Course Name: **Advanced Physical Metallurgy**
Course Code: MTN501
LTP: 3-0-0
Credits: 3
Pre-Req**.:** NIL **Total No. of Lectures – 42**

Course Objectives:
Most of the useful properties are related to the micro structural state of the material, which can be altered in a controlled way by the heat treating processing. In many products the control of the processing is closely coupled with some property test and/or a structural characterization. Analysis of failed products is used to obtain feedback into the processing and its control as well as the initial selection of both the material and the stages of processing.

Lecture wise breakup **No. of Lectures**

Phases*:* Physical Nature of phase mixtures, Thermodynamics of Solutions, Equilibrium between two phases, Two component systems containing two phases, Graphical determination of partial modal free Energies, Two components with three phases in equilibrium, Phase rule, Ternary systems (Introduction only), Problems. (4)

Solidification *:* Nucleation and growth, Nature of Liquid Solid interface, Continuous growth, Lateral growth, Dendritic growth, Solidification in alloys the Scheil Equation, grain size of castings, segregation, Homogenization. (7)

Phase Diagrams: Phase diagrams, Isomorphous alloy systems, Free Energy changes, Maxima minima, Super lattices, Miscibility Gaps, Eutectic Systems, Peritectic, Monotectic, other three phase reactions, intermediate phases, Introduction to Ternary diagram (10)

Diffusion in substitutional Solid Solutions: Kirkendall effect, Porosity, Darkens equations, Fick's second law, Determination of intrinsic diffusivities, Self diffusion in pure metals, Temperature dependence of diffusion, Diffusion along grain boundaries, Free surfaces, Problems. (6)

Interstitial Diffusion: Measurement of interstitial diffusivities, The Snoek effect (3)

The Iron – Carbon alloy systems: Austenitization of steels, TTT and CCT Curves, Hardenability - Concepts, measurement and calculations, Annealing, Normalizing, Hardening, Tempering, Case hardening processes, Selection and specification of steels, New technology such as thermo-chemical, thermo-mechanical & thermo-cycling treatments,
Quantitative approach to heat-treatment, Failure analysis of heat treated products, Applications and computer harmonizing techniques. (7)

Non -ferrous alloy systems: Cu-Alloy, Al alloy, Ti alloy. (5)

Course outcomes:

The student will able to evaluate critically the relevance of phase diagrams, isothermal transformation diagrams and continuous cooling transformation diagrams to understand real alloys and their microstructure.

The students will able to display a critical awareness of the relevance of key areas, e.g. diffusion, defects, transformation type, to current problems in designing, processing and exploiting real alloys.

The students will able to interpret the different heat treatments (annealing, normalising, quenching, tempering).

The students will be able to use the techniques, skills and modern engineering tools necessary for engineering practice.

Text Books:

1. Physical Metallurgy by Vijendra Singh, Standard Publishers Distributors, 2002.
2. Introduction to Physical Metallurgy by Avner, Tata McGraw-Hill Education, 1997.
3. Phase transformation in metals and alloys by K.E Easterling, D.A. Poater, Chapman & Hall, 1992.
4. Structure & properties of alloys: the application of phase diagrams to the interpretation and control of industrial alloy structures by Brick, Gordon and Phillips, McGraw-Hill.
5. Heat treatment of metals by Vijendra Singh, Standard Publishers Distributors, 2006.

Reference Books:

1. Elements of Structural Metallurgy by Willlliam Hume - Rothery, Institute of metal.
2. Principles of Heat treatment of steels by R.C. Sharma, New Age International, 2003
3. Physical Metallurgy Principles by Robert E. Reed-Hill, published by van nost. reinhold.

Course Name: **Industrial Materials**

Course Code: MTN502

LTP: 3-0-0

Credits: 3

Pre-Req.: NIL **Total No. of Lectures – 42**

Course Objectives:

The course is meant to impart knowledge relating to selection of material on basis of their application and service conditions. It includes metallic, composites and smart materials. The course is designed to give an overview of different types of industrial material used in industry these days.

Lecture wise breakup **No. of Lectures**

Selection of materials: Service requirement, Structure-Property correlations and reappraisal of the role of crystal structure and structural defects on properties. (5)

Metallic materials: Engineering Ferrous materials, Aluminium, Copper, Nickel, Magnesium, Titanium alloys. Phase diagrams, properties and typical alloys with reference to their applications. (10)

Composite materials: Fiber reinforced, laminated and dispersed materials with metallic matrix of aluminium, copper and Titanium alloys and with non-metallic matrix of unsaturated polyesters and epoxy resins. Development, Important properties and applications of these materials. (7)

Smart materials: Shape Memory Alloys, Varistors and Intelligent materials for bio-medical applications, Polymers and Plastics from industry. Development, important properties and applications of these materials. (10)

Case study: Case study of the failure of components due to wrong selection of materials. (4)

Study and analysis of appropriate material for some specific application like aerospace, boiler tubes, turbine blades, automobiles and infrastructures (building and bridges). (6)

Course Outcomes:

The student will acquire understanding of common material properties and characteristics of Metallic materials, Composite materials & Smart materials, various case studies of materials selection, designing, failure etc.

The students will be able to identify, formulate and solve engineering problems.

The students will be able to design a system, component or process to meet desired needs within realistic constraints such as manufacturability & technology/process, service conditions, and sustainability.

Text Books:

1. Engineering Material Technology, 5th edition, by James A. Jacobs & Thomas F. Kilduff. Prentice Hall. Copyright 2005.
2. Callister's Materials Science and Engineering by WD. Callister Jr., Wiley India Pvt. Ltd., 2010

Reference Books:

1. Foundations of Materials Science and Engineering, 3rd edition, by William F. Smith. McGraw Hill, Copyright 2004.
2. Engineering materials1: An introduction to properties, applications and design by Michael F Ashby and David R H Jones, Elsevier Butterworth Heinmann Publishers, 2007

Course Name: **Computer applications and simulations in Metallurgy**

Course Code: MTN503

LTP: 3-0-0

Credits: 3

Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:

It aims to impart the elements of design, simulation and optimization techniques being used in research and Metallurgical industries. It gives an insight to the process automation and its control.

Lecture wise breakup **No. of Lectures**

Introduction: Role of Computers in Metallurgy, Introduction to ANN, CAD, CATIA, Pro Engg, Applications of Mat lab (10)

Mathematical modeling: Needs, Techniques, Classifications and simple illustrations, Mathematical Modeling through Differential Equations, Mathematical Modeling through graphs, and Mathematical Modeling through Programming. (10)

Basic equations in Metallurgical Processes: (5)

Data reconciliation. Metal working Simulation, Matlab for Optimization, Procast or Flow cast for casting related problems, quantitative description of mineral processing units and its computer implementation, introduction to a general purpose modular, simulation for analysis. (10)

Applications: Applications in Heat treatment, Metal Working, Casting, Automation (PLC) in Heat treatment, Automation of Metallurgical processes, Sand Plant, Moisture control, Temperature control and regulation in Furnaces, Programmable Logical controls, System Automation in Metallurgical applications (7)

Course Outcomes:

The student will be able to apply modeling in all fields of Metallurgy and will be able to solve problems related to Metallurgical processes with the help of the Computer simulation and modeling.

The students will be able to apply knowledge of mathematics, science and engineering to develop model.

Text Books:

1. Mathematical Modeling by J N Kapur, New Ace International (P) Ltd. Publishers
2. Szekely, J., Evans, J.E. and Brimacambe, J.K., The Mathematical and Physical Modeling of Primary Metal Processing Operations, Wiley.
3. Hem Shankar Ray, Kinetics of Metallurgical reactions, Oxford & IBH Publishing Co. Pvt. Ltd. 1993.

Reference Books:

1. A. K. Mohanty , Rate processes in Metallurgy, Prentice-Hall India Ltd., 2000.
2. G.H. Geiger and D. R. Poirer, Transport Phenomena in Metallurgy, Wesley Publishing Co.
3. J. Szekely, J.W. Evans and H.Y. Sohn, Gas – Solid Reactions, Academic Press, New York.

Course Name: **Environmental Degradation of Materials**
Course Code: MTN504
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:
Promoting process-skills, solving abilities and applications of environmental concepts contents, useful in real-life situations for making Environmental Studies /Environmental Education more relevant, meaningful and interesting. Emphasis on the use of numerous illustrations to give the students the exact mental image of the subject discussed.

Lecture wise breakup **No. of Lectures**

Technological importance of corrosion study: corrosion as non-equilibrium process, corrosion rate expressions, electrochemical principles of corrosion-cell analogy, concept of single electrode potential, reference electrodes, e.m.f. and galvanic series-their uses in corrosion studies, polarization, passivity. (8)

Different forms of corrosion: Uniform attack, Galvanic, crevice, Pitting, Inter-granular, Selective leaching, Erosion, Stress corrosion cracking-their characteristic features, causes and remedial measures. Principles of corrosion prevention-material selection control of environment including inhibitors, cathodic and anodic protection, coatings and design consideration. (16)

Corrosion testing methods: Introduction to high temperature corrosion, Pilling-Bed worth relation, oxidation kinetics, oxide defect structures, Wagner-Hauffe valence approach in alloy oxidation, catastrophic oxidation, internal oxidation. Considerations in high temperature alloy design, prevention of high temperature corrosion -use of coatings. Liquid metal attack - liquid metal embrittlement, preventive measures (10)

Chemical degradation of non-metallic materials like rubbers, plastics, ceramics etc. Hydrogen damage-types, characteristics, mechanism and preventive measures (8)

Course Outcomes:
The student will be able to explain the environmental-related technological/ industrial aspects and will become more eco-friendly.

The students will be able to know of his professional and ethical responsibility. The students will be able identify the impact of material substitution in a global, economic, environmental and societal context.

Text Books:

1. Electrochemical Techniques in Corrosion Science and Engineering by R. G. Kelly, CRC Press, 2002.
2. ASM Handbook Volume 13A: Corrosion: Fundamentals, Testing, and Protection, ASM International 2003
3. Principles and Prevention of Corrosion (2nd Edition) By Denny A. Jones Prentice Hall, 1995.
4. Environmental Degradation of Materials, R Balasubramaniam, Cengage International, 2010.

Reference Books:

1. Corrosion and Corrosion Control, H.H. Uhlig and W. Revie, Wiley, New York, 2007.
2. Corrosion Science and Technology, By David Talbot, James Talbot, CRC Press, 1998.
3. Corrosion Engineering By Mars. G. Fontana, Third ed., TMH.
4. 4.NACE International: http://www.nace.org/

Course Name: **Mechanical behavior of materials**

Course Code: MTN505

LTP: 3-0-0

Credits: 3

Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:

This course imparts a quantitative view of the elastic, plastic and fracture properties of materials, and their relation to bonding and microstructure, a phenomenological view of processes such as fatigue, creep and fracture mechanics and how these processes relate to material selection and component design

Lecture wise breakup **No. of Lectures**

Basic Concepts: Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity – Griffith's theory – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps. (11)

Behaviour under dynamics loads and design: Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stress life, strain-life and fail – safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non-metallic materials – Failure analysis, sources of failure, procedure of failure analysis. (7)

Selection of materials: Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection. (8)

Modern metallic materials: Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Inter-metallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano-crystalline materials. (8)

Nonmetallic materials: Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al_2O_3, SiC,Si_3N_4 CBN and diamond – properties, processing and applications. (8)

Course Outcomes:

The student will be able to predict the changes in the mechanical behavior of materials due to thermo-mechanical processing**.**

Books:

1. George E. Dieter, Mechanical Metallurgy, McGraw Hill.
2. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill, 2000.
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use in engineering materials (34d Edition), Butterworth-Heinemann, 1997.

Reference Books:

1. Flynn, R.A., and Trojan, P.K., Engineering Materials and their Applications,(4th Edition) Jaico, 1999.
2. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.
3. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butterworth, 1999.

Course Name: **Composites and Polymers**

Course Code: MTN506

LTP: 3-0-0

Credits: 3

Pre-Req.: - NIL **Total No. of Lectures –42**

Course Objectives:

This course offers an overview of the applications and uses of polymeric and composite materials putting the subject in the context of the needs and advancements of society, industry and national well-being.

Lecture wise breakup **No. of Lectures**

Properties of polymers: Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics – Applications – Merits and Demerits (8)

Processing of polymers: Extrusion – Injection Molding – Blow Molding – Compression and Transfer Molding – Casting – Thermo Forming General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Mechanical Fasteners – Thermal bonding – Press Fitting. (8)

Introduction to fibers and composite materials: Fibers – Fabrication, Structure, properties and applications - Glass, Boron, carbon, organic, ceramic and metallic fibers whiskers– Matrix materials structure – polymers, – metals and ceramics – Physical and chemical properties. (8)

Processing of polymer matrix composites: Open mould process, bag molding, compression molding with BMC and SMC filament winding – centrifugal casting – injection molding. Structure, properties and application of PMC's and recycling of PMC – Carbon Matrix Composites (8)

Processing of metal matrix composites and ceramic matrix composites: Solid state fabrication techniques – diffusion bonding – powder metallurgy techniques plasma spray, chemical and physical vapour deposition of matrix on fibers Chemical vapour infiltration – Sol gel – liquid state fabrication methods – infiltration – squeeze, casting – rheocasting – compo-casting - Interfaces properties– application of MMC and ceramic matrix composites. (10)

Course Outcomes:

The student will be able to describe and apply the principles and theories related to polymer miscibility, toughening of rigid polymers and micromechanics of composites, principles related to the physical properties of polymers & composites, the evaluation of their performance and applications for component design.

TextBooks:

1. Krishnan K Chawla, Composite Materials Science and Engineering, International Edition,

Springer,2006.
2. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers, 2002.

Reference Books:

1. Bera.E and Moet.A, High performance polymers, Hanser Publishers, 2001.
2. Rauwendaal,C., Polymer extrusium, Hanser publishers, 2000.
3. Rosatao, D.V. Blow mouldingHandBook, Hanser Publishers.
4. Seamour, E.B. Modern Plastics Technology, Prentice Hall, 2002.
5. Mallick, P.K. and Newman S., Composite Materials Technology, Hanser Publishers, 2003.

Course Name: **Surface Engineering**
Course Code: MTN507
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:

Surface Engineering deals with the surface of solid matter. It involves altering the properties of the Surface Phase in order to reduce the degradation over time. This is accomplished by making the surface robust to the environment in which it will be used.

Lecture wise breakup **No. of Lectures**

Introduction: Tribology, surface degradation, wear and corrosion, types of wear, roles of friction and lubrication- overview of different forms of corrosion, introduction to surface engineering, importance of substrate (10)

Surface Modifications: Surface Modification of ferrous metal through heat treatment and Electrochemical techniques, Surface modification of non-ferrous metals-Aluminizing, Calorizing, Diffusional coatings (9)

Advanced Surface coating techniques: Surface engineering by- energy beams, Spray techniques, HVOF, Cold spray, CVD, PVD, ion implantation (10)

Characterization of coatings and surfaces: Measurement of coating thickness, porosity, adhesion, surface microscopy, spectroscopic analysis of modified surface (9)

Thin film technology: (4)

Course Outcomes:

The student will be able to identify and describe wear mechanism and corrosion mechanisms, and recognize appropriate mitigation technology and methods.

The students will be able to describe the surface analysis techniques used for routine investigation of surface characteristics.
He will be able to identify, compare and contrast surface engineering processing technologies, including vacuum technology as used in many surface engineering processes.

Text Books:

1. Surface Engineering & Heat Treatment By: P.H Morton I.I.T, Brooke field, (1991).
2. Corrosion Engineering By: M.G.Fontana, McGraw Hill, N. York.
3. Friction and wear of Materials by Ernest Rabinowicz, John-Wiley & Sons.

Reference Books:

1. M. Ohring, The Materials Science of Thin Films, Academic Press Inc, 2005
2. Metals Handbook Ninth Edition, Vol. 5, Surface Cleaning, Finishing & Coating, ASM, Metals Park Ohio.

Course Name: **Non Destructive Testing**
Course Code: MTN508
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:
To become familiar with NDT techniques and to get exposed to the concept and procedure associated with failure analysis.

Lecture wise breakup **No. of Lectures**

Liquid Penetration Test (LPT) , Magnetic Particle Testing (MPT) and Radiography: Visual examination; liquid penetrant testing – procedure; penetrant testing materials, penetrant testing method –sensitivity; application and limitations; magnetic particle testing; definition and principle; magnetizing technique, procedure, equipment sensitivity and limitation; radiography – basic principle, electromagnetic radiation in film, radiographic imaging, inspection techniques, applications, limitations, real time radiography, safety in industrial radiography. (12)

Eddy current and ultrasonic techniques: Eddy current testing – principle, instrument techniques, sensitivity application, limitation; ultrasonic testing – basic properties of sound beam, ultrasonic transducers, inspection methods, technique for normal beam inspection, flaw characterization technique, ultrasonic flaw detection equipment modes of display, immersion testing, advantage, limitations; acoustic emission testing – principles of AET and techniques.

(10)

Application of NDT to finished products: and selection of NDT methods – defects like casting defects, forging and rolling defect, extrusion defect, drawing defect, grinding cracks, heat treating cracks, service defects; selection of NDT methods- VE, LPT, MPT, ECT, RT, UT, AET and thermography; selection of instrumentation for various NDT methods; reliability in NDT. Failure analysis: methodology; approaches, tools and techniques of failure analysis; modes of failure; failure data retrieval; procedural steps for investigation of a failure for failure analysis. (16)

Failure Characterization: Improvements (design, material) derived from failure analysis; two case studies; application of fracture mechanics concepts to design for safety. (4)

Course Outcomes:

The student will be able to describe and select specific Non-Destructive techniques to predict maintain and test for reliability/maintainability and quality of equipment, components and/or structures to maintain safe, effective and efficient operation.

Text Books:

1. Baldev Raj, Jayakumar T., Thavasimuthu M., 'Practical Non-Destructive Testing', Narosa Publishing, 1997.
2. Das A.K., 'Metallurgy of Failure Analysis', TMH, 1992.

Reference Books:

1. Hull, 'Non-Destructive Testing', ELBS Edition, 1991
2. Halmshaw R., - 'Non-Destructive Testing', Edward Arnold.
3. Rolfe T., Barson J., 'Fracture and Fatigue Control and Structure – Application of Fracture Mechanics', Prentice Hall.

Course Name: **Aerospace Materials**

Course Code: MTN509

LTP: 3-0-0

Credits: 3

Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:

Aerospace materials are materials, frequently metal alloys, that have either been developed for, or have come to prominence through, their use for aerospace purposes. These uses often require exceptional performance, strength or heat resistance, even at the cost of considerable expense in their production or machining. Others are chosen for their long-term reliability in this safety-conscious field, particularly for their resistance to fatigue.

Lecture wise breakup **No. of Lectures**

Introduction: Broad classification of aircraft materials, Ferrous materials, nonferrous materials and alloys, ceramic materials and fiber-reinforced composite materials, polymers metal matrix particulate. (6)

Materials in aircraft construction (I): Aluminum and its alloys: Types and identification. Properties, Castings, Heat treatment processes – Surface treatments. Magnesium and its alloys: Cast and Wrought alloys–Aircraft application, features specification, fabrication problems, Special treatments. Titanium and its alloys: Applications, machining, forming, welding and heat treatment. (10)

Materials in Aircraft construction (II): Steels-Plain and low carbon steels, various low alloy steels, aircraft steel specifications, corrosion and heat resistant steels, structural applications. Maraging Steels: Properties and Applications Copper Alloys–Monel, Monel Super Alloys: Use–Nickel base–Cobalt base–Iron base–Forging and Casting of Super alloys–Welding, Heat treatment. (10)

Adhesive and sealant for aircraft: Advantages of Bonded structure in airframes–Crack arresting–Weight saving–Technology of adhesive Bonding Structural adhesive materials–Test for bonding structure. Typical bonded joints& non-destructive tests for bonded joint. Bonded Sandwich structures-Materials-Methods of construction of honeycombs. (8)

Corrosion: Detection and prevention. Protective finishes. Testing - Destructive and nondestructive testing techniques. Crack detection, inspection of parts by hot oil and chalk, dye penetrant, fluorescent and magnetic particles, X-ray, ultrasonic, eddy current and acoustic emission. (8)

Course Outcomes:

The student will be able to apply concepts from mathematics and physics to aviation scenario and changes in structural designs as they apply to aerospace vehicles. The students will identify variation in physical, mechanical, and chemical properties of materials and ability to generate an innovative design for products, systems, components or processes to fulfill new needs.

Text Books:

1. S K Hajra Choudhary, Materials Science and Engineering Processes, Media Promoters
2. George E.F. Titterton, Aircraft Materials, English Book Stores, Delhi
3. M L Begman, Manufacturing Processes, Asia Publishing House, Bombay.

Reference Books:

1. Aircraft General Engineering by LalitGupta, Himalaya Book House, New Delhi.
2. King and Butler, Principles of Engineering Inspection, Clever Humes Press.
3. C G K Nair, Aircraft Materials, Interline

4. Balram Gupta, Aerospace Materials, S Chand

Course Name: **Materials processing lab**
Course Code: MTN510
LTP: 0 0 3
Credits: 2

Course objective:

The course will design:

To demonstrate the use of a variety of processing techniques for metals and ceramics and to identify the changes in microstructure and properties they cause.

The basic teaming skills, i.e. divide class into groups to work on different aspects of the same problem and communicate data efficiently and accurately to other team members.

Demonstrate effective written communication in terms of lab reports.

Demonstrate effective oral communication in final project presentation.

Accurately present basic description of the materials being studied, the processing steps necessary to take the starting materials and create the desired end material and structure.

Demonstrate the ability to differentiate chemical and structural processing methods and major types of structural processing.

Develop, implement, and communicate plans for multi-step processing experiments.

List of Experiments:

1. To perform various heat treatments such as Annealing, Normalizing, Hardening, Tempering, and Austempering.
2. To study microstructural and Mechanical properties changes associated with heat treatment carried out in practical at S.No. 1.
3. To perform Jominey Hardenability test and plot the Hardenability curve of Carbon steel.
4. Surface modification by heat treatment techniques and Electro-chemical techniques.
5. Material joining by welding and characterization of Weldament.
6. To characterize the given powder and report the physical properties of the powder. Determine the compressibility and optimize the compacting pressure to achieve high and low densities.
7. To sinter the powder compacts and study the change in properties.
8. To perform slip casting of ceramic materials.
9. To develop an alloy by metal casting and study its characteristics.

Course Outcomes:

The student will be able to perform various heat treatment processes and analyse the change in microstructure and properties of material. He will be able to process materials using surface modification and other techniques.

Course Name: **Material Characterization**
Course Code: MTN520
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:

Characterizing a material involves the understanding of the ways the components of the material are arranged from atomic to a macro (visual with the eye) scale. These arrangements are correlated with the processing and coupled strongly with the material properties.

Lecture wise breakup **No. of Lectures**

Introduction: Stereographic Projections, X-ray diffraction, crystal structure and phase identification, residual stress measurement and other applications. (8)

Thermal Analysis Techniques: Outline of thermal analysis, technique, description of DTA/DSC/TGA techniques and instrumentation, applications, and case studies. (8)

Optical microscopy: Light optics, microscope components, possibilities& limitations. (4)

Scanning Electron Microscopy: Optics and performance of a SEM, Image interpretation**,** crystallographic information in a SEM, analytical microscopy (8)

Scanning Tunneling Microscopy: Construction and operation, Image interpretation (6)

Transmission Electron Microscopy: Construction and operation of a TEM, Electron Diffraction and image interpretation. (8)

Course Outcomes:

The students will be able to use the techniques, skills and modern characterization tool necessary for analyzing materials behaviour.

Text Books:

1. Materials Characterization, ASM Hand Book Vol. 10, Edited by: ASM International Handbook Committee, ASM International.
2. Materials characterization techniques by Sam Zhang; L Li; Ashok Kumar, Publisher: Boca Raton: CRC Press, 2009.

Reference Books:

1. Elements of X-ray Diffraction by B D Cullity and S R Stock, Prentice hall, 2001.
2. Developments in materials characterization technologies: Symposium held on 23 and 24 July 1995, during 28th Annual Technical Meeting of the International Metallographic Society, Albuquerque, New Mexico, USA, edited by George F. Vander Voort, John J. Friel.

Course Name:	**Introduction to Forming processes**
Course Code:	MTN521
LTP:	3-0-0
Credits:	3
Pre-Req.: -	NIL

Total No. of Lectures – 42

Course Objectives:

The course is designed to give an overview of different types of mechanical processes used now days. This course will make a student competent to undertake a suitable fabrication technique for the forming of the metal.

Lecture wise breakup **No. of Lectures**

Introduction: Fundamentals of Metal Working, Elements of the Theory of plasticity, mechanics of metal working, flow stress determination, temperature & strain rate effects in metal working. (8)

Metallurgical structures and manufacturing: Workability, experimental techniques for metal working processes, computer aided manufacturing. (8)

Mechanical working Processes: Forging, rolling, drawing of rod, wires and tubes, extrusions and sheet metal forming. (8)

Mathematical Analysis: Mathematical analysis of forging, rolling drawing, extrusions processes.

Advances in Mechanical working Technologies: Newer trends in rolling and forging. technology viz. isothermal forging, liquid forging, powder forging, stamp process etc. Superplastic forming, use of Electromagnetic and water hammer forces etc. Various duplex forming methods like cast weld construction and micro duplexing, slip casting etc. (10)

High Energy Rate forming Operations: Explosive forming advanced of high-energy rate forming operations & its application in present day technology. (8)

Course outcomes:

The student will be able to develop correlation between material, microstructure, the forming process and obtained properties of the realised product and to select a process for given application.

Text Books:

1. Mechanical Metallurgy by G E Dieter, NewYork McGraw-Hill.
2. Metalworking science & Engineering by Edward M Mielnik (1991) McGraw Hill Series in Materials Science and Engineering

Course Name: **Biomaterials**
Course Code: MTN522
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:

This course deals with studies on nonviable materials used in a medical device intended to interact with biological systems where the materials are expected to perform with an appropriate host response in a specific application. It will help the students to understand the current biomaterials scene, know how these materials are synthesized and fabricated and know the applications in which they are used.

Lecture wise breakup **No. of Lectures**

Introduction: Natural biological materials, structure and properties (bone, skin and other elastic tissues). (8)

Biocompatibility: Tissue response to biomaterials; corrosion. (7)

Testing of biomaterials: Metallic materials in medical application: Stainless steel, cobalt based alloys, titanium based alloys (including shape memory alloys). (8)

Ceramics and glasses - Bio-ceramics: Nearly inert ceramics, bio-reactive glasses and glass ceramics, porous ceramics; Calcium phosphate ceramics: grafts, coatings Physico-chemical surface modification of materials used in medicine. (9)

Composites: Reinforcing systems-fabrication, mechanical properties, absorbable matrix composites, non-absorbable matrix composites, Implants: internal fracture fixation. Joint replacement, shape memory alloys. (10)

Course Outcomes:

The student will be able to explain structure-property relationships in biopolymers, biofibers, biocomposites and cellular biomaterials.

He will be able to apply & choose micro-mechanical models to estimate properties of bio-composites and cellular biomaterials.

The students will be able to explain functional gradient, hierarchical structure, biomimetics, eco-design and eco-indicator.

Analyze and summarize scientific journal article in the field.

Text Books:

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons.
2. Biomaterials : An Introduction to Materials in Medicine, Academic Press, 2004, USA
3. J.B. Park and J.D. Bronzino, Biomaterials: Principles and Applications. CRC Press. 2002. ISBN: 0849314917.

Reference Books:

1. T. M. Wright, and S. B. Goodman. Implant Wear in Total Joint Replacement: Clinical and Biologic Issues, Material and Design Considerations. American Academy of OrthopaedicSurgeons, 2001.
2. Lambrosio. Biomedical composites, Woodhead Publishing Limited, UK, 2009.
3. K.C. Dee, D.A. Puleo and R. Bizios. An Introduction to Tissue-Biomaterial Interactions.Wiley 2002. ISBN: 0-471-25394-4.
4. T.S. Hin (Ed.) Engineering Materials for Biomedical Applications.World Scientific. 2004

Course Name:	**Failure Analysis**	
Course Code:	MTN523	
LTP:	3-0-0	
Credits:	3	
Pre-Req.: -	NIL	**Total No. of Lectures – 42**

Course Objectives:

Design against fracture has a technology of its own, and this is a very active area of current research. This course provides an introduction to an important aspect of this field, since without an understanding of fracture the methods in stress analysis would be of little use.

Lecture wise breakup	**No. of Lectures**
Metal Failure: Basic reasons of failure, various types	(6)

Basic principles of metal deformation: Introduction to crystal geometry, Deformation, Basic models of deformation, Resolved shear stress, relations of slip to crystal structure, critical resolved shear stress. (7)

Fracture in Metals : Types of fracture, Theoretical cohesive shear strength, Griffith theory, objections to Griffith theory, Nucleation of crack – different models, Propagation of crack, effect of grain size on brittle fracture, Inter-granular brittle fracture, effect of inclusions, temp. on brittle fracture, fracture toughness. (8)

Techniques of failure analysis: Destructive and Non-destructive Testing, Macro- examination, Microscopic examination, TEM, SEM,X-Ray diffraction techniques (8)

Failure modes: Failure by fatigue, creep, fretting creep, oxidation impact, wear, corrosion, case studies. (7)

Total Quality Management: A strong link to failure analysis, Quality control concept, quality assurance. (6)

Course Outcomes:

The students will be able to apply his knowledge to analyze the various cases of failure which could have occurred due to many reasons, including uncertainties in the loading or environment, defects in the materials, inadequacies in design, and deficiencies in construction or Maintenance and be able to device prevention plan to solve engineering problems.

Text Books:

1. Ductile fracture of metals by PF Thomason, Pergamon Press, Technology & Engineering.
2. Plastic Deformation & fracture of materials by HaelMughrabi, VCH 1993.
3. Non-destructive testing of welds by Baldev raj, Subramanian and Jayakumar, Narosa Publication house, 2000.

Reference Books:

1. Metals Hand Book by Joseph R Davis, ASM International hand book committee, 1998.
2. Damage and Fracture mechanics: failure analysis of Engineering materials and structures, Springer Science and Business media B V, 2009.

Course Name: **Nano-materials and Technology**
Course Code: MTN524
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:
Nano-materials is a field that takes a materials science and technology based approach on nanotechnology. It studies materials with morphological features on the nanoscale, and especially those that have special properties stemming from their nano-scale dimensions.

Lecture wise breakup **No. of Lectures**

Concept of nano materials: Scale / dimensional aspects, Top-down and bottom-up approaches for preparing nano materials, Advantages and limitations at the nano level – thermodynamic aspects at the nano level, health and environmental issues. (10)

Characterization: Characterization of nano materials and nano structures, important characterization techniques for nano size measurement. (10)

Overview of properties of nano materials, Introduction to nano - composites, processing of nano - composites. (8)

Applications: Applications in different areas such as semi-conductors, sensors, nanostructured bio-ceramics and nano-materials for drug delivery applications. (14)

Course Outcomes:
The student will be able to apply the structure property relationships in nanomaterials as well as the concepts, not applicable at larger length scales that need to be taken into consideration for nanoscience and nanotechnology. An ability to critically evaluate the promise of a nanotechnology device.

Text Books:

1. T. Pradeep: Nano: The essentials, Tata McGraw -Hill, 2008
2. Gunter Schmidt, “Nanoparticles: From Theory to Applications”, Wiley-VCH Verlag GmbH & Co., 2004.

Reference Books:

1. Zehetbauer M.J., R.Z.Valiev, “Nanoparticles by Severe Plastic Deformation”, Wiley-VCH VerlagGmbH & Co., 2004.
2. Poole and Owens, “Introduction to Nano- technology”, Wiley.

Course Name: **Design of Experiments and Research Methodology**
Course Code: MTN525
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:
To introduce the fundamental of statistical techniques, sampling techniques and data collection and their interpretation.

Lecture wise breakup **No. of Lectures**

Basics: Basic principles of design of experiments, Error analysis in experiments. (8)

Classification: Classification of experimental designs, Design and analysis of one factor experiments- Completely randomized and randomized complete block designs, Analysis of variance (7)

Estimation of parameters: Residual analysis and model checking, Sample size problem (5)

Design with two blocking variables, Latin squares, Analysis of data from a Latin square (4)

Experiment with two factors: Introduction, Main effects and interactions, Two-factor analysis of variance, Graphic analysis, Choice of sample size. (5)

Design of Experiments: Design of experiments with the help of orthogonal arrays, Taguchi's robust parameter design, Analysis, Noise factors, Tolerance on control factors. (5)

Research Methodology: Nature and objective of research, Research topic, Literature review, Formulation of problem, Research design, sampling techniques, Data collection, Statistical and sensitive analysis of data, Interpretation of result and report writing. (8)

Course Outcomes:
Students will be able to make use of various research methodologies and its application in the relevant field of engineering.

He will be able to design and conduct experiments as well as to analyze and interpret the data.

The students will be able to design a system component or process to meet desired need within realistic constraints such as manufacturability & technology/process, service conditions, and sustainability.

Text Books:

1. Probability and Statistics for Engineers and Scientists, Walpole, Myers, Myers and Ye, 7Th ed, 2002, Pearson Education.
2. Statistics in Research, Bernard Ostle and Richard N. Mensing, Oxford & IBH Pub Co.

3. Probability and Statistics in Engineering, Hines, Montgomery, Goldsman and Borror, 4th ed, 2003, John Wiley & sons.
4. Experimental design, Theory and applications, Federer, Oxford & IBH pub Co.

Course Name: **Material Characterization lab**
Course Code: MTN530
LTP: 0 0 3
Credits: 2

Course Objectives:
This laboratory gives practical exposure to characterization techniques and teaches to interpret results with knowledge gained from the theory subject on characterization of materials.

List of Experiments
1. Qualitative elemental analysis (Metascope, Spark test).
2. Quantitative elemental analysis
3. Macroscopic examination of metals and alloys-segregation, Flow lines etc.
4. Destructive testing-hardness, impact test etc.
5. Non-Destructive testing of samples (Dye penetrant test etc.).
6. X Ray Diffraction technique for elemental and phase analysis.
7. To detect crack using Ultrasonic Flaw detector etc.
8. XRF for elemental analysis.
9. Wear and Friction studies of samples using Wear Friction monitor.
10. Electron microscopy of samples.

Course Outcomes:
The students will be able to differentiate and interpret the qualitative and quantitative elemental analysis of materials, various NDT techniques and ability to perform studies of friction and wear.

Course Name:	**Inspection and Quality control**	
Course Code:	MTN540	
LTP:	3-0-0	
Credits:	3	
Pre-Req.: -	NIL	**Total No. of Lectures – 42**

Course Objectives:
The course is relevant for the best quality assurance of the products.

Lecture wise breakup **No. of Lectures**

Quality: Philosophy; cost of quality; overview of the works of Juran, Deming, Crosby, Taguchi; quality loss function; PDCA cycle; quality control; quality assurance; quality audit; vendor quality assurance. (16)

Quality Organization: Quality management; quality system; total quality management; quality awards; quality certification; typical procedure for ISO 9000, ISO 14000, QS 9000. (10)

Review of some calculation procedures involving statistics and probability: Exposure to some applications of statistics and probability; distribution functions; normal distribution curve, Variations; analysis of variance – statistical tools – statistical quality control; control charts; process capability analysis; statistical process control; introduction to six sigma, Inspection; inspection by sampling; acceptance sampling; statistical approaches; single, double and multiple sampling plans; statistical design of experiments. (16)

Course Outcomes:
The students will be able to device the systematic way in which the production of the commodities can be monitored and their quality controlled.

Text Books:
1. Hansen B.L., P.M. Ghare, 'Quality Control and Application', PHI – EEE, 1997.

2. Juran J.M., and F.M.Gryna, 'Quality Planning and Analysis', McGraw Hill, New York.

Course Name: **Advanced Materials Joining**
Course Code: MTN541
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:
The student should be able to realize the importance of welding as a competitive component development/ reconditioning process.

Lecture wise breakup **No. of Lectures**

Introduction: Welding as a Fabrication and repair process. Solidification structures in weld joints, alloying, diffusion and dilution. Metallurgical Changes in material during arc and gas welding. (9)

Pressure welding processes: Solid phase bonding, friction welding, friction stir welding, Cold welding, ultrasonic welding, explosive welding, diffusion bonding and adhesive bonding. Resistance welding: spot, seam and projection welding. Flash and upset butt welding, percussion welding, HFRW & HFIW. (8)

Electron beam and laser welding: Controls and applications of these processes.
Welding equipment, weld joint design, operations, techniques metal fusion and weld penetration, electrodes and their motion, Applications of GRAW for welding low steels, structures. (7)

Welding of Stainless Steels and Aluminium: Automotive, aeronautical and nuclear Industry: (5)

Basic principle: Welding variable and electrodes used joint design. Applications, Metal transfer modes of metal transfer parameters affecting it and weld characteristics. (7)

Metal surfacing and spraying: Introduction, selection of a surfacing process, materials of substrate like, low alloy steels, plain 'C' steel with C O-45% classification & characteristics of surfacing materials – iron-base, Ni-base cobalt-base, Copper base alloys, carbides of Tungsten, Chromium surfacing techniques, Metal spraying & substrate, ceramic coatings, IS codes and specifications for welding materials & practices. (6)

Course Outcomes:
Since the attainment of properties is of vital significance, the outcome of the course will be aligned to the objective.

Text Books:

1. Trends in welding research by, ASM International, Proceedings of the 7th International conference, Georgia, USA, 2006.
2. Metal cutting by Edward Trent and Paul Wright, Butterworth Heinemann, 2000.

Reference Books:

1. Solders and Soldering, H.H.Manko, McGraw Hill, 2001
2. Welding Metallurgy by SindoKou, John Wiley and sons, Inc. Publication, 2003.

Course Name: **Energy Conservation & Pollution Control in Metallurgical Industries**
Course Code: MTN542
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:

The Metallurgical processes involve energy. There is thus a need to optimize this energy consumption. Moreover these processes can be a cause of pollution which needs to be taken care of. This course aims to guide the student to carry out the Metallurgical processes efficiently without causing environment pollution.

Lecture wise breakup **No. of Lectures**

Energy Conservation: Forms of energy, energy conversion, energy sources and resources, present and future energy demands. Review of commercial energies from solid, liquid and gaseous fuels. Nuclear energy systems, Alternate energy sources, Improving energy efficiency in extractive metallurgical processes with emphasis on alternate processes of aluminum production, Design and management of energy conservation, Recycling of energy, Energy conversion techniques. (22)

Pollution Control: Gas recovery in metal processing industries, gas cleaning and removal of particulate matter from gases, Heat exchangers and water cleaning of solids, Pollution control in specific metal process industries, viz. Iron and steel, Cu, Ni, Pb, Zn, Al, Co etc. Environmental considerations in metal casting, metal forming, metal plating and heat treatment industries. (20)

Course Outcomes:

The student will be equipped with all the technicalities to improve process efficiency without causing pollution.

Text Books:

1. Harker and Backhurst , Fuel and Energy, Academic Press, London.
2. C. B. Gill, Non- Ferrous Extractive Metallurgy, John Wiley.

Reference Books:

1. Proceedings of National Seminar on Energy for Steel Industry- IIM.
2. S. P. Mahajan, Pollution control in Process Industries, Tata McGraw Hill.
3. Cheremisinoff and Young, Hand Book of Pollution Engineering Practice, Ann Arbor Science Publication.

Course Name: **Advanced Metal Forming**
Course Code: MTN543
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:

The course is designed to give an overview of different types of mechanical processes used now days.

Lecture wise breakup **No. of Lectures**

Introduction: Fundamentals of Metal Working, Elements of the Theory of plasticity, Mechanics of metal working, Flow stress determination and the effect of temperature and strain rate effects in metal working. (7)

Metallurgical structures and manufacturing: Workability, experimental techniques for metal working processes, computer aided manufacturing. (7)

Mechanical working Processes: Forging, rolling, drawing of rod, wires and tubes, extrusions and sheet metal forming. (7)

Mathematical Analysis: Mathematical analysis for the mechanical processes like forging, rolling drawing, extrusions processes. (6)

Advances in Mechanical working Technologies: Newer trends in rolling and forging technology viz. isothermal forging, liquid forging, powder forging, stamp process etc. Superplastic forming, use of Electromagnetic and water hammer forces etc. Various duplex forming methods like cast weld construction and micro duplexing, slip casting etc. (11)

High Energy Rate forming Operations: Explosive forming advanced of high-energy rate forming operations & its application in present day technology. (4)

Course Outcomes:

Since the attainment of properties is of vital significance, the outcome of the course will be aligned to the objective

Text Books:

1.Mechanical Metallurgy by G E Dieter, NewYork McGraw-Hill.

2.Metalworking science & Engineering by Edward M Mielnik (1991)McGraw Hill Series in Materials Science and Engineering.

Reference Books:

1. Manufacturing Technology: Foundry, Forming & Welding by P N Rao, Tata McGraw-Hill Education, 2001.
2. Metal Forming by Uday S. Dixit, R. Ganesh Narayanan, McGraw-Hill Education, 2013

Course Name:	**Advanced Foundry Technology**
Course Code:	MTN544
LTP:	3-0-0
Credits:	3
Pre-Req.: -	NIL

Total No. of Lectures – 42

Course Objectives:

The graduate student should be able to realize the importance of Founding Technology as a competitive component development/ reconditioning process. Since the attainment of properties being of vital significance, the appreciation of course will be aligned to the objective of producing a sound casting with low energy and environmental burden.

Lecture wise breakup **No. of Lectures**

Introduction: Casting as a competitive manufacturing process (5)

Casting with ferrous, non-ferrous and super alloys: Technology in molding materials/ Dies, Influence of mechanical properties w.r.t pattern of solidification/ molding materials. (8)

Casting design: Melt treatment and casting techniques, modeling of casting (7)

Solidification: automation and quality control, solidification structures, influence and control of grain size and second phase (8)

Net-shape casting: Advances, goal of net shaping, net shaping processes viz. liquid forging, Watts Technic on processes, DC casting, Thixo-forming etc. (7)

Foundry Pollution: Foundry pollution and control, energy conservation in foundries (7)

Course Outcomes:

The student will be able to know about the material and processes for casting necessary to produce sound castings economically

Text Books:

1. Principles of metal casting by R.W. Heine, C.R. Loper and P.C. Rosenthal, , Tata McGraw-Hill Education, 2001 - Technology & Engineering.
2. Principles of Foundry technology by P L Jain, Tata Mc-Graw Hill Education, 2003.
3. Solidification and Casting by G J.Davies, Applied Science Publishers.

Reference Books:

1. Solidification and Cast Structure by I.Minkoff, Wiley,Technology& Engineering
2. Foundry Technology by P.R. Beeley, Butterworth-Heinemenn, 2001.
3. Metals Handbook by Joseph R. Davis, ASM International handbook Committee, 1998

Course Name: **Advanced Powder Metallurgy**
Course Code: MTN545
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:
This course teaches powder preparation, characterization, compaction and sintering. This knowledge is essential to understand powder metallurgy applications in aerospace, automobile and machining materials.

Lecture wise breakup **No. of Lectures**

Characteristics and testing of metal powders: Sampling, chemical composition purity, surface contamination etc. Particle size and its measurement, Principle and procedure of sieve analysis, microscopic analysis, sedimentation, elutriation, permeability. Adsorption methods and resistivity methods, particle shape, classifications, microstructure. Specific surface area, apparent and tap density, green density, green strength, sintered compact density, porosity, shrinkage. (8)

Powder manufacture and conditioning: Mechanical methods Machine milling, ball milling, atomization, shotting. Chemical methods, condensation, thermal decomposition, carbonyl reduction by gas-hydride, dehydride process, electro deposition, precipitation from aqueous solution and fused salts, hydrometallurgical method. Physical methods: Electrolysis and atomization processes, types of equipment, factors affecting these processes, examples of powders produced by these methods, applications, powder conditioning, heat treatment, blending and mixing, types of equipment, types of mixing and blending. (8)

Powder compaction: Pressure-less compaction, slip casting and slurry casting. Pressure compaction lubrication, single ended and double ended compaction, isostatic pressing, powder

rolling, forging and extrusion, explosive compaction. (5)

Sintering: Stage of sintering, property changes, mechanisms of sintering, liquid phase sintering and infiltration, activated sintering, hot pressing and Hot Isostatic Pressing HIP, vacuum sintering, sintering furnaces and sintering atmosphere, finishing operations – sizing, coining, repressing and heat treatment. (8)

Applications: Major applications in aerospace. Nuclear and automobile industries. Bearing Materials types, self-lubrication and other types, methods of production, properties, and applications.

Sintered Friction Materials-clutches, brake linings, Tool Materials-cemented carbides, oxide ceramics, Cermets - Dispersion strengthened materials. (13)

Course Outcomes:

The student will come to know of the environmental-related technologically/industrial aspects.

He will be able to develop sensitivity for the environment and becomes more eco-friendly.

Text Books:

1. Sinha A. K., “Powder Metallurgy”, Dhanpat Rai& Sons. New Delhi.
2. Ramakrishnan P, “Powder Metallurgy”,New-Age International Publishers,1st ed2007

Reference Books:

1. ASM Handbook. Vol.7, “Powder Metallurgy”, Metals Park, Ohio, USA, 1990.
2. Animesh Bose., “Advances in Particulate Materials”, Butterworth - Heinemann. New Delhi, 1995.
3. Kempton. H Roll., “Powder Metallurgy”, Metallurgical Society of AMlE.
4. Ramakrishnan. P.,“Powder Metallurgy Opportunities for Engineering Industries”, Oxford and IBH Publishing Co., Pvt. Ltd, New Delhi, 1987.
5. Erhard Klar., “Powder Metallurgy Applications, Advantages and Limitations” ,American Society for Metals, Ohio.
6. Sands. R. L. and Shakespeare. C. R. “Powder Metallurgy”, George Newnes Ltd. London.

Course Name: **Industrial Heat Treatment**
Course Code: MTN546
LTP: 3-0-0
Credits: 3
Pre-Req.: - NIL **Total No. of Lectures – 42**

Course Objectives:
The heat treatment technology deals with the factors and mechanisms involved in the control of composition and properties of various materials with 'getting it right' economically, operationally, and environmentally.

Lecture wise breakup **No. of Lectures**

Principles of Heat treatment: Austenitic Transformation, Pearlitic Transformation, Bainitic Transformation, Martensitic Transformation, Annealing, Normalizing, Hardening, mechanism of heat removal during quenching, quenching media, size and mass effect, hardenability, tempering, austempering, manufacturing, deep freezing. (10)

Surface heat treatment: Carburizing, cyaniding, flame and induction hardening, residual stresses, deep freezing, thermo mechanical treatments: HTMT, LTMT, Ausforming, Isoforming, Cryoforming. (8)

Effect of alloying elements: Purpose of alloying, effect of alloying elements on ferrite, cementite, Fe-Fe_3C system, tempering and TTT Curves. (3)

Alloy steels: Structural and constructional steels, Maraging steels, tool and die steels. (4)
Corrosion and heat resistant steels, Hadfield steels, magnetic steels and alloys, free machining steels. (4)

Cast irons: White cast iron, grey cast iron, spheroidal graphite iron, malleable cast iron, alloy cast iron. (4)

Non-ferrous metals and alloys: Precipitation hardening, aging treatment, study of copper and its alloys, aluminum and its alloys, nickel and its alloys. (5)

Furnaces: Heat treatment furnaces and their design, atmosphere control vacuum heat treatment etc. (4)

Course Outcomes:
The student will have the ability to understand the advantages of heat treatment like increasing the strength of material, improve machining, improving formability, restore ductility after a cold working operation. Thus it is a very enabling manufacturing process that can not only help other manufacturing process, but can also improve product performance by increasing strength or other desirable characteristics.

Text Books:

1. Heat Treatment Principle and Techniques by Rajan, Sharma
2. Principles of Heat treatment of steels by R C Sharma, New Age International, 2007
3. The steel Handbook by Alok Nayar, McGraw-Hill Education, 2001.

Reference Books:

1. Handbook of Heat Treatment of steels by K H Prabhudev, Tata McGraw-Hill Publication.
2. Hand book on Heat Treatment of steels-Tata McGraw-Hill Education.

Course Name:	**Case Histories and Industry Experiences**	
Course Code:	MTN547	
LTP:	0-0-2	
Credits:	01	
Pre-Req.: -	NIL	**Total No. of Lectures – 16**

Course Objectives:

Students learn more effectively when involved in the learning process which is problem/project based. By analysis during case study, its report writing and paper preparation, the candidate is actively involved in all these learning processes. His approach towards problem solving and analyzing skills are thus enhanced.

Course Outcomes:

The student will gain the current practical knowledge from the industry. He will be able to assess the live industrial projects to solve engineering problems and contemporary issues.

The student will be able to understand the impact of engineering solutions in a global, economic, environmental and societal context.

Course Name:	**Seminar and Term Paper**	
Course Code:	MTN 548	
LTP:	0-0-2	
Credits:	01	
Pre-Req.: -	NIL	**Total No. of Lectures – 16**

Course Objectives:

The objective of the term paper is to train the student's ability to critically evaluate a well-defined set of research subjects, and to summarize the findings concisely in a paper of scientific

quality. The paper will be evaluated based on its ability to communicate an understanding of a topic, and to identify key outstanding questions.

Course Outcomes:

The student will be able to communicate effectively his work in the form of power point presentation and term paper.

Course Name: **Project/ Industry based Project -I**

Course Code: MTN598
LTP: 0-0-24
Credits: 12

Course Objectives:

The purpose of a thesis is to enable the student to develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study. The thesis should be written at the end of the programme and offers the opportunity to delve more deeply into and synthesize knowledge acquired in previous studies. A thesis for M.E. (IMM) programme should place emphasis on the technical/scientific/artistic aspects of the subject matter.

Course Outcomes:

The student will be able to

- know about the major subject/field of study, including deeper insight into current research and development work
- contribute into research and development work
- use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.
- plan and use adequate methods to conduct qualified tasks in given frameworks and to evaluate this work.
- create, analyze and critically evaluate different technical/architectural solutions.
- to critically and systematically integrate knowledge
- to clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings in written and spoken English
- identify the issues that must be addressed within the framework of the specific thesis in order to take into consideration all relevant dimensions of sustainable development.
- Know of the ethical aspects of research and development.

Course Name: Project/ Industry based Project -II

Course Code: MTN599

LTP: 0-0-36

Credits: 18

Course Objectives:

The purpose of a thesis is to enable the student to develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study. The thesis should be written at the end of the programme and offers the opportunity to delve more deeply into and synthesize knowledge acquired in previous studies. A thesis for M.E. (IMM) programme should place emphasis on the technical/scientific/artistic aspects of the subject matter.

Course Outcomes:

The student will be able to

- know about the major subject/field of study, including deeper insight into current research and development work
- contribute into research and development work
- use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.
- plan and use adequate methods to conduct qualified tasks in given frameworks and to evaluate this work.
- create, analyze and critically evaluate different technical/architectural solutions.
- to critically and systematically integrate knowledge
- to clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings in written and spoken English
- identify the issues that must be addressed within the framework of the specific thesis in order to take into consideration all relevant dimensions of sustainable development.
- Know of the ethical aspects of research and development.