M.Tech. in Materials & Manufacturing Technology
Department of Mechanical Engineering
Scheme and Credits

Semester-I

CODE	SUBJECT NAME	L	T	P	C
ME 530	Advanced Material Science	**3**	**0**	**0**	**6**
ME 581	Structural Property Correlation of Engineering Materials	**3**	**0**	**0**	**6**
ME 582	Composite Materials	**3**	**0**	**0**	**6**
ME 5XX	Elective I	**3**	**0**	**0**	**6**
ME 5XX	Elective II	**3**	**0**	**0**	**6**
ME 583	Seminar/ Mini Project	**0**	**0**	**2**	**2**
	Total	**15**	**0**	**2**	**32**

Semester-II

CODE	SUBJECT NAME	L	T	P	C
ME 523	Advanced Solid Mechanics	**3**	**0**	**0**	**6**
ME 593	Advanced Heat Treatment of Metals	**3**	**0**	**0**	**6**
ME 544	Modern Manufacturing Methods	**3**	**0**	**0**	**6**
ME 5XX	Elective III	**3**	**0**	**0**	**6**
ME 5XX	Elective IV	**3**	**0**	**0**	**6**
ME 586	MMT-Lab	**0**	**0**	**2**	**2**
ME 587	Seminar	**0**	**0**	**2**	**2**
	Total	**15**	**0**	**4**	**34**

Semester-III

CODE	SUBJECT NAME	L	T	P	C
ME 607	Project Work - Phase-I	**0**	**0**	**-**	**-**

Semester-IV

CODE	SUBJECT NAME	L	T	P	C
ME 608	Project Work - Phase-II	**0**	**0**	**34**	**34**

Grand Total Credits 100

Electives-I

CODE	SUBJECT NAME	L	T	P	C
ME 507	Optimization Techniques	**3**	**0**	**0**	**6**
ME 528	Computer Aided Manufacturing	**3**	**0**	**0**	**6**
ME 589	Physical and Chemical Characterization of Materials	**3**	**0**	**0**	**6**
ME 575	Innovation & Design	**2**	**1**	**0**	**6**

Electives-II

CODE	SUBJECT NAME	L	T	P	C

ME 588	Failure Analysis and Prevention	**3**	**0**	**0**	**6**
ME 590	Advances in Polymeric Materials	**3**	**0**	**0**	**6**
ME 591	Advanced Ceramics for Strategic Applications	**3**	**0**	**0**	**6**
ME 592	Material Selection and Safety	**3**	**0**	**0**	**6**

Electives-III

CODE	**SUBJECT NAME**	**L**	**T**	**P**	**C**
ME 573	MEMS Technology	**3**	**0**	**0**	**6**
ME 521	Theories of Elasticity	**3**	**0**	**0**	**6**
ME 585	Manufacturing Management	**3**	**0**	**0**	**6**
ME 594	Nano Structured Materials-Synthesis, Properties and Applications	**3**	**0**	**0**	**6**

Electives-IV

CODE	**SUBJECT NAME**	**L**	**T**	**P**	**C**
ME 515	FEM in Engineering Applications	**3**	**0**	**0**	**6**
ME 595	Modelling and Simulation	**3**	**0**	**0**	**6**
ME 596	Advanced Casting and Welding Technology	**3**	**0**	**0**	**6**
ME 540	Production and Operations Management	**3**	**0**	**0**	**6**
ME 584	Processing of Engineering Materials	**3**	**0**	**0**	**6**

ME 530	ADVANCED MATERIAL SCIENCE	L	T	P	C
	First Semester (Core)	3	0	0	6

Atomic structure and interatomic bonding. Lattices, basic idea of symmetry. Bravais lattices, unit cells, crystal structures, crystal planes and directions, co-ordination number. Single crystals, polycrystalline, non-crystalline, nano crystalline materials. Imperfections in solids: point defects, line defects, surface defects. Solid solutions, phases, phase diagrams. Diffusion henomenon, phase transformations. Strengthening mechanisms. Classification of materials, properties of materials. Structure, properties and applications of different metals and alloys, ceramics and polymers.

REFERENCES

1. Materials Science and Engineering, an Introduction, William D. Callister. John Willey and Sons Inc. Singapore.
2. Physical Metallurgy: Principle and Practice, V. Raghavan. Prentice Hall India Pvt Ltd.

ME 581	STRUCTURAL PROPERTY CORRELATION OF ENGINEERING MATERIALS	L	T	P	C
	First Semester (Core)	3	0	0	6

UNIT I Introduction

Stiffness, Strength, and Toughness, Types of mechanical behavior, Relevance, Measurement, data, Macroscopic, continuum behavior, Physical mechanisms controlling behavior.

UNIT II **Elasticity**

Introduction, Stress, strain, compliance and stiffness tensors, Physical origin of elastic moduli, Generalized Hooke's law and its application to crystals, Designing for modulus and Composites.

UNIT III **Continuum Plasticity**

True stress-true strain, Necking and Considere's Criterion, Yield Criteria and yield locus, Normality, Isotropic and kinematic hardening, Plastic stress-strain relations.

UNIT IV **Fracture**

Importance of Fracture Mechanics, Griffith Fracture Theory, Crack Driving Force & Energy Release Rate, Modes of fracture, Stress intensity factors, Similitude, Role of Crack-tip Plasticity--Plastic Zone Size & Shape, K-dominance, Fracture Toughness-Microstructural Issues.

UNIT V **Fatigue**

Total life approaches, Fatigue design approaches, HCF and LCF, Fatigue crack inhibition, Fatigue crack growth, Paris law and models, Threshold, Damage tolerant approach, Striations, Different stages of fatigue crack growth, Examples.

UNIT VI Mechanical Testing Behaviour

Mechanical Characterization: Mechanical Property characterization- Principles & characterization techniques related to tensile, compressive, hardness, fatigue, and fracture toughness properties. Deformation, Super plasticity Stress-strain diagram, Determination of YS, UTS, MoE, %E, %RA, Hardness testing, true stress-strain diagram, stretcher strain characteristics, effects of cold working, & n values, poison's ratio, Deep drawn quality of sheets, Impact test, bend test, shear test, Significances of property evaluation, SN curves and fatigue life, non-destructive testing, residual stress measurements, corrosion testing, wear & tear characteristics, slow strain rate characteristics.

REFERENCES

1. GE Dieter, Mechanical Metallurgy, McGraw-Hill
2. RW Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons
3. MF Ashby and DRH Jones, Engineering Materials 1, Butterworth-Heinemann
4. D Hull and DJ Bacon, Introduction to Dislocations, Pergamon
5. Fracture Mechanics – T.L. Anderson, CRC Press.

ADDITIONAL READINGS

1. MA Meyers and K Chawla, Mechanical Behavior of Materials, Prentice Hall
2. S Suresh, Fatigue of Materials, Cambridge University Press
3. JP Hirth and J Lothe, Theory of Dislocations, John Wiley & Sons
4. And Handouts from time to time

ME 582	**COMPOSITE MATERIALS**	**L**	**T**	**P**	**C**
	First Semester (Core)	3	0	0	6

UNIT I FIBRE REINFORCED PLASTICS (FRP)

Definition; Types; General properties and characteristics; Reinforcing materials – particles, fibers, whiskers; Properties of reinforcing materials; Matrix materials; Additives; Properties of FRP materials; Applications

UNIT II MANUFACTURING PROCESSES

Open mold processes – Hand layup, Spray up, Vacuum bag, Pressure bag & autoclave, Centrifugal casting, Filament winding; Closed mold processes – Compression molding, Resin transfer molding (RTM), Injection molding, Pultrusion; SMC & DMC products, etc.

UNIT III MACROMECHANICAL BEHAVIOR OF FIBRE REINFORCED PLASTICS

Design variables; Selection of fiber-matrix and manufacturing process; Effects of mechanical, thermal, electrical and environmental properties, Fiber orientation, Symmetric and asymmetric structure; Effects of unidirectional continuous and short fibers; Lamination theory; Failure theories.

UNIT IV MICROMECHANICAL BEHAVIOR OF FIBRE REINFORCED PLASTICS

Strengthening methods, Elasticity of fibre composites, Plasticity and fracture of composites, Crack propagation in fibre composites, Failure under compressive loads. Law of Mixtures, Shear lag model, Laminated plate model, Eshelby's models, Other models.

TEXT BOOK

1. Haslehurst.S.E., "Manufacturing Technology ", ELBS, London, 1990.
2. Krishnan K. Chawle. "Composite Material: Science and Engineering" Second Edition, Springer, 1998
3. T.W.Clyne, P.J. Withers, "An Introduction to metal matrix composites", Cambridge University Press, 1993.
4. F.C. Campbell "Structural Composite Materials", Materials Park,ASM International,2010

ME 523	**Advanced Solid Mechanics**	**L**	**T**	**P**	**C**
	Second Semester (Core)	2	1	0	6

Advanced Strength of Materials: Beam Bending and Stability problems, Analysis of Thick Cylinder and Rotating Disk etc., Application of Energy Methods. Equation of Stress Equilibrium: Cauchy's Equation, Stress Quadratic, Principle stresses; Strain Compatibility: Strain Displacement Relations, Principle Strains; Stress and Strain Invariants. Generalized Hooke's law, Lame's Equation of Equilibrium. Introduction to Theory of Plasticity. Experimental stress analysis: basic concept of measuring systems, Causes and types of experimental errors, models and scale factors. Strain gauges: mechanical, optical, electrical etc., Rosette analysis, dynamic applications, strain gauge circuits, recording and indicating devices, digital interfacing, data acquisition and processing. Introduction to theory of photoelasticity.

Reference

1. L. S. Srinath, Advanced Mechanics of Solids, TMH Publishing Co. Ltd., New Delhi.
2. R. G. Budynas, Advanced Strength and Applied Stress Analysis, McGraw Hill Publishing Co.
3. A. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, John Willey and Sons Inc.
4. S. P. Timoshenko, J. N. Goodier, Theory of Elasticity, McGraw Hill Publishing Co.

5. P. Raymond, Solid Mechanics for Engineering, John Willey & Sons.
6. J. W. Dally and W. F. Riley, Experimental Stress Analysis, McGraw Hill Publishing Co., New York.

ME 593	ADVANCED HEAT TREATMENT OF METALS	L	T	P	C
	Second Semester Core	3	0	0	6

UNIT I PHASE TRANSFORMATION IN STEEL

Iron - carbon equilibrium diagram: Transformations on heating and cooling, influence of alloying elements, general principles of heat treatment of steels, isothermal and continuous cooling transformations in steels. Continuous cooling curves TTT and CCT diagrams. mechanism of pearlitic, bainitic and martensitic transformations. Hardenability – Purpose of Hardenability test, Effects of alloy additions, Jominy end-quench test, Understanding the effect of heating & cooling rate, Effect of quenching in different media, effect of prior microstructures on decomposition of austenite and effects of austenitic grain size, limiting ruling sections for different grades of steel, making of test report, significance of test on component performance.

UNIT II HEAT TREATMENT PROCESSES

Annealing, Normalizing, Hardening - retained austenite - measurement and methods of its elimination, hardenability studies- Jominy end quench test, Grossman's experiments. Tempering- Hollomon & Jaffe tempering correlations, Austempering and Martempering, Precipitation hardening, thermomechanical treatment, intercritical heat treatment, other heat treatment processes - splat cooling. Induction and Flame hardening .

UNIT III CASE HARDENING

Introduction, carburising: principle, carbon potential, mechanism, application of Fick‟s law, depth of carburization and its control, methods of carburising, heat treatment after carburising, structure, properties and common problems in carburising. Nitriding: introduction, steels used, mechanism, effect of microstructure, white layer, nitriding methods, ion nitriding and nitro-carburising. Induction and flame hardening: principle, methods, operating variables. Measurement of case depth.

UNIT IV HEA T TREA TMENT EQUIPMENTS

Various heating media used for heat treatment. Temperature and atmosphere control, carburising atmosphere and carbon potential measurement, nitriding gas atmospheres. Quenching media and their

characteristics. Various heat treatment furnaces, fluidized bed furnaces, cryo chamber, cryo treatment of steels, sealed quenched furnace, plasma equipment.

UNIT V HEA T TREA TMENT OF SPECIFIC ALLOYS

Heat treatment of carbon steels, various types of tool steels, high speed steels, maraging steels and die steels. Heat treatment of gray cast irons, white cast irons, malleabilising and S.G.irons, austempering of S.G.Iron. Heat treatment of aluminium alloys. copper alloys and nickel alloys. Defects in heat treated parts: causes and remedies.

Textbooks

1. Rajan, T. V., Sharma C. P., Ashok Sharma., "Heat Treatment Principles And Techniques" Prentice-Hall of India Pvt. Ltd., New Delhi, 2002

2. Vijendra Singh, "Heat Treatment of Metals", First edition, Standard Publisher Distributors New Delhi, 1998.

3. American Society for Metals, "Metals Handbook Vol. 4", ASM Metals Parks. Ohio, USA, 1991

4. Prabhudev. K H. "Handbook of Heat Treatment of Steels", Tata McGraw-Hill Publishing Co., New Delhi, 1988.

5. Novikov,.I., "Theory of Heat Treatment of Metals", MIR Publishers, Moscow, 1978

6. Thelning K. E., "Steel and its heat treatment", Bofors Handbook, 1975

ME 544	**MODERN MANUFACTURING METHODS**	**L**	**T**	**P**	**C**
	Second Semester (Core)	3	0	0	6

Introduction to Modern Manufacturing Methods, their needs in today's manufacturing scenario, identification and characteristics of these processes, conventional versus modern manufacturing methods.

Mechanical Processes: Abrasive jet machining, Water jet machining, Abrasive water jet machining, Abrasive flow machining, Ultrasonic machining, Ultrasonic welding, their working principles, equipments, process capabilities, applications, advantages and limitations.

Chemical and Electrochemical Processes: Chemical machining, Photo chemical machining, Electrochemical machining, drilling, grinding, deburring, their working principles, equipments, process capabilities, applications, advantages and limitations.

Electrothermal Processes: Electrodischarge machining (EDM), Electrodischarge wire cutting or wire EDM, Electro discharge grinding, Electrochemical discharge grinding, their working principles, equipments, process capabilities, applications, advantages and limitations.

Electron Beam Machining, Electron Beam welding, Plasma arc cutting, Ion beam machining.

Laser Processing: Process principle, types of laser, equipments, and laser processes: drilling, cutting, machining, welding, heat treating, cladding; applications, advantages and limitations.

High energy rate forming: Electromagnetic forming, explosive forming, electro-hydraulic forming, their process principles, applications.

Introduction to some emerging trends in manufacturing: Micro manufacturing, manufacturing processes lead towards micro manufacturing, micro electro mechanical systems (MEMS), Rapid prototyping, concept of nanotechnology.

References:

Sl. No.	Author	Title	Publisher
1	V. K. Jain	Advanced Machining Processes	Allied Publishing Pvt. Ltd.
2	G. F. Benedict	Nontraditional Manufacturing Processes	Marcel Dekker Inc
3	P. K. Mishra	Nonconventional Machining	Narosa Publishing House
4	A. Ghosh & A. K. Mallik	Manufacturing Science	Affiliated East-West Press Pvt. Ltd.
5	G. Boothroyd & W.A. Knight	Fundamentals of Machining and Machine Tools	CRC Press, Taylor & Francis Group
6	J.A. McGeogh	Advanced Methods of Machining	Chapman & Hall
7	N. P. Mahalik	Micromanufacturing and Nanotechology	Springer

ELLECTIVE-I

ME 507	OPTIMIZATION TECHNIQUES	L	T	P	C
	Elective-I	3	0	0	6

UNIT I ANOVA & DESIGN OF EXPERIMENTS

Analysis of Variance and its meaning- one-way classification- two-way classification. Basic principles of design of experiments (replication, randomization and local control) - CRD- RBD- LSD.

UNIT II FACTORIAL EXPERIMENTS & TA GUCHI APPROACH

Factorial experiments and their need- and Factorial Experimental Designs without confounding (Theory and Problem only, no derivation expected). Taguchi Approach: Parameter Design, Robust Design

UNIT III OPTIMIZA TION TECHNIQUE BY SEARCH METHOD

Optimal problem formulation -Boundary phase method – Fibonacci search method – Golden section search method – Powell‟s conjugate direction method – Conjugate gradient method – Variable-metric method.

UNIT IV ALGORITHMIC OPTIMIZA TION TECHNIQUE

Kuhn-Trucker conditions – Penalty function method – Frank-Wolfe method – Generalized reduced gradient method – Generalized projection method.

UNIT V OPTIMIZATION TECHNIQUE BY GENETIC ALGORITHM

Genetic algorithms(GAs) - working principle – difference between GAs and the traditional methods – GAs for constrained optimization – Simulated annealing – Global optimization: using steepest descent method and GA.

REFERENCE BOOKS

1. Cochran, W.G. and Cox, G.M.: Experimental Designs, 2nd Edition, John Wiley & Sons, Inc, 1957.
2. Davis, L.: Handbook of genetic algorithms, Van Nostrand Reinhold, 1991.
3. Deb, K.: Optimization for engineering design, Prentice Hall of India, 2005.
4. Montgomery, D. C.: Design and Analysis of Experiments, John Wiley & Sons, 1984.
5. Phadke, M. S: Quality Engineering using robust design, Prentice Hall, 1989.
6. Philip, R. J.: Taguchi Techniques for quality engineering, McGraw Hill, 1989.
7. Rao, S.S.: Optimization theory and applications, Wiley Eastern, 1984.

ME 528	COMPUTER AIDED MANUFACTURING	L	T	P	C
	Elective-I	3	0	0	6

Introduction to Computer Aided Design (CAD), Computer Aided Process Planning (CAPP), Computer Aided Manufacturing (CAM), Computer Integrated Manufacturing (CIM), product cycle and automation in CAD/CAM, Need of CAD/CAM.

Process Planning: Basic concepts of process planning, computer aided process planning (CAPP), Retrieval or vaiant and generative approach of CAPP, Implementation consideration of CAPP.

Numerical control of Machine tools: Principles of Numerical control (NC), Computer Numerical control (CNC), Direct Numerical control (DNC), comparison between conventional and CNC systems, Classification of CNC system, NC coordinate system, positional control, system devices; drives, ball screws, transducers, feedback devices, counting devices, signal converters, interpolators, adaptive control system.

NC Part programming: Concept, format, codes, preparatory and miscellaneous coded, manual part programming, APT programming, macros, fixed cycles.

Rapid Prototyping: Phases of Prototyping. Fundamentals of R.P., Classification of R.P. Processes.

Rapid Prototyping Process: Automated Processes, Difference between Additive and Subtractive Processes, Process Chain, steps in involved in R.P.

Types of R.P. systems: Liquid Based, Solid Based & Powder Based. Data Formats in R.P. Application of R.P. in Manufacturing and Rapid Tooling.

References:

Sl. No	Author	Title	Publisher
1.	Groover	Automation, Production systems and computer integrated manufacturing	PHI
2.	Groover and Zimmer	CAD/CAM	PHI
3.	Chang, Wysk and Wang	Computer Aided Manufacturing	PHI
4.	YoramKoren	Computer control of manufacturing system	McGraw Hill Book Co.
5.	B.L. Jones	Computer Numerical Control	John Wiley and Sens
6.	Rao, Tiwari and Kunda	Computer Aided Manufacturing	Tata Mc.Graw Hill
7.	Vajpayee	Principles of Computer Integrated Manufacturing	PHI
8.	Radhakrishna Subramanyan and Raju	CAD/CAM/CIM	New Age International (P) Ltd., Publishers
9.	Sharma	Fundamentals of Computer aided Manufacturing	S.K. Kataria and Sons.
10.	Kenneth Cooper	Rapid Prototyping Technology Selection and Application	CRC Press; 1st edition.
11.	Miltiadis A. Boboulos	CAD-CAM & Rapid prototyping Application Evaluation	

ME 589	**PHYSICAL AND CHEMICAL CHARACTERIZATION OF MATERIALS**	**L**	**T**	**P**	**C**
	Elective-I	3	0	0	6

UNIT I ANALYSIS AND EVALUATION OF PROPERTIES OF PLASTICS, ELASTOMERS A ND COMPOSITES

Molecular weight distribution, MFI, HDT & VICAT softening point, cold temperature behaviors, Rheological behaviors, hardness and impact properties, identification of polymers, weathering characteristics, cyclic temperature test, flammability, VOC and odor test, scratch resistance test, metal composition analysis, RoHS analysis Electrical properties of Materials – Dielectric constant, electrical resistivity, coefficient of thermal expansion & contraction, wire harness test.

UNIT II INSTRUMENTAL TECHNIQUES 12

FTIR spectrometer, Thermal analyzer, X-ray analyzer, Optical emission spectroscopy, Ion Chromatography, Gas and Liquid Chromatography, High strain rate tester, Non-destructive instruments, etc.New innovations in testing and characterization, X-ray Diffraction, Electron microscope (SEM, TEM), Scanning probe microscopy (SPM, AFM), Spectroscopic methods (EDS, FTIR); Mechanical behaviors, Thermal response, Fire retardancy, Chemical resistance and Electrical-Magnetic-Optical properties of ploymer nano-composites;

TEXTBOOK

1. Material Characterization: Introduction to Microscopic & Spectroscopic Methods by Yang Leng John Wiley & Sons (Asia) Pte Ltd.
2. ASM Handbook on Metals Handbook: Vol. 8 Mechanical Testing – 1978.
3. Dictionary of Materials and Testing, Second Edition by Joan Tomsic

ELLECTIVE-II

ME 588	**FAILURE ANALYSIS AND PREVENTION**	**L**	**T**	**P**	**C**
	Elective-II	3	0	0	6

UNIT I FUNDAMENTALS OF FAILURE ANALYSIS

Importance of failure analysis for automotive components, Steps in typical failure analysis: Collection of background data (review documentation and speak with appropriate individuals), Selection of failed and unfailed samples for examination, Preliminary examination of the failed part, Non-destructive evaluation, Mechanical testing, Macroscopic examination and analysis, Microscopic examination and analysis, Determination of failure mode, Chemical analysis, Fracture mechanics considerations, Full scale testing under service conditions, Analysis of the evidence, Formulation of conclusions, Recommendations to prevent reoccurrence, Sample preparation methods for failure analysis, Selection of locations/samples for failure analysis.

UNIT II INTRODUCTION TO FAILURE ANALYSIS

Failure mode identification methods, Failure mechanisms: Fatigue failures, fractography, effect of variables: part shape, type of loading, stress concentration, metallurgical factors, etc. Wear failures, adhesive, abrasive, erosive, corrosive wear. Corrosion failures, types of corrosion: uniform, pitting, selective leaching, intergranular, crevice, etc. Elevated temperature failures, creep, thermal fatigue, micro structural instability, and oxidation. Causes of failure in components: Misuse or Abuse, Assembly errors, Manufacturing defects, Improper maintenance, Fastener failure, Design errors, Improper material, Improper heat treatments, Unforeseen operating conditions, Inadequate quality assurance, Inadequate environmental protection/control, Casting discontinuities. Data compilation and identification of root cause.

UNIT III TYPES OF FAILURES IN COMPONENTS

Fatigue failures, Corrosion failures, Stress corrosion cracking, Ductile and brittle fractures, Hydrogen embrittlement, Liquid metal embrittlement, Creep and stress rupture.

UNIT IV METHODS AND EQUIPMENT FOR FA ILURE A NALYSIS

Selection of suitable testing methods for failure analysis Selection of metallurgical equipments for failure analysis SEM-EDAX.

UNIT V PREVENTION OF FAILURE

REFERENCE BOOKS

1. “Understanding How Components Fail” by Donald J. Wulpi; ASM International Publication.
2. “Analysis of Metallurgical Failures: by Vito J. Colangelo; Francis A. Heiser Wiley Publication.
3. ASM Handbook Vol.11 - Failure Analysis and Prevention, ASM International Publication, 1995.
4. “Metallurgy of Failure Analysis” by A K. Das; by McGraw-Hill Professional Publication.
5. Metallurgical Failure Analysis by Charlie R. Brooks; Ashok Choudury; McGraw-Hill Publication.
6. Automotive Component Failures by A. M. Heyes
7. Handbook of Case Histories of Failure Analysis, Vol 2. by A Esaklul Khlefa.
8. Handbook of Case Histories of Failure Analysis, Vol 1 by C.Uhietal Robert.
9. Metallography Principles and Practice by Voort, George F. Vander; ASM International Publication.

ME 590	ADVANCES IN POLYMERIC MATERIALS	L	T	P	C
	Elective-II	3	0	0	6

UNIT I POLYMERIC MATERIALS

Polymerization – Thermosets Vs Thermoplastics – Classes and types of polymers; Properties and limitations of plastic material species; Additives; Auto applications – exterior, interior, engine and fuel line, transmission systems, electrical and electronic components.

UNIT II MA NUFA CTURING PROCESSES

Injection molding, Reaction injection molding (RIM), Transfer molding, Extrusion, compression molding, blow molding, scopes and limitations of various manufacturing processes, mold making, safety in handling of materials, hands on training on processes, selection criteria for auto applications, economics.

UNIT III ELASTOMERS

Physics of raw and vulcanized rubbers; Kinetic and thermodynamics theory of rubber elasticity; Stress strain relationships for the vulcanized rubbers; Molecular basis for the material to act as rubber; Study of various additives like peptizers, antioxidants, accelerators, activators, fillers, carbon black, chords and fabrics, blowing agents, colorants, processing aids like – tackifiers, plasticizers, extender oils etc. Characterization of compounds, rheological behaviors, properties influenced by compounding ingredients. Processing of rubbers by - extrusion, calendaring and injection molding. Manufacturing techniques of auto components – tires, belts, hoses, mounts wiper blades, seals, O rings, etc. Study of major synthetic auto rubbers like – NR, SBR, BR, IIR, NBR, SBR, fluorocarbons, silicone, etc – their functional properties and needs of auto industries; uses in fuel systems, chassis and body components, NVH applications.

UNIT IV DESIGN IN PLASTICS A ND ELASTOMERS

Selection of polymers, additives and process; Effects of mechanical, thermal, electrical properties, importance of environmental factors, structural analysis; Mold design; Part geometry; Gating, cooling, ejection, joining and assembling; Geometric tolerances; Safety factor & failure criteria; Machining, finishing and decorating, etc. Designing in rubbers, effects of material, process and environment parameters, life cycle analysis, design software packages, failure mechanics.

UNIT V FOA MS, ADHESIVES, COATINGS A ND PAINTS

PU & Latex foams - Formulations and manufacturing Control of various foam properties – density, modulus of elasticity, compression set, dynamic properties, etc. Adhesives - Condensation polymerization of products like phenol formaldehyde (Phenolic resins), Amino resins, Polyester resins, Alkyl resins, Epoxy resins, Polyurethane resins, Polyamide resins; Additional polymerization products like – Vinyl resins, Vinyl alcohol resins, vinylidine resins, Styrene resins and Acrylic resins. Protective coatings and Paints - Organic paints and coatings, metal coatings, ceramic coatings, Linings, primers, varnishes, enamels, galvanizing,

anodizing, black iodizing, electro plating, CVD & PVD surface coatings Other Materials - Seals and Gaskets, Automotive glasses, Refractory materials

REFERENCE BOOKS

1. Kalyan Sehanobish, “Engineering Plastics and Plastic Composites in Automotive Applications”, SAE International, April 2009

2. Francis Gardiner and Eleanor Garmson “Plastics and the Environment” Smithers Rapra, 2010

3. Mahendra D Baijal “Plastic Polymer Science and Technology”, John Wiley & Sons, 1982

4. Natti S. Rao, Gunter “Design Formulas for Plastic Engineers” Hanser Publishers 2nd Edition, 2004

5. John Moalli “Plastics Failures”, Plastics Design Library, William Andrew Inc, 2001

ME 591	**ADVANCED CERAMICS FOR STRATEGIC APPLICATIONS**	**L**	**T**	**P**	**C**
	Elective-II	3	0	0	6

UNIT I

Introduction: oxide and non-oxide ceramics, their chemical formulae, crystal and defect structures, non-stoichiometry and typical properties.

UNIT II

Powder Preparation: Physical methods (different techniques of grinding), chemical routes - co-precipitation, sol-gel, hydrothermal, combustion synthesis, high temperature reaction (solid state reaction). Basic principles and techniques of consolidation and shaping of ceramics: powder pressing- uniaxial, biaxial and cold isostatic and hot isostatic, injection moulding, slip casting, tape-casting, calendaring, multilayering.

UNIT III

Sintering: different mechanisms and development of microstructure (including microwave sintering). Preparation of single crystal, thick and thin film ceramics. Mechanical behaviour: fracture mechanics and tribology. Engineering applications: at room and high temperatures (including armour application)

UNIT IV

Electrical behaviour: insulating (dielectric, ferroelectric, piezoelectric, pyroelectric) semiconducting, conducting, superconducting and ionically conducting, specific materials and their applications. Magnetic behaviour: basic principles, materials and their applications.

UNIT V

Transparent ceramics, coatings and films: preparation and applications Porous ceramics and ceramic membrane: fabrication techniques and applications in separation technology. Bio-medical applications of ceramic materials Ceramics for energy and environment technologies (fuel cell, lithium battery, gas sensor

and catalytic support) Ceramics matrix composites: different types, their preparation and properties (including nano-composites) Exotic ceramics: functionally graded, smart/ Intelligent, bio-mimetic and nano-ceramics - basic principles, preparation and applications

REFERENCES

1. Fundamental of Ceramics by Michel W. Barsoum, McGraw Hill International edition, 1997
2. Modern Ceramic Engineering by David. W. Richerson, Mercel Dekker, NY 1992
3. Ceramic Processing and Sintering by M. N. Rahman, Mercel Dekker, 2003
4. Handbook of Advanced Ceramics by S. Somiya, Academic Press 2003
5. Handbook of Advanced Ceramics, Parts 1 and 2, S. Somiya, Aacdemic Press, 2006

ME 592	**MATERIAL SELECTION AND SAFETY**	**L**	**T**	**P**	**C**
	Elective-II	3	0	0	6

UNIT I INTRODUCTION

Classification of design - Engineering materials and their physical properties applied to design - Selection of material - Factors of safety in design - Endurance limit of material - Determination of endurance limit for ductile material - Notch sensitivity - Principles of design optimization - Future trends - CAD - Euler's formula – Theories of failure - Rankine's formula - Tetmajer's formula - Johnson formula - Design of push - rods –eccentricity loaded columns - Reduction of stress concentration. Technologically important properties of materials, Physical, Chemical, Mechanical and Electrical properties of metals, Criteria of selection of materials like properties, cost, manufacturing process, availability, legal and safety factors.

UNIT II MATERIALS FOR CORROSION A ND WEAR RESISTA NCE

Materials for atmospheric, soil, water, acid and alkaline resistance, Corrosion prevention coatings, material for Chemical and Petroleum industries, materials and coatings for wear resistance.

UNIT III MATERIALS FOR HIGH A ND LOW TEMPERATURES 12

High temperature strength and stability, Hot hardness requirements, High temperature steels and super alloys, ductile to brittle transition-HSLA steel, low temperature materials.

UNIT IV MATERIALS FOR A UTOMOTIVE APPLICA TIONS

Criteria of selecting materials for automotive components viz cylinder block, Cylinder head, piston, piston ring, Gudgeon pin, connecting rod, crank shaft, crank case, cam, cam shaft, engine valve, gear wheel, clutch plate, axle, bearings, chassis, spring, body panel - radiator, brake lining etc. Application of nonmetallic materials like ceramics MMCs for engine components, Polymers and FRPs for exterior and interior.

UNIT V MATERIALS FOR AUTOMOTIVE ELECTRONIC SYSTEMS

Dielectric Materials – Classifications, Organic polymers, Resins, Plastics, Laminated plastics, Elastomers, Ceramics, Inorganic dielectric films. Properties, selection criteria and automotive applications Conducting Materials – High conduction materials, Superconductors and Hyper conductors, Various Metals and Alloys, Properties, selection criteria and auto applications

Semiconducting Materials – Intrinsic and extrinsic semiconductors, Methods of determining the type of conduction and parameters, Effects of thermal, deformation, radiation and high field on electric conduction, Elemental and compound semiconductors. Properties and auto applications. On Board level – Powertrain, Engine Management System, Mechatronic: EMS, ABS. Embedded Electronic systems and Silicon components – Transistors, microprocessors, diodes, ECU, sensors, actuators, communication, power supply, wiring harness On Vehicle level – Vehicle stability control, Break-by-wire.

TEXT BOOKS

1. Gladius Lewis, “Selection of Engineering Materials", Prentice Hall Inc. New Jersey, USA, 1995.
2. Charles J A and Crane. F A.A., “Selection and Use of Engineering Materials”,3rd Edition, Butterworths, London UK, 1996.

ELECTIVE III

ME 573	MEMS TECHNOLOGY	L	T	P	C
	Elective-III	3	0	0	6

Overview of MEMS and microsystems, microelectronics, microfabrication, miniaturization, typical MEMS and microsystems products.

Working principles of microsystems: microsensors, microactuation, MEMS with microactuators, microfluidics, microvalves, micropumps, micro-heatpipes.

Overview of materials for MEMS and microsystems: atomic structure of matter, ions and ionization, doping of semiconductors, diffusion process, electrochemistry.

Microsystem fabrication: photolithography, ion implantation, diffusion, oxidation, chemical vapor deposition, physical vapor deposition, sputtering, etching.

Micromanufacturing: bulk micromanufacturing, surface micromanufacturing, LIGA process.

Assembly, packaging and testing of microsystems: overview of microassembly, microassembly processes, major technical problems of microassembly, microsystem packaging and its levels, essential packaging technologies, reliability and testing in MEMS packaging.

Reference books:

1 MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering, Tai-Ran Hsu, John Wiley & Sons, Inc.
2 Micromanufacturing and Nanotechnology, N. P. Mahalik, Springer
2 An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf, Kirt Williams, Artech House, Inc.
4 Nanotechnology, Mark Ratner, Danier Ratner, Pearson Education Inc.
5 Introduction to Nanotechnology, Charles P. Poole Jr. & Frank J. Owens, John Wiley & Sons, Inc.
6 Nanotechnology Understanding Small systems, Roger, Pennathur, Adams, CRC Press
7. MEMS Mechanical Sensors, Stephen Beeby, Graham Ensell, Michael Kraft, Neil White, Artech House, Inc.
8 MEMS Introduction and Fundamentals, Mohamed Gad-el-Hak, CRC Press

ME 521	**Theory of Elasticity**	**L**	**T**	**P**	**C**
	Elective – III	3	0	0	6

Surface and Body forces, Stress and Strain Tensor, Transformation Laws, Lagrangian and Eulerian Description, Equation of Elasticity (Equilibrium, Constitutive law and Boundary Conditions), Cauchy's formula, Principle of Stresses, Lami's stress Ellipsoid, Cauchy stress quadratic, octahedral stress, Stress – strain relationship, Uniqueness of Solutions, St. Venant's Principle, Strain Energy functions, Two-dimensional problems in rectangular coordinates (polynomial solution, bending of beam, Fourier series solution). Two-dimensional problems in polar coordinates (axisymmetric problems – rotating discs, Cylindrical shells, plate with a hole, infinite plate with point load, curved beams). Two-dimensional problems in curvilinear coordinates using stress functions. Torsion (circular and non-circular cross section, membrane analogy, thin walled members, hydrodynamic analogy). Scalar and Vector potentials, Strain potentials. Plane state of stress and strain (Two & Three Dimensional), Airy's stress function for problems, Representation of biharmonic function using complex variables, kolosoff-Mushkelishvili method. Thermal stress and its Applications to problems of curved beam, thick cylinder and rotating disc, stress concentration.

Reference Books:

1. S. Timoshenko and J.N. Goodier, Theory of Elasticity, McGraw – Hill International Publication.
2. Vitor Dias da Silva, Mechanics and Strength of Materials, Springer.
3. I. S. Sokolnikoff, Mathematical Theory of Elasticity, McGraw-Hill International Publication
4. A. E. Green and W. Zerna, Theoretical Elasticity, Dover Publications.
5. L. D. Landau and E. M. Lifschitz, Theory of Elasticity, Pergamon Press.

6. F. P. Beer, E. R. Johnston and J. T. DeWolf, Mechanics of Materials, McGraw – Hill International Publication.

ME 585	MANUFACTURING MANAGEMENT	L	T	P	C
	Elective -III	3	0	0	6

STRATEGY PLANNING

Nature of production-inventory management systems. Strategic, Tactical and Operational decisions. general discrete location-allocation problems - features and formulations. Facility location models - median model - distribution model - brown and gibson model

TACTICAL PLANNING

Aggregate production planning - ways to absorb demand fluctuations - costs relevant to aggregate production planning - aggregate production planning models - Inventory management - EOQ decision rules - costs in an inventory system - simple lot size model

SCHEDULING

Operations scheduling - Flow shop - n jobs – 2 machine Johnson's rule, 2 Jobs –M machine, N-Jobs M machine Sequencing Job on parallel machine - Assembly Line Balancing- Project Scheduling-crashing of project network with cost trade off

MRP & MRP-II

Material Requirement Planning (MRP) - working of MRP - Use of MRP system - evolution from MRP to MRP II - master production scheduling - rough cut capacity planning - capacity requirement planning - Lot sizing in MRP II system.

SCM & QUALITY MANAGEMENT

Concept of supply management and SCM, Flow in supply chains, Key issues in supply chain management, Decision phases in supply chain, concept of quality management - standards for quality management - statistical process control - Taguchi method of quality control.

REFERENCES

1. H.G. Menon, “TQM in New Product Manufacturing”, Mc Graw Hill, 1992.

2. Hax and Candea, “Production and Inventory Management”, Prentice Hall, 1984.

3. Buffa., “Modern Production Management”, John Welley, 1983.

ME 594	NANO STRUCTURED MATERIALS-SYNTHESIS, PROPERTIES AND APPLICATIONS	L	T	P	C
	Elective-III	3	0	0	6

UNIT I

Introduction to nanotechnology and the two approaches (bottom up and top down) followed for the synthesis of nanomaterials.

UNIT II

Synthetic methodologies: i) Sol-gel. ii) Micromulsion. iii) CVD,PVD,Molecular beam epitaxy. iv) Vapor (solution)-liquid-solid growth, (VLS or SLS). v) Spary Pyrolysis. vi) Template based synthesis. vii) Lithography.

UNIT III

Various kind of Nanostructures: i) Carbon fullerenes and CNT. ii) Metal and metal oxide nanowires. iii) Self-assembly of nanostructures. iv) Core-shell nanostructures. v) Nanocomposites.

UNIT IV

Physical Properties of nanomaterials: i) Photocatalytic. ii) Dielectric. iii) Magnetic. iv) Optical. v) Mechanical.

REFERENCE BOOKS

1. William D. Callister, Jr., "Materials Science and Engineering an Introduction", John Wiley & Sons, 6th
   Edition, Inc., 2004.
2. **Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press 2004.**
3. **T. Pradeep, Nano: The Essentials Understanding nanoscience and nanotechnology, Tata McGraw-Hill Publishing Company Limited** NEW DELHI, 2007.
4. **Nanomaterials Synthesis, Properties and Applications** Edited by A S Edelstein and R C Cammarata, IOP Publishing Ltd 1996.

ELECTIVE IV

ME 515	FEM IN ENGINEERING APPLICATIONS	L	T	P	C
	Elective-IV	3	0	0	6

Introduction to FEM. Theory for 1-D element and 2-D element. Focus on software development and usage for 1-D, 2-D and 3-Delements. Variational methods. Element types and properties. Boundary conditions. Stress-strain determination. Solution techniques. Mesh refinement. Convergence criterion. Frames, beams and axial element. Plane stress. Plain strain. Ax symmetric problems. Plate bending. Fluid mechanics and Heat transfer, Modules modeling and elastic analysis. Super elements. Structural instability of frames and beams.

Pre Processing, Mesh generation, element connecting, boundary conditions, input of material and processing characteristics – Solution and post processing - Overview of application packages such as ANSYS/ SIMULIA (Abaqus)/Nastran/Altair-HyperWorks. Applications of FE analysis in metal casting, cutting tools, structural analysis of parts, heat transfer etc.

Reference:

1. J. N. Reddy, An Introduction to the Finite Element Method, Tata McGraw-Hill
2. K.J. Bathe, Finite Element Procedures, Klaus-Jurgen Bathe
3. O.C. Zienkiewicz, The Finite Element Method.
4. C.S. Krishnamurthy, Finite Element Analysis: Theory & Programming, TMH Publishing Co.
5. S.S. Rao The Finite Element Method in Engineering, Pergamon Press.

ME 595	MODELLING AND SIMULATION	L	T	P	C
	Elective-IV	3	0	0	6

UNIT I

Introduction to systems and modeling - discrete and continuous system - Limitations of simulation, areas of application - Monte Carlo Simulation. Discrete event simulation and their applications in queueing and inventory problems.

UNIT II

Random number generation and their techniques - tests for random numbers.

UNIT III

Random variable generation.

UNIT IV

Analysis of simulation data. - Input modeling – verification and validation of simulation models – output analysis for a single model.

Simulation languages and packages - FORTRAN, C , C++, GPSS, SIMAN V, MODSIM III, ARENA, QUEST, VMAP - Introduction to GPSS – Case studies - Simulation of manufacturing and material handling system.

REFERENCES

1. Jerry Banks and John S, Carson II “Discrete Event system Simulation”, Prentice Hall, 1984.
6. 3. Geoffrey Gordon., “System Simulation”, Prentice Hall, 1978.
7. 4. Francis Neelamkovil, “Computer Simulation and Modelling”, John Willey and sons, 1987.

ME 596	ADVANCED CASTING AND WELDING TECHNOLOGY	L	T	P	C
	Elective-IV	3	0	0	6

UNIT I

Core making processes - design for moulding and casting - different moulding and casting processes-function of the gating system-permanent mould casting-centrifugal casting investment casting mercast casting-continuous casting-low pressure casting.

UNIT II

Melting and quality control of various steels and non-ferrous alloys casting defects fettling, inspection and testing of castings - Manufacturing of Cast irons - Design for casting.

UNIT III

Arc welding power sources-Different arc welding processes-solid state welding process soldering, Brazing and adhesive bonding – metal surfacing and spraying-thermal cutting processes.

UNIT IV

Welding metallurgy – weldability criteria – Different types of joint configuration-different types of welding position-design of weldments and joints.

UNIT V

Inspection and testing of welding and casting – Defects, Destructive tests – Non-destructive testing techniques – surface treatments-safety aspects in welding processes- specific welding applications and innovations.

REFERENCES

1. Dr.R.S.Parmar “Welding processes and technology” Khanna Publishers.
2. H.S.Bawa “Manufacturing Technology-I” Tata Mc Graw Hill Publishers New Delhi, 2007.
3. Scrope Kalpakjian, “Manufacturing processes for Engineering Materials”, Addision Wesley, 1997.

ME 540	PRODUCTION AND OPERATIONS MANAGEMENT	L	T	P	C
	Elective-IV	3	0	0	6

Product development: Principal of good product design, Component and tolerance design, Efficiency, quality and cost construction, Product life cycle. Standardization, simplification, diversification.

Supply chain management

Quality management – Quality analysis and control, Total Quality Management, TQM and continuous improvement, customer focus, Quality awards and concepts, PDCA cycles, Bench marking, Quality function deployment, Taguchi Method, Design of Experiments, Zero defects and six sigma, Quality circle.

Forcasting techniques – Forecasting, Casual and time series models, moving average, exponential smoothening, trend and seasonality.

Aggregate Production Planning: Master scheduling, bills of materials and MRP, Purpose and scope, Basic strategies, Disaggregating methods, Order control and flow control, Routing, Scheduling and priority dispatching, Operations scheduling.

Logistic and facility Design: Facility location factors, evaluation of alternatives, Types of plant layout, evaluation, Computer aided layout, Assembly line balancing.

JIT, Kanban pull system, Bottleneck scheduling and theory of constraints.

Management information system: Value of information, Information storage and retrieval system-data base and data structure, Interactive system, and knowledge base systems.

References:

1. Production & Operations Management by Panneerselvam R Publisher: Prentice HSecond Edition.
2. Theory And Problems In Production And Operations Management by Chary, S N Publisher: Tata McGraw-Hill
3. Production Management – a New Concept by V K Dubey Publisher: Commonwealth Publishers
4. Production And Operations Management by Kanishka Bedi Publisher: Oxford University Press.

ME 584	PROCESSING OF ENGINEERING MATERIALS	L	T	P	C
	Elective IV	3	0	0	6

UNIT I FERROUS METALS

Iron-Carbon equilibrium diagram; Effects of alloy additions; Types of steel – plain carbon steels, low alloy steels, heat treatable steels, tool steels, die steels, stainless steels, special steels; International systems to classify steel grades – AISI/SAE, DIN, EN series/BS, BIS; Automotive grades and compositions; Mechanical, thermal, electrical and physical properties of steels, applications.

UNIT II STEEL MAKING

Principles of steel making, melting practices – Development of steel making processes, physiochemical principles and kinetic aspects of steel making, carbon boil, oxygen transport mechanism, desulphurization, dephosphorization, slag-functions, composition control, properties and theories, raw materials for steel making and plant layout, Effects of melting practices on end product. Principle equipment used and applications of steel making processes.

UNIT III CAST IRON

Types of Cast irons – grey cast irons, alloy CI, Spheroidal cast irons, white iron, malleable iron, vermicular cast irons; Chemical compositions and properties.

UNIT IV ALUMINIUM AND ALUMINIUM BASE ALLOYS

Enhancing properties of aluminium for auto applications; Classification system and grades of alloys; Roles of alloy additions on properties; Significance of various equilibrium diagrams in designing alloys; Solution treatment (age hardening) and microstructural changes; Chemical compositions & properties of aluminium alloys; Environmental benefits of recycling. Aluminium alloy melting practices; Component forming processes – castings, extrusions, sheet forming and forgings, material defects and their significances on properties and performances on end product; Automotive applications of aluminium alloys and manufacturing processes for body to Power train components.

UNIT V MAGNESIUM AND TITANIUM BASE ALLOYS

Properties and benefits over other traditional metals; Classifications of alloys; Melting practices; Manufacturing processes – Casting, extrusion and forging processes; Solution treatment and microstructures; Alloy compositions and properties; Surface coatings; Auto applications and limitations.

TEXT BOOK

1. William D. Callister, Jr., “Materials Science and Engineering an Introduction”, John Wiley & Sons, 6th
   Edition, Inc., 2004.

2. V. Raghavan, “Materials Science and Engineering”, Prentice Hall of India Pvt. Ltd.,5th Edition, 2007
3. Hajra Choudhary, “Elements of Workshop Technology”, Asia Publishing House, Vol. I & II; 1996
4. R.K. Jain and S.C. Gupta, “Production Technology”, Hanna Publishers, 1997
5. H.M.T. “Production Technology”, Tata McGraw Hill, 1990
6. 1. Avner, S. H., “Introduction to Physical Metallurgy”, second edition, McGraw Hill, 1985.
7. Henkel & Pense “Structure and Properties of Engineering materials”, 2001
8. ASM Handbook, Vol. 2, “Properties and Selection - Nonferrous Alloys and Special-Purpose Materials”
9. ASM Handbook, Vol.3, “Alloy Phase Diagrams.

REFERENCE BOOK

1. Flinn, R.A., and Trojan, P.K., “Engineering Materials and their Applications”, Jaico 4th Edition, 1999.
2. ASM Metals Hand book, “Failure Analysis and Prevention”, 10th Edition, Vol.11, ASM 2002.
3. Ashby M.F., “Material Selection in Mechanical Design”, Butter Worth 3rd Edition, 2005. Smithells Metals Reference Book, Eighth Edition
4. ASM Metals Hand Book, Vol.15, “Casting”, ASM International, 10th Edition, 1991