VISVESVARAYA TECHNOLOGICAL UNIVERSITY,
BELAGAVI Scheme of Teaching and Examination – 2018-19
M.Tech in Material Science & Technology (MST)
Choice Based Credit System (CBCS)

I SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Hours Per Week		Examinations				Credits
				Theory	Practical/ SDA	Duration in hours	CIE Marks	SEE Marks	Total	
1	PCC	18MST11	Applied Mathematics	04	--	03	40	60	100	4
2	PCC	18MST12	Finite Element Method	04	--	03	40	60	100	4
3	PCC	18MST13	Materials for Cryogenic and High Temperature Applications	04	--	03	40	60	100	4
4	PCC	18MST14	Nano science and Nano materials	04	--	03	40	60	100	4
5	PEC	18MST15X	Professional Elective -1	04	--	03	40	60	100	4
6	PCC	18MSTL16	Material Characterization Laboratory 1	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
TOTAL				**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1

Course Code under 18XXX15X	Course title
18MST151	Advances in Materials and Processing
18MST152	Advanced Foundry Technology
18MST153	Non Destructive Testing
18MST154	Selection of Material in Engineering

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination will be conducted during III semester and prescribed credit shall be included in the III semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY,
BELAGAVI Scheme of Teaching and Examination – 2018-19
M.Tech. in Material Science & Technology (MST)
Choice Based Credit System (CBCS)

II SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Hours Per Week		Examinations				Credits
				Theory	Practical/ SDA	Duration in hours	CIE Marks	SEE Marks	Total	
1	PCC	18MST21	Smart Materials and Structures	04	--	03	40	60	100	4
2	PCC	18MST22	Testing of Materials	04	--	03	40	60	100	4
3	PEC	18MST23X	Professional Elective 2	04	--	03	40	60	100	4
4	PEC	18MST24X	Professional Elective 3	04	--	03	40	60	100	4
5	OEC	18MST25X	Open Elective 1	04	--	03	40	60	100	4
6	PCC	18MSTL26	Advanced Material Processing Laboratory	--	04	03	40	60	100	2
7	PCC	18MST27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective, OEC: Open Elective

Professional Elective 2		**Professional Elective 3**	
Course Code under 18XXX23X	**Course title**	**Course Code under 18XXX24X**	**Course title**
18MST231	Surface Treatment And Finishing	18MST241	Modeling, Simulation and Analysis of Manufacturing Systems
18MST232	Agile Manufacturing	18MST242	Bio Materials & Technology
18MST233	Advanced Moulding Techniques	18MST243	Mechanical Behaviour of Materials

Open Elective 1

Course Code under 18MST25X	**Course Title**
18MST251	Business Analytics
18MST252	Industrial Safety
18MST253	Operation Research

Open Elective-1

Students can select any one of the open electives offered by any Department (Please refer to list of open electives). Selection of an open elective is not allowed provided,

1. The candidate has studied the same course during the previous semesters of the programme.
2. The syllabus content of open elective is similar to that of professional core courses or professional electives. Registration to electives shall be documented under the guidance of Programme Coordinator/ Adviser/Mentor.

Note:

1. **Technical Seminar :** CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide in any and a senior faculty of the department. Participation in seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.
The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.
2. **Internship:** All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination will be conducted during III semester and prescribed credit shall be included in the III semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY,
BELAGAVI Scheme of Teaching and Examination – 2018-19
M.Tech in Material Science & Technology (MST)
Choice Based Credit System (CBCS)

III SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Hours Per Week		Examinations				Credits
				Theory	Practical/ SDA	Duration in hours	CIE Marks	SEE Marks	Total	
1	PCC	18MST31	Plastic Processing	04	--	03	40	60	100	4
2	PEC	18 MST32X	Professional elective -4	04	--	03	40	60	100	4
3	OEC	18XXX33X	Open elective 2	04	--	03	40	60	100	4
4	Proj	18XXX34	Evaluation of Project phase -1	--	02	--	100	--	100	2
5	INT	18XXXI35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				12	02	12	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective, OEC: Open Elective, Proj: Project, INT: Internship,

Professional elective 4

Course Code under 18XXX32X	Course title
18MST321	Experimental Method in Engineering
18MST322	Manufacturing of Electronics Components
18MST323	Non-Traditional Machining

Open Elective 2

Course Code under 18XXX33X	Course Title
18MST331	Cost Management and Engineering Projects
18MST332	Composite Materials
18MST333	Waste to Energy

Students can select any one of the open electives offered by any Department (Please refer tolist of open electives). Selection of an open elective is not allowed provided,

1. The candidate has studied the same course during the previous semesters of theprogramme.
2. The syllabus content of open elective is similar to that of professional core courses or professional electives. Registration to electives shall be documented under the guidance of Programme Coordinator/ Adviser/Mentor.

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide and a senior faculty of the department.The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent University examinations after satisfy the internship requirements.

Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY,
BELAGAVI Scheme of Teaching and Examination – 2018-19

M.Tech in Material Science & Technology (MST)

Choice Based Credit System (CBCS)

IV SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Hours Per Week		Examinations				Credits
				Theory	Practical/ SDA	Duration in hours	CIE Marks	SEE Marks	Total	
	Project work	18MST41	Project work phase -2	--	04	03	40	60	100	20
TOTAL				--	**04**	**03**	**40**	**60**	**100**	**20**

Note: Proj: Project.

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

I Semester

APPLIED MATHEMATICS

(Common to MST/CAE)

Sub Code :	**18MST11**	**IA Marks:**	**40**
Hrs/ Week :	**04**	**Exam Hours :**	**03**
Total Hrs. :	**50**	**Exam Marks :**	**100**

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. **6Hours**

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. **12Hours**

3) **Numerical Differentiation and Numerical Integration:** Newton –Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae. **6Hours**

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 .

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	**:**	**18 MST12**	**IA Marks**	**:**	**40**
Hrs/ Week :		**04**	**Exam Hours**	**:**	**03**
Total Hrs.	**:**	**50**	**Exam Marks**	**:**	**100**

CourseObjectives

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 **16 Hours**

4. **Beam Elements-Analysis of Beams and Frames:** 1–D Beam 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. **11Hours**

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.
   Cook R. D., et al. "Conceptsand Application of Fini te Elements Analysis"- 4th Edition, Wiley & Sons, 2003.

Course Outcome:

Students will be able to

1. Define the element properties such as shape functions and stiffness matrix for the one, two and three dimensional elements. (PO-1,2,4)
2. Understand the fundamental theory of the FEA method. (PO-1)
3. Develop the ability to generate the governing FE equations for systems governed by partial differential equations. (PO-1,2)
4. Understand and apply the basic finite elements for structural applications using truss, beam, frame, and plane elements. (PO-1,2,3)
5. Analyze and design the FE method for Galerkin approach of 1D element heat transfer problems. (PO-2,3,5)
6. Optimize the design using analysis software. (PO-4,5)

MATERIALS FOR CRYOGENIC AND HIGH TEMPRATURE APPLICATIONS

Sub Code	**: 18 MST13**	**IA Marks**	**40**
Hrs/ Week	**: 04**	**Exam Hours**	**03**
Total Hrs.	**: 50**	**Exam Marks : 100**	

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 J oule Thompson Effect – Magnetic effect – O rtho and Para H2 – Helium4 and Helium3.

12Hours

2. Efficiency of Cryogenic Systems: Types of losses and efficiency cycles – Specific amount of cooling – The fraction liquefied – Coolin g coefficient of performance – Thermodynamic efficiency – The energy balance Metho ds.

Cycles Of Cryogenic Plant: Classification of cryogenic cycles – The structure of cycle – Throttle expansion cycles – Expander cycles – Thermodynamic analysis – Numerical problem s. **12Hours**

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. **12 Hours**

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 Automotive and Aerospace Applications: Cryogenic liquids in missile launching and space simulation – storage of cryogen ic liquids- Effect of cryogenic liquids on properties of Aerospace materials – Cryogenic loadi ng problems – Zero gravity 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

1. Analyze the properties of material at low temperature. Pressure, temperature, flow, fluid quality and liquid level measurement at low temperature. (PO-2)
2. Analyse the different types of cryogenic insulations. (PO-2,4)
3. Understand and analyze material used for the different cryogenic applications and Low temperature hazards. (PO-2,7)

NANOSCIENCE AND NANOMATERIALS
(Common to MST,MTE)

Sub Code	**: 18MST14**	**IA Marks**	**40**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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 o f gas permeation and separation membranes.

Nanostructure Design: Functionality of nanostructures and their characteristics evaluation, size effect in semiconductor nanoparticles– particl e size, shape density – Melting point, sur face tension, wettability – specific surface area a nd pore – Assembly of nanoparticles and fictionalization – nanoparticles arranged struc tur es as nanipores and nanocomposites – Structure c ontrol of nanoparticle collectives by sintering and bounding – Self – assembly. Nanoparticle dispersion and aggression behaviour – Single nanoparticle motion in fluid – Brownian diffusion – Adsorption properties – intera ctions between particles – Aggregation and dispersion, characterization and control – Rheo logy of slurry – Simlation of colloidal dispersion system **12 Hours**

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 p otential as a function of surface curvature
– Electrostatic stabilization – surface charge dens ity-electric potential at the proximity of solid surface-vander 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**. 16 Hours**

4. Application Of Quantum Dots For Bio-Medical Engineering: Bio- imaging with quantum dots – Pinpoint drug and gene delivery- del ivery to the brain – Development of th e thermo responsive 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-fu nctionalization of high – functional s eparation membranes – Design of nanoparticles for o ral delivery of peptide drugs. **6 Hours**

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 Wile y & 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

1. Demonstrate the working knowledge of nanotechnology principles and industry applications. (PO-2)
2. Design the nanoscale paradigm in terms of properties at the nanoscale dimension. (PO-2)
3. Apply key concepts in materials science, chemistry, physics, biology and engineering to the field of nanotechnology. (PO-2)
4. Identify current nanotechnology solutions in design, engineering and manufacturing. (PO-3)
5. Explain chemical reactivity on the basis of structure and electronic arrangements. (PO-2)

Understand and interpret the melting point and phase transition of nano materials. (PO-1,4)

Professional Elective-I

ADVANCED MATERIALS AND PROCESSING

Sub Code	**: 18 MST151**	**IA Marks**	**40**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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 application. **12 Hours**

3. Polymers and Polymerizations: Structure and properties of thermoplastics and thermo sets – Engineering Applications - property modifica tions - 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. **7 Hours**

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

1. Understand and apply the various processing and manufacturing techniques. (PO-5)
2. Knowledge of basics of process and important parameters of equipment design. (PO-3)
3. Understand and apply the techniques and their characteristics/limitations of synthesis of polymers. (PO-1,5)
4. Understand the structure-processing-property relationship of metals and polymers. (PO-3)
5. Understand the basic issues involved in polymer blends, metal matrix composites and ceramic matrix composites. (PO-2)
6. Understand the significance of alloying element and phase diagrams. (PO-3,4)

ADVANCED FOUNDRY TECHNOLOGY

Sub Code	**: 18MST152**	**IA Marks**	**40**
Hrs/ Week	**: 04**	**Exam Hours**	**03**
Total Hrs.	**: 50**	**Exam Marks**	**100**

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. **12 Hours**

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.

12 Hours

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 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 Foundry Technology - 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 be able to

1. To promote understanding of basic facts and concepts in foundry process while retaining the excitement of foundry industry. (PO-1)
2. Understand and apply the studies of different processes used in Foundry Industries and their applications. (PO-1, 2)
3. Acquire the skill and knowledge of terms, facts, concepts, processes, techniques and principles of foundry industries. (PO-2,3)
4. Apply the skill and knowledge of contents of principles of furnace technology. (PO-1,2)
5. Inquire of new skill and knowledge of foundry practises and developments therein. (PO-2,5)
6. Expose and to develop interest in the fields of design of casting. (PO-3,4,7)

NON DESTRUCTIVE TESTING
(Common to MST,MTE)

Sub Code	**: 18 MST153**	**IA Marks**	**20**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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. **7 Hours**

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

1. Understand and analyze the significance and suitability of various non destructive testing for different industrial applications.(PO-1,2)
2. Analyze different metals and alloys by visual inspection method and Thermo graphic method. (PO-2,3)
3. Perform non-destructive tests like: Liquid penetrant test, Magnetic particle test, Eddy current test and Ultrasonic test, X-ray and Gamma ray radiography. (PO-4,5)
4. Identify defects by using relevant NDT methods. .(PO-2,3)
5. Apply the knowledge of optical holography and industrial applications according to Indian standards for NDT. (PO-1,2)

SELECTIONS OF MATERIALS IN ENGINEERING

Sub Code	**: 18 MST154**	**IA Marks**	**: 40**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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. **12 Hours**

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. **13Hours**

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

1. Understand and analyze the physical and chemical properties of materials. (PO-1,2)
2. Formulate the relationships between structure and properties of different materials. (PO-2,3)
3. Select appropriate material for a specific application. (PO-1,2)
4. Identify the relation between material selection and various material processing techniques. (PO-1,4)
5. Analyse the factors and select materials for structure applications like Aerospace, automobile and ship. (PO-2,3)
6. Analyse the factors which influence selection of material for elevated temperature applications. (PO-3,4)

Material Characterization Lab – 1

Sub Code	**: 18MSTL16**	**IA Marks**	**40**
Hrs/ Week	**: 06**	**Exam Hours**	**03**
Total Hrs.	**: 84**	**Exam Marks**	**100**

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 micro hardness and grain size of aluminium 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.

Course Outcome's:

Students will be able to

1. Apply the behaviour of materials under various operating conditions. (PO-1,2)
2. Identification of materials based on micro structure. (PO-2,3)
3. Compare hardness of various materials. (PO-2,4)
4. Design and analyze the effect of heat treatment process on materials. (PO-1,2)

RESEARCH METHODOLOGY AND IPR

Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. ■

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. ■

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. ■

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. ■

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. ■

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR. ■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.

(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,3rd Edition, 2011.

(3) Study Material (For the topic Intellectual Property under module 5),
Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books

(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.

(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

II Semester

SMART MATERIALS AND STRUCTURES

Sub Code	**: 18 MST21**	**IA Marks**	**: 40**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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	**: 18 MST22**	**IA Marks**	**: 40**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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. Appearanc es 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.

Professional Elective-2

SURFACE TREATMENT AND FINISHING

Sub Code	**: 18MST231**	**IA Marks**	**: 40**
Hrs/ Week	**: 06**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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. **12 Hours**

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

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. **12 Hours**

Heat treatment methods, Aneleaing, Normalizing, Tempering, Case hardening methods, flame hardening sub zero treatment. **6 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	**: 18MST232**	**IA Marks**	**: 40**
Hrs/ Week	**: 06**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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.

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 – comp arison 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 CenturyCompetitivestrategy, 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 advant age, 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	**: 18MST233**	**IA Marks**	**: 40**
Hrs/ Week	**: 06**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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.

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**.**

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 and its advantages over conventional injection moulding, RRIM.

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.

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.

Professional Elective-3

MODELING, SIMULATION AND ANALYSIS OF MANUFACTURING SYSTEMS
(Common to MCM,MAR,IAE,MST)

Sub Code	**: 18MST241**	**IA Marks**	**: 40**
Hrs/ Week	**: 06**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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	**: 18MST242**	**IA Marks**	**: 40**
Hrs/ Week	**: 06**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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. 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	**: 18MST243**	**IA Marks**	**: 40**
Hrs/ Week	**: 06**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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. **7 Hours**

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, 1995.
2. Colangelo.V.J. and Heiser.F.A., "Analysis of Metall urgical Failures", John Wileyand 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.

OPEN ELECTIVES–1
(Under the Course code 18XXX25X)

Business Analytics

Subject Code:	: 18MST251	CIE Marks	: 40
Teaching Hours/Week	: (04:0:0)	SEE Marks	: 60
Credits	: 04	Exam Hours	: 03

Course objective:

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Module-1

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

Module – 2

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Module-3

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.

Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Module-4

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using

Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Module-5

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism

COURSE OUTCOMES:

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

Reference Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

INDUSTRUAL SAFETY

Subject Code:	: 18MST252	CIE Marks	: 40
Teaching Hours/Week	: (04:0:0)	SEE Marks	: 60
Credits	: 04	Exam Hours	: 03

Course Objective:

- The course gives a complete overview about the safety concerns in an industry. Handling, disposal and occupational health. Hazards related to industry. Safety of the Individual, machine, material and the premises.

Course Content:

MODULE 01

1) Introduction to industrial safety : 10 Hours

Introduction to industrial safety ,safe use of machines and tools, safety in the use of power presses(all ypes),Shearing,bending,Rolling,Drawing,Turning,Boring,Milling,shaping,Planning,Preventive Maintenance, Incidental safety devices and tools.

MODULE 02

2) **Industrial Hazards:** Types of Hazards ,Radiation its types and effects on human body , handling and disposal of radioactive materials.

Electrical ,safe limits of amperages ,voltages, distance from lines, safe operating procedures for electrical components.

MODULE 03

3) Principles of Accident Prevention:

Definitions: Incident, Accident, injury, Dangerous occurrences, unsafe acts, unsafe conditions, Hazards, error, oversight, mistakes etc.

Accident Prevention theories(models of accident occurrences, principles of accident prevention, financial implications due to accidents, fault tree analysis, Role of government, Role of Management, local authorities and public.

First aid,PPE.

MODULE 04

4) Plant Layout for safety:

Design and location, distance between hazardous units, color coding, lighting , ventilation, flow charts, pilot plant application, machine guarding and its types, Housekeeping.

Machine maintenance, Typical accidents due to poor housekeeping.

Disposal of scrap and other waste, Prevention of spillage, Cleaning methods, Inspections and checklists. Importance of standards and codes of practice for plant equipment.

MODULE 05

5) Safety Management Systems and occupational Health

Introduction and development of OSHAS 18001, Benefits and Implementation.

Industrial Hygiene, Local exhaust ventilation personal Hygiene, Dangerous properties of dust, gases, fumes, mist, smoke, aerosols etc.

Course Outcomes:

- The Student by the end of this syllabus will be able to understand the standard working and safety procedures at an industry.

- Learn the various safety practices while handling different materials.
- Understand the Importance of Safety and first aid.
- Finally the student will be industry ready in terms of safety aspects and handling.

Reference Books:

1) R K Jain And Sunil S. Rao, Industrial Safety, Health and Environment management systems. Khanna Publications, New Delhi(2006).
2) Slote.L Handbook of occupational safety and health. John Wielley and sons , New York.
3) L M Deshmukh, Industrial Safety Management. McGraw Hill Education India Private limited.
4) Frank Pless – Loss of Prevention in process industries Vol 1 and 2. Bulter worth Heineman Ltd London.
5) Industrial safety – National Safety Council of India.
6) OSHAS – 18001 Standard.

Operations Research

Subject Code:	: 18MST253	CIE Marks	: 40
Teaching Hours/Week	: (04:0:0)	SEE Marks	: 60
Credits	: 04	Exam Hours	: 03

Course Outcomes: At the end of the course, the student should be able to

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

Module- 1:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Module - 2

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Module - 3:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Module - 4

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Module - 5

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010.

Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

III Semester

PLASTIC PROCESSING

Sub Code	**: 18MST31**	**IA Marks**	**: 40**
Hrs/ Week	**: 06**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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.

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.

Professional Elective-4

EXPERIMENTAL METHODS IN ENGINEERING

Sub Code	**: 18MST321**	**IA Marks**	**: 40**
Hrs/ Week	**: 06**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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.

MANUFACTURING OF ELECTRONIC COMPONENTS

Sub Code	**: 18MST322**	**IA Marks**	**: 40**
Hrs/ Week	**: 06**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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.

NON-TRADITIONAL MACHINING

Sub Code	**: 18 MST323**	**IA Marks**	**: 40**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**Exam Marks**	**: 100**

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 ofthe 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, removal 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. CO2 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.

OPEN ELECTIVE-2
Cost Management and Engineering Projects

Subject Code:	: 18MST331	CIE Marks	: 40
Teaching Hours/Week	: (04:0:0)	SEE Marks	: 60
Credits	: 04	Exam Hours	: 03

Module-1

Introduction and Overview of the Strategic Cost Management Process

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Module-2

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non- technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Module-3

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

Module-4

Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Module-5

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

References Books:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Composite Materials

Subject Code:	: 18MST332	CIE Marks	: 40
Teaching Hours/Week	: (04:0:0)	SEE Marks	: 60
Credits	: 04	Exam Hours	: 03

Module–I:

INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

Module – II:

REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

Module – III:

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

Module–IV:

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

Module – V:

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References Books:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Waste to Energy

Subject Code:	: 18MST333	CIE Marks	: 40
Teaching Hours/Week	: (04:0:0)	SEE Marks	: 60
Credits	: 04	Exam Hours	: 03

Module--1

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Module-1

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Module-3

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Module-4

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Module--5

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

References Books:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.