Titanium/nickel/Iron based)
10. Correlation of microstructure and hardness of Anodized surfaces.

II Semester

COMPOSITE MATERIALS TECHNOLOGY

(Common to MST,MDE,MMD,CAE,MEA)

Sub Code	**:**	**16MST21**	**IA Marks**	**:**	**20**
Hrs/ Week	**:**	**04**	**Exam Hours**	**:**	**03**
Total Hrs.	**:**	**50**	**Exam Marks**	**:**	**80**

Course Objective:

This course aims at providing comprehensive knowledge on composite materials, its design, analysis and fabrication.

Course Content:

1. Introduction to Composite Materials: Definition, Classification, Types of matrices material and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction.
   Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems. **12 Hours**

2. Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems.

   Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problems.

   12 Hours

3. Macro Mechanical Analysis of Laminate: Introduction, code, Kirchoff hypothesis, CLT, A, B, and D matrices (Detailed derivation) Engineering constants, Special cases of laminates, Numerical problems.

   Manufacturing and Testing: Layup and curing - open and closed mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests – Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.

   14 Hours

==========

4. Metal Matrix Composites: Re-inforcement materials, Types, Characteristics and selection, Base metals, Selection,Applications. **6 Hours**

5. Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites. **6 Hours**

Text Books:

1. Composite Materials handbook, Mein Schwartz Mc Graw Hill Book Company, 1984.
2. Mechanics of composite materials, Autar K. Kaw CRC Press New York.

Reference Books:

1. Mechanics of Composite Materials, Rober M. Joness Mc-Graw Hill Kogakusha Ltd.
2. Stress analysis of fiber Reinforced Composite Materials, Michael W, Hyer Mc-Graw Hill International.
3. Composite Material Science and Engineering, Krishan K. Chawla Springer.
4. Fibre Reinforced Composites, P.C. Mallik Marcel Decker.

Course Outcome:

Students develop expertise in Composite materials application and its analysis in designing components for engineering applications.

SMART MATERIALS AND STRUCTURES

(Common to MST,MTR)

Sub Code	:	16 MST 22	IA Marks	:	20
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	80

Course Objective:

Knowledge of smart materials and structures is essential designing mechanical systems for advanced engineering applications ,the course aims at training students in smart materials and structures application and analysis

Course Content:

1. Smart Structures: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements Of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor.

Beam Modeling: Beam Modeling with induced strain Rate effects, Inchworm Linear Motor Beam Modeling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezoelectrical Applications. **12 Hours**

2. Shape memory Alloy: Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications Of SMA and Problems.

ER and MR Fluids: Mechanisms and properties, Fluid Composition and behavior, The Bingham Plastic and Related Models, Pre-Yield Response.Post-Yield flow applications in Clatches, Dampers and Others.

13Hours

3. Vibration Absorbers: series and Parallel Damped Vibrations (OverView), Active Vibration Absorbers, Fiber Optics, Physical Phenomena,Characteristics, Sensors, Fiber Optics in Crack Detection, applications.

Control of Structures: Modeling, Control Strategies and Limitations, Active Structures in Practice.

13Hours

4. MEMS – Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration. **6 Hours**

5. Devices: Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions), Polymers in MEMS, Optical MEMS Applications.

6 Hours

TEXT BOOKS :

1. Smart Materials and Structures - M. V. Gandhi and B. So Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials - B. Culshaw, Artech House, Boston, 1996 (ISBN :0890066817).
3. Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

REFERENCE BOOKS:

1. Electroceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN: 0471497429
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4. Handbook of Giant Magnetostrictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5. Shape Memory Materials - K. Otsuka and C. M. Wayman, Cambridge University Press, Cambridge; New York, 199~ (ISBN: 052144487X).

Course Outcome:

At the completion of this course, students will be able to:

1) Understand the behaviour and applicability of various smart materials
2) Design simple models for smart structures & materials
3) Perform simulations of smart structures & materials application
4) Conduct experiments to verify the predictions

TESTING OF MATERIALS

Sub Code	: 16MST23	*IA Marks*	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:
Students are oriented to various testing methods used to characterize materials in engineering applications.

Course Content:

1. Testing machines and sensors: types of Universal Testing machines and principles of operations, Machine stiffness, load and strain measurement. Calibration and verification of UTM.

Friction, wear and surface testing: Testing of sliding contact, damage, abrasive wear, adhesive wear, erosive wear. Testing and dermination of surface characteristics of solid materials.(Surface roughness measurements)

12Hours

2. Importance of calibration of Testing Instruments: Calibration methods and standards .Tests / experiments based on methods with active reference to various codes and standard for each test.

Failure Analysis: Principles and Approaches of Failure analysis, objectives, scope, planning, preparation. Failure Analysis procedures. examination of damages and materials evaluation. Tools and Techniques in FA – An overview. Appearances of fracture in common conditions like unit axial loads, tensional and shear loads, fatigue and creep loading. **12 Hours**

3. Microscopy : Optical microscope, scanning electron microscope. Preparation of Specimens for microscopic study**.**

Speed & Control of Testing Background ,Developments in testing Machine Technology, Effects of testing rates on properties ,Results before servo control ,Results from servo controlled machines.

13Hours

4. Strain Rate Testing Aim of Recommendations ,Abbreviations and Symbols ,Test Machine Requirements ,Specimens Measurements , Data Processing , General Defi nitions Strength Hardening Constitutive Relations to Model Material Strain Rate Dependency. **7 Hours**

5. Lubrication & Determination of characteristics of lubricants: Introduction, Types of lubricants, characteristics of lubricants Methods of lubrication, four ball testing. **6 Hours**

TEXT BOOKS:

1. Testing of Metallic Materials – A.V.K. Suryanarayan , Prentice Hall of India.

REFERENCE BOOKS:

1. ASM Vol Testing of materials
2. Inspection of Materials, Vol. II – Destructive Meth ods, R.C. Andersen, ASM 1988.
3. Workability Testing Techniques, G.E. Dieter, ASM 1984.
4. Relevant codes and standards.

Course outcome:

Students will be able to understand and correlate various testing methods used in industries.

NON-TRADITIONAL MACHINING

(Common to MST,MTE,MCM,IAE,MAR)

Sub Code	:	16MST24	IA Marks	:	20
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	80

Course learning objectives:

1. To demonstrate the need for development of newer/ non-traditional machining processes.
2. The student will be able to identify different energy sources like fluid motion, electric current, high speed electrons, high energy radiation, etc.
3. To analyse the concept, mechanism, parameters associated with the processes.
4. To demonstrate the operational principles, advantages applications, limitations of the various non-traditional machining processes.

Course Content:

1. Introduction: Need for non-traditional machining processes, Process selection, classification, comparative study of different processes.

Ultra Sonic Machining: Definition, Mechanism of metal removal, elements of the process, Tool feed mechanisms, Theories of mechanics, effect of parameters, Different types of concentrators, horn design, applications, Limitations**.**

Abrasive Jet Machining: Principle, Process parameters, Influence of process parameters on MRR , applications, advantages and disadvantages.

Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of water Jet machinery.

14Hours

2. Thermal Metal Removal Processes: Electric discharge machining, Principle of operation, mechanism of metal removal, basic EDM circuitry, spark erosion generators, Analysis of relaxation type of circuit, material, rem
oval rate in relaxation circuits, critical resistance parameters in Ro Circuit, Die electric fluids, Electrodes for spark erosion- surface finish, applications.

Electro Chemical machining (ECM): Classification of ECM process, Principle of ECM, Chemistry of the ECM process, parameters of the process, Determination of the metal removal rate, dynamics of ECM process, Hydrodynamics of ECM process, polarization, Tool Design, advantages and disadvantages-applications. Electro Chemical grinding, Electro Chemical honning, Electrochemical deburring.

14 Hours

3. Chemical Machining: Introduction, fundamental principle types of chemical machining, Maskants, Etchants, Advantages and disadvantages, applications, chemical blanking, chemical milling (contour machining), Hydrogen embrittlement.

Plasma arc Machining: Introduction, Plasma, Generation of Plasma and equipment, Mechanism of metals removal, PAM parameters, process characteristics, types of torches, applications.
Electron beam machining(EBM): Introduction, Equipment for production of Electron beam, Theory of electron beam machining, Thermal & Non thermal type, Process characteristics, applications.

12Hours

4. Laser Beam Machining: Introduction, principles of generation of lasers, Equipment and Machining Procedure, Types of Lasers, Process characteristics, advantages and limitations, applications of laser beam machining. CO_2 Laser: Principle, Equipment, Applications.
Ion Beam Machining: principle, equipment, working, sputtering rate, applications.

6 Hours

5. High Velocity forming processes: Introduction, development of specific process, selection, comparison of conventional and high velocity forming methods.
Types of high velocity forming methods: explosion forming process, electro-hydraulics forming, magnetic pulse forming. Applications, Advantages and limitations. **12 Hours**

Text Books:
1. **Modern Machining Process -** P.C Pandy & H.S Shan Tata Mc Graw Hill.
2. **Modern Machining Processes -** P.K Mishra
3.Thermal Metal Cutting Processes-Dr.B.J.Ranganath,I K International,New Delhi

Reference Books:
1. **New technology -** Bhattacharya, Institution of Engineers, India
2. **Production technology -** HMT Tata Mc Graw Hill.
3. **Metals hand book** - ASM Vol-3.
4. **High velocity forming of metals -** F.M Wilson ASTME PreticeHall.
5. **Modern Manufacturing Methods -** Adithan

Course Outcomes:
1. Student will be in a position to appreciate the merits of non traditional machining and its application in Industries.
2. Justify and demonstrate the benefits of non-traditional machining processes over traditional machining processes.
3. Students will be able to decide a process suitable for a particular material based on the availability of the sources.

SURFACE TREATMENT AND FINISHING

Sub Code	: 16MST251	*IA Marks*	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:
Students will be able to learn various surface treatment and finishing techniques used in various industrial applications.

Course Content:

1. **Fundamentals of Electro plating**, galvanizing, Hot dip metal coating, thin coating, thin coating, chromium plating, Nickel plating.

Vacuum coating, FVD & CVD metal spraying - Methods, surface preparation, mechanical. **12 Hours**

2. **Properties of sprayed metals**, Various types and plasma coating.

Plastic coating of metal - PVC coating Spherodising process details, phosphate coating - mechanism of formation. **14Hours**

3. **Testing of surface coating**- Various methods used.

Heat treatment methods, Aneleaing, Normalizing, Tempering, Case hardening methods, flame hardening sub zero treatment **12 Hours**

4.Heat treatment methods for gears, spindles, cutting tools. **6 Hours**

5 Advanced coating technologies: Hard facing, electro deposition technique, nanocoatings, **coating** characterization **6 Hours**

TEXT BOOK:

1. Surface preparations & finishes for Metals - James A Murphy - McGraw Hill.

REFERENCE BOOKS:

1. Principles of metal surface treatment and protection - Pergamon Press Gabe, David Russell - Description, Oxford ; New York - 2d ed., 1978.
2. Handbook of metal treatment and testing - John wiley & sons.
3. Heat Treatment of Metals – Zakrov - MlR Publication s.
4. Metals Hand Book – ASM.

Course Outcome:
Students will be able gain knowledge in surface treatment, electroplating, surface coating and heat treatment techniques.

AGILE MANUFACTURING
(Common to MST,MCM,IAE,MAR)

Sub Code	:	16MST 252	IA Marks	:	20
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	80

Course Objectives:

The Student will

1. Get an overview of Agile Manufacturing, need and strategies.
2. Know the process of developing an agile manufacturing/enterprise. Integrating Product/Process development.
3. Learn the computer control of agile manufacturing.

Course Content:

1. **Agile Manufacturing:** Definition, business need, conceptual frame work, characteristics, generic features. Four Core concepts: Strategy driven approach-integrating organization, people technology, interdisciplinary design methodology.

   6Hours

2. **Developing Agile Manufacturing:** Enterprise design, System concepts as the basic manufacturing theory-joint technical & Organizational design and a model for the design of agile manufacturing enterprise. Enterprise design process insights into design processes, what is interdisciplinary design, main issues, simple design example.

   Integration of Product /Process Development: Principles, Robust design approach, Approaches to enhance ability in manufacturing, Role of QFD, Managing people in Agile organization, Approaches. **12 Hours**

3. **Application of IT/IS Concepts In Agile Manufacturing:** Strategies, Management of complexities and information. flow, approaches, applications of multimedia to improve agility in manufacturing, system concepts.

   Agile Supply Chain Management: Principles, IT/IS concepts in supply chain management, enterprise integration and management in agile manufacturing, concepts, Agility, Adaptability and learners – comparison of concepts.

   13Hours

4. **Computer Control Of Agile Manufacturing:** CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing, Cellular manufacturing, concepts, examples.

   Corporate Knowledge Management In Agile Manufacturing: Strategies, strategic options in Agile manufacturing, Role of

standards.

12Hours

5. **Design of Skill & Knowledge**: Enhancing technology for Machine tool system, Resumption of design requirement geometry, definition, methods, decision support for selection of cutting parameters, design enhancements, parametric approach only.

7 Hours

TEXT BOOKS:

1. 'Agile Manufacturing - Forging Mew Frontiers', Poul T Kidd**,** Amagow Co. UK, ISBN-0-201-63163-6, 1994.

2. ''Agile Manufacturing", A Gunasekharan, the 21st CenturyCompetitive strategy, ISBN -13 978-0-08-04 3567-1, Elsevier Press, India.

REFERENCE BOOKS:

1. O Levine Transitions to Agile Manufacturing, Joseph C Moutigomery and Lawrence – Staying Flexibl e for competitive advantage, ASQC quality press, Milwaukee. Wisconsin, USA, 1996.

2. Agile Development for Mass Customization, David M Anderson and B Joseph Pine, Irwin Professional Publishing, Chicago, USA, 1997.

Course Outcomes:

Students will be able to:

1. Understand conceptual frame work of agile manufacturing environment.
2. Get insight into Enterprise design process, apply interdisciplinary design concepts.
3. Develop characteristic difference between lean manufacturing and agile manufacturing and appreciate benefits that can be derived by adopting newer manufacturing strategies.

ADVANCED MOULDING TECHNIQUES

Sub Code	: 16MST253	*IA Marks*	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:
The course gives complete overview of advanced moulding techniques in various industrial applications.

Course Content:

1. Injection Moulding Technology : Microprocessor control injection moulding machine, close loop control, open loop control, CNC control, multi color injection moulding, rotary injection moulding, structural foam moulding, sandwich injection moulding**.**

Metal injection moulding: contact injection moulding, moulding of cellular product like EPS, steam chest moulding, future trends in injection moulding like external & internal inter locking alignment of large moulds, processing of specialty polymers.

10Hours

2. Extrusion : General consideration during extrusion process like specific heat, latent heat, internal conductivity, shape & size of granular hygroscopic nature over temperature, effect of flow property like relaxation time & defects like shark skin, elastic turbulence, influence of TG, TM & crystal growth rate, cooling rate, impact strength, manufacturing of woven sacks etc. co extrusion, co extruded pipe, muilt layer pipe, foam pipe, biaxial oriented pipe. **8 Hours**

3. Lamination : Lamination by extrusion coating, twin screw extrusion, co-rotating & counter rotating, feeding mechanism in twin screw extruder, roll of side feeder & injection feeder, principles of compounding, mixing mechanism etc**.**

6Hours

4. Blow Moulding : Micro processor / CNC controlled blow moulding machine, injection stretch blow moulding of PET, precut moulding, multi layer blow moulding, Parission programming.

Reaction Injection Moulding (RIM): RIM of Polyurethane, material for RIM, liquid RIM & its advantages over conventional injection moulding, RRIM. **12 Hours**

5. PTFE Moulding : Processing techniques used for PTFE, Material consideration, sintering, Ram extrusion, and Paste extrusion, lso statistic. Moulding and skewing technique for PTFE processing.

Advancement in Other Processing Technique : New techniques like Resin transfer moulding, Pultrusion. Filament winding, multi 34

layer rotation moulding, Electro plating and printings, Centrifugal casting, Shrink film, Clink film.

14 Hours

TEXT BOOKS:

1. Injection Moulding, Rubin.
2. Extrusion –Berln.

REFERENCE BOOKS:

1. Extrusion Die Design, M. V. Joshi.
2. Polymer Chemistry, Gowriker

Course Outcome:

Students will be able to demonstrate their knowledge in the field of advanced moulding methods.

MANUFACTURING OF ELECTRONIC COMPONENTS

Sub Code	: 16MST 254	*IA Marks*	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:
Students will be able to learn manufacturing of electronic components like IC's,Silicon wafer,electronic assembly which gives them processing methods used in electronic industries.

Course Content:

1. Introduction: Important components of Electronic products. Types of Semiconductor materials and properties and their properties.

Manufacturing ICs: The functions of Ics manufacturing of diodes. Production of a single I component classification of Ic Architecture. **12 Hours**

2. Manufacturing of Silicon Water: fabrication of IC on silicon wafers Fabrication of IC on Silicon wafers. Diffusion doping, Ion Implantation, Rapid thermal processing- Thermal oxidation Monolithic processing, Lithography, Photolithography, Etching processes.

Thin film Deposition: Physical vapour Deposition, chemical vapor deposition, Epitoxial growth, IC component interconnection, IC yield and economics. **12 Hours**

3. IC packing. Types of packaging process.

Printed Circuit Boards: Typical substrate (base) Materials and selection of substrate materials, Types of PCBs. Methods of manufacturing Of PCBs. **12 Hours**

4. Electronic Assembly: General Description of Electronic Assembly detailed study of sequences of operation for through-hole and surface mount process. **6 Hours**

5. Micro Electro-Mechanical systems Introduction to micro sensors MEMS, micro machines fundamentals of Silicon micro machining- Bulk & surface micromachining. Micro stereo lithography.Micro sensors: Types & brief description and applications of Thermal and Smart sensors & MEMS Devices**.** **8 Hours**

TEXT BOOKS:
1. E. Paul Degarmo, IT Black and Ronald A Kohser: Materials and processes in manufacturing. Wiley student Edition 2004

2. Minger ML. Electronics materials handbook Vol 1. Packing ASM

REFERENCE BOOKS:

1. RF: Semiconductor fundamentals Addisor-Wisley, Reading mass.1998.

2. CA Harper & RM Sampson : Electronic materials & processes handbook 2nd Edition Mc Graw Hill 1994. Jarger RC: introduction to Microelectronic Fabrication. Addision – Wesley 1990

3. Cambell A: The science and Engineering of microelectronics Oxford University press 2001.

Course Outcome:

Students will be able to realise intricate manufacturing techniques associated with manufacturing electronic components.

Advanced Material Processing Lab-2

Subject Code:16MST 26	IA Marks: 20
Hours/Week : 3	Exam Hours : 03
Total Hours : 38	Exam Marks : 80

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Contents:

1. Fractography analysis of failed mechanical components.
2. Effect of heat treatment on fatigue life of structural steels.
3. Hot corrosion testing on super alloys.
4. Friction stir welding on non ferrous alloys.
5. Study on heat affected zone (HAZ) - microstructure and microhardness of TIG welded Aluminum alloys (T6) /ferrous alloys.
6. Effect of pouring temperature on fluidity of A356 automotive alloy.
7. Use of simulation package like deform - to study the effect of process parameters on the extruded/forged/rolled products.
8. Demonstration of thermal spray processes (Wire spray/ arc spray/ plasma spray/HVOF).
9. Construction of merchant circle diagram for turning operation of mild steel and to compute power requirement for turning operation.
10. Prediction of cooling curves of castings using the commercially available FEA software.

IV Semester
PLASTIC PROCESSING
(Common to MST,MTE)

Sub Code	: 16MST41	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:

The course aims at providing knowledge about various aspects of plastic processing.

Course Content:

1. Plastic Processing: Basic principle of processing, shape and size, processing parameters, their effect and behavior, Rheology of ideal fluids, and real polymers, Effects of melt behavior on processing and product performance.

7

Injection Moulding: Principles, process variables, moulding cycle, machinery used, parts and function, specification, construction and maintenance of injection moulding machine, start up and shut down procedure, cylinder, nozzles, interaction of moulding variables, press capacity, projected area, shot weight, concepts and their relationship to processing, trouble shooting in injection moulding, microprocessors controlled injection moulding machines. **14 Hours**

2. Extrusion: Basic principles of extruders, and extrusion process, different types of extrudes i.e. barrel, screw, drive mechanics, head, constructional features of dies, sizing and haul-off equipment for extruders of mono filaments and tubes, blown film lines, wire and cable covering system, pipe profile extrusion, co-extrusion, process variables in extrusion like heating, temperature control, dies well, and melt fracture, spacing and orientation, treating, printing and sealing, quality of extruder products, fault, causes and remedy.

Compression and Transfer Moulding: Techniques, various types of compression moulds, machinery used, and common moulding faults and remedies. Transfer moulding, its advantage over compression moulding, equipment used, press capacity, integral mold, and auxiliary mould, moulding cycle, ram pressure, clamping pressure, faults and remedies.

14Hours

3. Blow Moulding: Blow moulding process, processing parameter, materials used, hand operated and automatic blow moulding machine, extrusion blow moulding, moulding cycle, faults and remedies**.**

Thermo Forming: Basic principles, types of thermoforming, thermoforming moulds, processing parameters, faults and remedies. Rotational Moulding: Basic principle, charge size, wall thickness, temperature control, fault causes and remedies.

12Hours

4. Calendaring: Basic principle, process variable, end product properties and applications, secondary processing techniques like powder coating, casting, machining, and joining of plastics, metalizing, printing.

6 Hours

5. Processing of Engineering Plastics: precautions, and start up procedure, preheating, shutdown procedure, quality control, and waste management. Ram Extrusion of PTFE, Processing of reinforced plastics, like filament winding, Hand-lay-up, spray moulding, SMC, DMC, Centrifugal casting, pultrusion, resin transfer moulding.

6 Hours

TEXT BOOKS:

1. Plastic Processing Data Hand Book – Dominic V Rosat o P.E.
2. Modern Plastics Hand Book – Charles A Harper.

REFERENCE BOOKS:

1. Injection Mould Design, Pye R.G. W. - New York-John Wiley & Sons 12th Ed.1989.
2. Injection Moulding Theory & Practice, Rubin. J. Irvin, New York John Wiley & Sons.
3. Blow Moulding Hand Book, Rosato, New York-Oxford University-Hanser Publishers.
4. Principles of Rotational Moulding Process, Bruins.

Course Outcome:

Students will demonstrate their understanding of plastic processing,injection moulding, extrusion and thermo forming.

MODELING, SIMULATION AND ANALYSIS OF MANUFACTURING SYSTEMS

(Common to MCM,MAR,IAE,MST)

Sub Code	**:**	**16MST421**	**IA Marks**	**:**	**20**
Hrs/ Week	**:**	**04**	**Exam Hours**	**:**	**03**
Total Hrs.	**:**	**50**	**Exam Marks**	**:**	**80**

Course Objectives

- To present basic knowledge about modeling, simulation and analysis of a manufacturing system using various techniques.
- To absorb various case studies on MONTE CARLO principle.

Course Content:

1. **Principles of Modeling & Simulation:** Basic Simulation Modeling, Limitation of Simulation, Monte - Carlo Simulation, Areas of Applications, Discrete and Continuous Systems.

10 Hours

2. **Modeling Approaches:** Modeling Complex Systems, Simulation Software, Basics Probability and Statistics, Building Valid and Credible Simulation Models.

10 Hours

3. **Random Number and Variable Generation:** Selecting Input Probability Distributions, Random Number Generators, Generating Random Variants, and Output Data Analysis for a Single System.

10 Hours

4. **Statistical Techniques:** Comparison of Alternative Systems, Variance Reduction Techniques.

10 Hours

5. **Simulation Studies:** Discrete Event Simulation, Simulation of Inventory Problems, Experimental Design and Optimization, Simulation of Manufacturing Systems, Case Studies.

10 Hours

Text Books:

1. **Simulation**, Modeling and Analysis –Averill Law & David M.Kelt on, TMH 3rd Edition.
2. **Discrete event and Simulation Systems** – Banks & Carson, Prentice Hall Inc.

Reference Books:

1. **"System Simulation"** - Gordon, PHI.
2. **"System Simulation with Digital computer"** – Deo, PHI
3. **"Computer Simulation And Modeling"** – Francis Neelamkovil, John Wiley & Sons.

Course Outcome:

Students will be able to

1. Know about various techniques of simulation and modeling used to analyze manufacturing system.
2. Undergo various case studies using real time simulation.

BIO MATERIAL AND TECHNOLOGY

Sub Code	: 16MST422	*IA Marks*	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:

Students learn about various biomaterials and the technology associated with its testing

Course Content:

1. Introduction : Definition of Bio materials , Classification of Bio materials, Comparision of properties of some common bio materials, effects of physiological fluid on properties of bio materials, surface properties, physical and Mechanical properties of Bio materials.
Metallic Implants Materials : Stainless Steel, Co-based alloys, Ti and Ti based alloys, Important of stress corrosion cracking, Host tissue reaction with Bio metal, corrosion behaviour, hard tissue replacement implant, orthopedic implant, dental implants,Percutaneous and skin implants, Vascular implants, Heart valve implant.

12 Hours

2. Polymeric Implant Materials: polyolefins, polyamides, acrylic polymers, fluoro carnon polymers, Silicon rubber acetals. Visco elastic behaviour, creep recovery, stress relaxation, strain rate sensitivity, importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives, aging and environmental stress cracking, physiochemical characteristics of bio polymers, bio degradable polymers for medical purpose and their biological applications.

Ceramic Implant Materials : Definitions of Bio ceramics, common type of Bio ceramics, Aluminium oxides, Glass ceramics, Carbons. Bioresorbable and Bioactive ceramics, Importance of wear resistance and low fracture toughness. Host Tissue reactions, Imprtance of Interfacial tissue reaction**.** **14 Hours**

3. Composite Implant Materials : Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement, polymers filled with osteogenic fillers (e.g. hydrosyapatite). Host tissue reactions.

Bio Compatibility And Toxicological Screening Of Bio Materials : Definition of bio compatibility, blood compatibility and tissue compatibility, toxicity tests, acute and chronic toxicity (in situ implantation, tissue culture, haemolysis, thermombogenic, potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenesity and special tests.

12 Hours

4. **Testing Of Bio Materials Implants** : In vitro testing (Mechanical testing): tensile, compression, wears, fatigue, corrosion studies and fracture toughness. In vivo testing (animals): biolocical performance of implants. Exo- vivo testig, standards of implant materials.

6Hours

5. **Sterilisation Techniques** : ETO, gamma radiation, autoclaving, Effects of Sterilisation on material properties**.**

6 Hours

TEXT BOOKS:

1. **1.** Jonathan Black, Biological performance of materials, MarceDecker,1981.
2. C.P. Sharma & M.Szyehen, Blood Compatible Materials and Devices, Technonic Publishing Co Ltd.,1991.

REFERENCE BOOKS :

1. Piskin and a.S.Hofmann, Polymetric Biomaterials Mantinus Nijhoff publication bordrechnt 1986.
2. J.B. Park, Biomaterials, Science and engineering Plenum Press 1984
3. Sjuata V. Bhat Biomaterials Nonosa Publishing House – 2002

Course Outcome:

Students will be able to know various biomaterials and its testing methods and will be able to understand the significance of its use in various industrial applications.

MECHANICAL BEHAVIOUR OF MATERIALS

Sub Code	: 16MST423	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:
The course aims at giving complete exposure to mechanical behavior of materials and characterization of materials.

Course Content:

1. Strength of materials- basic assumptions, elastic and plastic behaviour, stress–strain relationship for elastic behaviour, elements of plastic deformation of metallic materials Mohr's circle, yielding theories.

Theory of plasticity: Elements of theory of plasticity, dislocation theory properties of dislocation, stress fields around dislocations, application of dislocation theory to work hardening, solid solution strengthening, grain boundary strengthening, dispersion hardening **10Hours**

2. Ductile and Brittle Fracture: Ductile and brittle fracture, Charpy and Izod testing, significance of DBTT, ECT, NDT and FATT; elements of fractography - Griffith's theory, LEFM– COD and J integral –determination of KIC, COD and J integral.

Characteristics of fatigue failure: Initiation and propagation of fatigue cracks, factors affecting fatigue strength and methods of improving fatigue behaviour – testing analysis of f atigue data, mechanics of fatigue crack propagation, corrosion fatigue. **14Hours**

3. Introduction to creep:- creep mechanisms, creep curve, variables affecting creep, accelerated creep testing, development of creep resistant alloys, Larsen Miller parameter – Manson Hafred parameter. **6 Hours**

Stages of failure analysis, classification and identification of various types of fracture.Overview of fracture mechanics, characteristics of ductile and brittle fracture.General concepts, fracture characteristics revealed by microscopy, factors affecting fatigue life Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure. Some case studies failures. **7Hours**

4. Types of wear, analyzing wear failure. Corrosion failures- factors influencing corrosion failures, overview of various types of corrosion stress corrosion cracking, sources, characteristics of stress corrosion cracking. Procedure for analyzing stress corrosion cracking, various types of hydrogen damage failures. **7 Hours**

5. Causes of failure in forging; failure of iron and steel castings, improper heat treatment, stress concentration and service conditions. Failure of weldments - reasons for failure procedure for weld failure analysis.

6 Hours

TEXT BOOKS

1. Dieter G. E., 'Mechanical Metallurgy', 3rd Edition, McGraw Hill, 1988.
2. Suryanarayana, 'Testing of Metallic Materials', Pr entice Hall India, 1979.
3. Rose R. M., Shepard L. A., Wulff J., 'Structure and Properties of Materials', Volume III, 4th Edition, John Wiley, 1984

REFERENCES BOOKS

1. ASM Metals Handbook "Failure Analysis and Preventio n", ASM Metals Park. Ohio,Vol.10, 10th Edition, 199 5.
2. Colangelo.V.J. and Heiser.F.A., "Analysis of Metall urgical Failures", John Wiley and Sons Inc. New Yor k, USA, 1974.

Course Outcome:

Students will develop skill sets to analyse behaviour of materials and analyse its characteristics to find its adoptability for an industrial application.

EXPERIMENTAL METHODS IN ENGINEERING

Sub Code	: 16MST424	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective:

The knowledge of experimental methods in engineering is very essential from the point of view of measurements and experiments that are adopted in industries for evaluation of various parameters, the present course aims at providing a complete insight in this regard.

Course Content:

1. Introduction: Basic concepts of measurement methods, single and multipoint measurement Min space and time. Processing of experimental data, curve fitting and regression analysis. Data Acquisition systems: Fundamentals of digital signals and their transmission, A/D-and D/A converters, Basic components of data acquisition system. Computer interfacing of digital instrument and data acquisition systems; Digital multiplexes, Data acquisition board (DAQ), Digital image processing fundamentals. **8 Hours**

2. Design and Construction of Experimental facilities: wind tunnel, general test rigs, Test cells for flow visualization and temperature mapping**.**

Modeling and Simulation of Measurement System: Lumped analysis, first order and second order systems: Frequency response and time constant calculation. Response of a generalized instrument to random data input, FFT analysis.

12Hours

3. Temperature Measurement: Measurement Design, Construction and Analysis of liquid and gas thermometers, resistance thermometer with wheat stone bridge, Thermo-electric effect, Construction, testing and calibration of thermocouples and thermopiles, Analysis of effect of bead size and shielding on time constant and frequency response, characteristics of thermocouple, pyrometers, radiation thermometers.

Interferometry & Humidity measurement: interferometers, Humidity measurement: Conventional methods, electrical transducers, Dunmox humidity and microprocessor based dew point instrument, Calibration of humidity sensors.

12Hours

4. Flow and Velocity Measurement: Industrial flow measuring devices, design, selection and calibration, velocity measurements, pitot tubes, yaw tubes, pitot static tubes; frequency response and time constant calculation. Hot-wire anemometer; 2d/3d flow measurement and turbulence measurement, Laser application in flow measurement, Flow visualization techniques, Combustion photography.

6 Hours

5. Measurement of Pressure, Force, and Torque: Analysis of liquid manometer, dynamics of variable area and inclined manometer, Pressure transducers, Speed and torque measurement:, speed and torque measurement of rotating system.

Air Pollution sampling and measurement: Units for pollution measurement, gas sampling technique s, particulate sampling technique, gas chromatography. **12 Hours**

TEXT BOOKS:

1. Experimental Methods for Engineers - J.P. Holman, McGraw-Hill Publications

REFERENCE BOOKS:

1. Mechanical Measurements - Beckwith M.G., Marangoni R.D. and Lienhard J.H., Pearson Education.

2. Measurements systems-Application and Design - E.O. Doebelin, Tata McGraw-Hill Publications.

Course Outcome:

Students learn various experimental and measurement techniques which they can adopt in practical applications.