MAHATMA GANDHI INSTITUTE OF TECHNOLOGY

(Autonomous)
Gandipet, Hyderabad – 500 075

Department of Metallurgical and Materials Engineering
List of Open Electives Offered Excursively to CSB, CSD and CSM branches under MR-21 Regulation

VI Semester Open Elective-I for CSB, CSM and CSD branches

S,No	Code	Name of the Course
1	MM631OE	Testing of Materials
2	MM63OE	Metallurgy for Non-Metallurgists

VII Semester Open Elective-II for CSB, CSM and CSD branches

S,No	Code	Name of the Course
1	MM731OE	Design and Selection of Materials
2	MM732OE	Engineering Materials

VIII Semester Open Elective-III for CSB, CSM and CSD branches

S,No	Code	Name of the Course
1	MM831OE	Light Metal Technology
2	MM832OE	Surface Engineering

L	T	P	C
2	0	0	2

B.Tech in Metallurgical and Materials Engineering
VI Semester Syllabus
Open Elective -I
MM631OE: TESTING OF MATERIALS

Course Objectives

- To gain an understanding of the response of various metals under the application of stress and/or temperature.
- To build necessary theoretical background of the role of lattice defects in governing both elastic and plastic properties of metals will be discussed.
- Obtain a working knowledge of various hardness testing machines
- Obtain a working knowledge of creep and fatigue and analysis of data.

Course Outcomes

- Classify mechanical testing of ferrous and non-ferrous metals and alloys.
- Recognize the importance of crystal defects including dislocations in plastic deformation.
- Identify the testing methods for obtaining strength and hardness.
- Examine the mechanisms of materials failure through fatigue and creep

Unit - I: Hardness and Impact Test

Introduction, Importance of testing Hardness Test: Methods of hardness testing – Brinell, Vickers, Rockwell hardness tests. The Impact Test: Notched bar impact test and its significance, Charpy and Izod Tests, fracture toughness testing - COD and CTOD tests, significance of transition temperature curve, Metallurgical factors affecting Transition Temperature

Unit - II: The Tension Test

The Tension Test: Engineering stress-strain and True stress-strain curves. Tensile properties, conditions for necking. Relationship between True stress and Engineering Stress, True Strain and Engineering strain, Toughness, Resilience, Stress-Strain diagrams for steel, Aluminum and cast iron. Compression Test.

Unit - III: Fatigue Test

Introduction, Stress cycles, S-N Curve, Effect of mean stress, Fatigue limit, Mechanism of fatigue failure, Effect of stress concentration, size effect, Metallurgical Factors affecting Fatigue life, surface condition and environments on fatigue

Unit - IV: Creep and Stress Rupture

Introduction, High Temperature problem, The creep curve, Stress-rupture test, Structural changes during creep, Mechanism of creep deformation, Deformation Mechanism Maps, theories of creep. High Temperature alloys, Fracture at elevated temperature.

Unit - V: NDT

Introduction to NDT: Principle, Operation, Advantages and Limitations of Liquid Penetrant, Types of Penetrants, Function of Developer, Steps in Liquid Penetrant Test Principle, Operation, Advantages and Limitations of Magnetic Particle Test, Methods of magnetisation, Longitudinal Magnetisation, Circular magnetisation, Demagnetisation methods Principle, Operation, Advantages and Limitations of Radiography, characteristics of X-Rays and Gamma rays, Radiographic film, Processing of Radiographic film, contrast, sharpness of Radiographic film Principle, Operation, Advantages and Limitations of Ultrasonic testing, pulse echo method

Textbooks:

1. Mechanical Metallurgy – G. E. Dieter, third edition, published by New York Mc GrawHill, 1986.
2. Mechanical Behaviour of Metals, Meyers and Chawla.
3. Mechanical behavior - Ed. Wulf.

Reference Books:

1. Mechanical Metallurgy – White & Lemay.
2. Testing of Metallic Materials - A.V.K. Suryanarayana

L	T	P	C
2	0	0	2

B.Tech in Metallurgical and Materials Engineering
VI Semester Syllabus
Open Elective -I
MM632OE: Metallurgy for Non-Metallurgists

Course Objectives

- To describe the basic principles of Materials and the importance of materials in various disciplines of engineering.
- Introduction to crystal defects to understand the deformation behaviour of materials.
- Gain a thorough knowledge about heat treatment of steels.
- Gain knowledge about properties and uses of cast irons and nonferrous metals.
- Gain a working knowledge of basic testing methods for metals.

Course Outcomes

At the end of the course student would be able

- to get a brief idea of materials w.r.to applications
- to understand the deformation behaviour of materials
- to apply heat treatment principles to solve engineering applications
- to apply the knowledge of light metals for specific applications
- to select different testing methods based on applications.

Unit - I

Introduction to materials, classification of materials, Crystal structure and defects, Crystal structure of metals, Classification of steels, Carbon steels

Unit - II

Heat Treatment of Steels: The Iron carbon system, Common phases in steels, Annealing,Normalizing, Hardening, and tempering

Unit - III

Cast irons: Properties and applications of Ductile irons, Malleable irons, Compacted graphite iron.

Unit - IV

Non-Ferrous Metals: Properties and applications of Light Metals (Al, Be, Mg, Ti), Super Alloys

Unit - V

Testing of Metals: Hardness testing, Tensile Testing, Impact Testing, Fatigue Testing, Creep testing

Suggested Readings:

1. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007
2. Introduction to Physical Metallurgy – SH Avner, TATA Mc GRAW HILL ,1997
3. Mechanical Metallurgy – G. E. Dieter

References Books:

1. Engineering Physical Metallurgy and Heat treatment – Y Lakhtin
2. C. Suryanarayana, Experimental Techniques in Mechanics and Materials, John Wiley, John Wiley, NJ, USA, 2006.
3. Foundations of Materials Science and Engineering – WF Smith

L	T	P	C
2	0	0	2

B.Tech in Metallurgical and Materials Engineering
VII Semester Syllabus
Open Elective -II
MM731OE: Design and Selection of Materials

Course Objectives

This course aims at making student to understand and design a material for a given application considering the composition, manufacturing process and properties that are required in service.

- Knowledge of selection of materials and factors affecting them in design
- Role of microstructure processing and properties in design and selection of materials
- Design of and selection materials for high temperature applications based on mechanical properties
- Knowledge of materials selection for Nuclear applications
- Knowledge of special materials for specific applications

Course Outcomes

Student is able to

- Gain knowledge in different materials and factors affecting in selection of materials
- Analyse and co relate the structure, processing and properties in designing the components
- Select the materials for high temperature applications
- Select the materials for Nuclear applications
- Design and select smart materials for any applications

Unit - I

Introduction to Roles & Responsibilities of Materials Engineer; Introduction to Materials Selection, Criteria for selection of materials; Factors affecting the selection of materials; Introduction to Engineering Materials

Unit - II

Effect of composition, processing and structure on materials properties: Concepts in the design of industrial components

Unit - III

Properties vs Performance of materials: Aerospace and defense applications: design and alloySelection based on LCF, TMF, Creep fatigue interaction, hot corrosion resistance, role of DBTT for Naval applications, Intermetallics, Aluminides

Unit - IV

Nuclear Materials: Design aspects of materials for fission and fusion reactors.
Nuclear applications: Radiation damage, effect of radiation damage on YS, UTS, DBTT

Unit - V

Special Materials: Manufacturing aspects w.r.to design. Selection and design of ceramics composites and polymers for specific applications

Suggested Readings:

1. M.F. Ashby, Materials Selection in Mechanical Design, Pergamon Press, 1992
2. G.E. Dieter, Engineering Design, A Materials and Processing Approach, 2nd ed. McGraw-Hill, 1991
3. Material Selection and Design, Vol 20, ASM Hand Book, ASM International.

References Books:

1. T.H. Courtney, Mechanical Behavior of Materials, McGraw-Hill, 1990
2. J.R. Dixon and C. Poli, Engineering Design and Design for Manufacturing, Field Stone Publishers, 1995.

L	T	P	C
2	0	0	2

B.Tech in Metallurgical and Materials Engineering
VII Semester Syllabus
Open Elective - II
MM732OE: Engineering Materials

Course Objectives

This course has the basic idea of the properties of materials.
The objectives aim to:

- Learn fundamentals of Advanced high strength steels
- Fundamentals of high temperature materials
- Knowledge of ceramic materials
- Knowledge of Polymeric materials
- Knowledge of Composite materials

Course Outcomes

At the end of the course the students are able to:

- Gain knowledge on advanced high strength steels
- Learn Fundamentals of high temperature materials
- Learn about ceramics and their applications
- Learn about Polymers and their applications
- Can apply his knowledge in design and selection of composite materials.

Unit - I: Alloy Steels

Steels, purpose of alloying, Classification of alloy steels; Steels for Automobile applications, comparative study of interstitial free steels and dual phase steels; HSLA steels, TRIP steels, TWIP steels, bainitic steels and heat treatments, Stainless steels: classification, Properties and applications.

Unit - II: High temperature materials

Superalloys: Classification of Superalloys: Fe-Ni base Superalloys, Ni base superalloys, Co base superalloys, Microstructure and mechanical properties co-relation; Ti alloys, classification and mechanical properties, Introduction to Intermetallics.

Unit - III: Ceramics

Types and application of Ceramics: Glasses, Glass–Ceramics, Clay Products, Refractories, Abrasives, Cements, Advanced Ceramics; Structures and Properties of Ceramics: Crystal Structures, Silicate Ceramics, Imperfections in Ceramics, Diffusion in Ionic Materials. Fabrication and processing of ceramics: Fabrication and Processing of Glasses, Glass–Ceramics, Fabrication and Processing of Clay Products, Powder Pressing, Tape Casting.

Unit - IV: Polymers

Introduction, Hydrocarbon Molecules, Polymer Molecules, The Chemistry of Polymer Molecules, Molecular Weight , Molecular Shape , Molecular Structure ,Molecular

Configurations ,Thermoplastic and Thermosetting Polymers , Copolymers, Polymer Crystallinity, Polymer Crystals , Defects in Polymers ,Diffusion in Polymeric Materials; **polymer types :**Plastics , Elastomers, Fibers; Characteristics, Applications, and Processing of Polymers **:**mechanical behavior of polymers stress–strain behavior, macroscopic deformation, viscoelastic deformation, fracture of mechanisms of deformation , Deformation of Semicrystalline Polymers , Factors That Influence the Mechanical Properties of Semicrystalline Polymers, Deformation of Elastomers.

Unit - V: Composite Materials

The nature of composite materials**:** Composites, Conventional materials and their limitations; Strong fibres:glass fibres, carbon fibres, silicon carbide alumina and alumina/silica compounds. Organic fibresstyles of reinforcement, the scope for reinforcement of conventional materials Functions of matrix, Metals, Polymeric materials, Glasses, ceramics and cement, Carbon; making composite materials: the combining of materials, the interface; manufacturing processes:polymer-matrix composites, metal-matrix composites, ceramic-matrix composites. hybrid composites

Suggested Readings:

1. Introduction to Physical Metallurgy / Sidney H. Avner.
2. Materials Science and engineering / William D callister.
3. Elements of Material science / V. Rahghavan

References Books:

1. Elements of Metallurgy and Engineering Alloys-Cambell; ASM International-2008.
2. Engineering Composite materials by Bryan Harris, The Institute of Materials, London1999.

L	T	P	C
2	0	0	2

B.Tech in Metallurgical and Materials Engineering
VIII Semester Syllabus
Open Elective - III
MM831OE: Light Metal Technology

Course Objectives

The prime aim of this course is to understand and gain

- Basic knowledge of light metals and alloys and their strengthening mechanisms.
- Knowledge of Physical metallurgy of Al alloys for aerospace applications
- Knowledge of processing of Al alloys for mechanical systems.
- Knowledge of Physical metallurgy of Ti alloys and their processing for industrial applications
- Knowledge of production, processing of physical metallurgy of Be and Mg alloys for industrial applications

Course Outcomes

Upon successful completion of this course, the students will be able to

- Learn about Al alloys and can analyze the mechanical properties of Al alloys in real time aerospace applications
- Learn and apply physical metallurgy aspects and corrosion aspects of Ti alloys in industry
- Learn and apply Be alloys for various industrial applications.
- Learn and apply physical metallurgy and corrosion aspects of Mg alloys to the need of industry
- Apply their basic knowledge in Design and selection of light metals and alloys for mechanical systems.

Unit - I

General introduction – Light metals and alloys, strengthening by solid solution, precipitation, dispersion of second phase particles, grain refinement and work hardening; Scenario of India in worlds production of light metals and alloys.

Unit - II

Aluminum alloys: Classification, properties, applications; binary phase diagrams; Heat treatment and strengthening mechanisms of Al-Cu, Al-Mg, Al-Zn, Al-Mn and Al-Si and Al-Li systems.

Unit - III

Development of high strength Aluminum alloys by non-equilibrium processing routes such as rapid solidification and powder metallurgy. Applications in consumer, automotive and aerospace industry. Processing of Al-alloys;

Unit - IV

Commercially Pure Titanium and its properties, applications, interstitial solid solutions of

Titanium, Titanium alloys, Strengthening mechanisms of Ti alloy, alpha Ti alloys, Beta Ti-alloys, alpha plus Beta Ti alloys, Heat treatment, Properties and applications of Ti-8Al-1Mo-1V, Ti-6Al-4V, Ti-5553 alloys; Processing of Ti -alloys.

Unit - V

Beryllium alloys: Classification properties and applications.

Magnesium Alloys: Properties, Designation, Heat treatment of Magnesium alloys Mg-Sn, Mg-Zn, Mg-Gd, Mg-Li systems. Corrosion resistance of Mg-alloys; Production and processing of Mg alloys; Applications in consumer, automotive and aerospace industry.

Suggested Readings:

1. Heat treatment, structure and properties of nonferrous alloys - Charlie Brooks, ASMMetals Park, Ohio, USA.
2. I.J.Polmear, Light Alloys - From Traditional alloys to nano crystals, Fourth Edition, Butterworth Heinemann, 2005.
3. D.H. Kirkwood, M. Surey, P. Kapranos, H.V. Atkinson, K.P. Young, Semisolid Processing of Alloys, Springer Series in materials Science, 2010.
4. M. Gupta, N.M.L. Sharon, Magnesium, Magnesium Alloys, and Magnesium Composites, Wiley, 2011.

References Books:

1. Introduction to Physical Metallurgy – S. H. Avner
2. Engineering Physical Metallurgy – Lakhtin
3. R.W.Heine, C.R.Loper, P.C.Rosenthal, Principles of Metal Casting,Tata McGraw Hill, 1976.
4. G. Lutjering, J.C. Williams, Titanium, Springer, 2007

L	T	P	C
2	0	0	2

B.Tech in Metallurgical and Materials Engineering
VIII Semester Syllabus
Open Elective - III
MM832OE: Surface Engineering

Course Objectives

- This course is mainly designed to make the students understand the importance of surface engineering techniques, scope, limitations and areas ofapplications.
- This course also focuses on industrially significant coating techniques, selection, and evaluation of coating characteristics

Course Outcomes

At the conclusion of this course, the student will be able to

- Understand the significance of surface modification processes
- Describe the principles of surface modification processes
- Identify the testing approaches to evaluate a modified surface
- Suggest a surface modification process for a particular wear situation

Unit - I: Introduction to Surface Engineering

Conceptual study of surfaces, Significance and necessity of engineering of surfaces; Scenario of Surface Engineering: Yesterday-Today-Tomorrow; Classification of surface engineering processes; Types of substrates and their pretreatments; Applications of Surface Engineering; Characteristics of Surface Coatings: thickness, continuity, hardness, adhesion, porosity, and bond strength; Characterization techniques of surfaces.

Unit - II: Thermally Sprayed Coatings

Introduction, classification, affecting factors; Industrial applications; Plasma spraying; flame spraying, detonation spray coating, High velocity oxy-fuel spraying; thermal barrier coatings; comparison among the coating technologies.

Unit - III: Diffusion Coatings

Introduction, Process parameters, advantages, limitations and applications; carburizing, liquid nitriding, carbonitriding, nitrocarburizing, and boronizing. Aluminized, chromized, and siliconized coatings. Other coating methods: Electrochemical coatings.

Unit - IV: Thin Film Coating Technologies

Introduction to thin films, Significance of thin films; classification of thin film coating technologies, Chemical Vapor deposition (CVD); Physical Vapor Deposition (PVD); Electron beam evaporation; sputtering; diamond like carbon coating technology; sol-gel coating technologies.

Unit - V: Other Methods of Surface Coating

Plasma Processes: Plasma carburizing and plasma nitriding; plasma immersed ion implantation; plasma enhanced physical vapor deposition; plasma enhanced chemical vapor deposition.

Thermal Modification Processes: Different types of lasers and their applications; Laser assisted surface modification processes.

Suggested Readings:

1. K G Budinski, Surface Engineering for wear resistance, Prentice Hall, New Jersey,1998
2. Surface Engineering, Process fundamentals and applications, Vol I and II, Lecture Notes of SERC school of SurfaceEngineering
3. Howard E. Boyer (Editor), Case Hardening of Steel, ASM International, metals Park, OH44073

References Books:

1. Materials science- VanVlack
2. Electroplating: Basic Principles and Practice - Kanan. N (Elsevier)2004