

# **MECHANICAL ENGINEERING DEPARTMENT**

## **M.Tech. ENGINEERING MATERIALS**

**Course of Study & Scheme of Examination  
2016-17**



**Maulana Azad National Institute of Technology  
Bhopal**

**M.TECH. IN ENGINEERING MATERIALS**

***First Semester***

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
MTH511D	Advanced Engineering Mathematics & Optimization Techniques	3	-	-	3
EM512	Material Science	3	-	-	3
EM513	Behavior of Materials	3	-	-	3
	Elective - 1	3	-	-	3
	Elective - 2	3	-	-	3
	Open elective-1	3	-	-	3
EM514	Behavior of Materials Laboratory	-	-	2	2
EM515	Seminar 1 and mini project	-	2	-	2
Total credit 22					

***Second Semester***

Course Number	Subject	Scheme of Studies Periods per week			Total Credits
		L	T	P	
EM521	Material Processing	3	-	-	3
EM522	Materials Management	3	-	-	3
EM523	Tribology	3	-	-	3
	Elective - 3	3	-	-	3
	Elective - 4	3	-	-	3
	Open elective-2	3	-	-	3
EM524	Advanced Materials Laboratory	-	-	2	2
EM525	Seminar 2 and mini project	-	2	-	2
Total credit 22					

**List of department Electives**

EM531 Bio-Materials	EM532 Nuclear Materials
EM533 Aerospace Materials	EM534 Polymer Engineering
EM535 Corrosion Engineering	EM536 Metal Forming
EM537 Theory of Plasticity	EM538 Advanced Materials
EM539 Product Design & Development	EM-541 Intellectual Property Right
EM 542 Fracture & Failure of Materials	EM543 Composite Materials

**List of open Electives**

EM 551 Advance Mechanics of Materials
EM 552 Finite Element Methods

## SYLLABUS

### **MTH511D ADVANCED ENGINEERING MATHEMATICS & OPTIMIZATION**

#### **TECHNIQUES**

Numerical Methods: Solution of algebraic and transcendental equations, Solution of linear simultaneous equations, finite differences, Interpolation and Extrapolation, Inverse Interpolation, Numerical differentiation and integration, Numerical solution of ordinary and partial differential equations.

Introduction to optimization by linear programming, solution by graphical and simplex method, concept of degeneracy and duality, artificial variable techniques-Big-method, transportation and assignment problem.

#### **References**

1. Numerical Methods for Engineers                      Stevan C. Chapra and Raymond P Canale.
2. Numerical Methods for Engineers                      Iyengar and M.K.Jain.
3. Operation Research    S.D.Sharma.
4. Numerical Optimization Techniques with Applications                      Suresh Chandra.

**EM512 MATERIAL SCIENCE**

Crystal structure and characterization of materials, Solid solutions, Phase diagrams, Iron Carbon equilibrium diagram, Mechanical Properties of metals, Diffusion in solids, Magnetic and Electrical properties of materials.

References

1. Material Science and Engg. V. Raghvan
2. Material Science G.K.Narula
3. Physical Metallurgy Principles Robert E. Reed Hill

**EM513 BEHAVIOUR OF MATERIALS**

Mechanical behaviour of materials under Tension and Compression, Mechanical behaviour of materials under Shear and bending, Utilization of shear/bending properties in design. Static stress-strain properties for combined stresses, theories of failures Fracture toughness, LEFM, Mechanical behaviour of materials under Fatigue and Creep.

References

1. Behaviour of Material Joseph Marin
2. Mech. Behaviour of Materials Norman E. Dowling
3. Mech. Behaviour of Materials K.K.Chawla
4. Mech. Behaviour of Material Thomas H Courtney

**EM 514 BEHAVIOR OF MATERIALS LABORATORY**

Experiments on mechanical, thermal and electrical properties of materials, Studies of crystal structures, Corrosion.

**EM515 SEMINAR 1 & MINI PROJECT**

Heat treatment processes, TTT diagram, Hardening methods, Hardenability, Heat treatment of Aluminium and its alloys. Powder metallurgy. Composites preparation, properties and uses. Fiber reinforced resin plastics., coatings.

References:

1. Heat treatment Principles & Techniques T.V.Rajan & Sharma
2. Physical Metallurgy Principles Robert E. Reed Hill
3. Engineering Materials Technology by Smith

## SECOND SEMESTER

### EM 521 MATERIALS PROCESSING

Heat treatment processes, TTT diagram, Hardening methods, Hardenability, Heat treatment of Aluminium and its alloys. Powder metallurgy. Composites preparation, properties and uses. Fiber reinforced resin plastics., coatings.

References:

1. Heat treatment Principles & Techniques T.V.Rajan & Sharma
2. Physical Metallurgy Principles Robert E. Reed Hill
3. Engineering Materials Technology by Smith

**EM522 MATERIALS MANAGEMENT**

Importance of material management system, Planning and Organization, Store, Codification, standardization, waste management. Purchase and Sales management. Inventory management, JIT, Cost reduction through material management, value analysis, computer applications in material management.

References :1. Materials Management P.B. Pandey ;2. Materials Management H.C. Sharma  
3. Operation Research Heera Gupta



**EM523 TRIBOLOGY**

Tribology over view, friction, wear & lubrication, economic significance, impact of tribology on maintenance, plant life, energy conservation, material conservation, safety & pollution. Types of wear, its significance, wear regimes, adhesive, abrasive, corrosive, erosive & fatigue wear, effect of surface film, control of wear, Bearings, Gears lubrication and failure, seals, elastomers, seal failures.

References:

1. Introduction to Tribology of bearings B.C. Majumdar
2. Maintenance Engineering Handbook Ed. Lindley R. Higgins
3. Friction & Wear of Materials Rabinowicz

**EM 524ADVANCED MATERIALS LABORATORY**

Experiments related to advances materials

**EM525 SEMINAR 2 & MINI PROJECT**

Students have to collect a International Journal paper on the topics of their interest, prepare a write up and present with suitable demonstration by software or experimental work. Evaluation will be based on relevant topic student has studied, communication skill and reporting/documenting procedure

## DEPARTMENT ELECTIVES

### EM531 BIO MATERIALS

Studies of Biomaterials-Biocompatible, Teflon, Silastics, Siloconized rubbers, Acrelic cements for dentures and Bine setting cements. Biodegradable materials such as polymers, high concentrated protein compounds with a short life time. Impact failure fields and degradation of implants biosensors, bioreactors. Bioprocess instrumentation and control system. Biomechanical behaviour under biological and/or medical condition such as fracture toughness, fatigue, plasticity, viscoelasticity, rheology, tribology and wear and behaviour under impact. Mechanics and device for promotion of physical strength. Biomechanics: Mechanics of forces and movements of joints. Fracture mechanics of the human skeleton with special reference to dynamic impact. Effect of vibration on human skeleton, Mechanical and biological properties of membrane biomaterials, cellular and tissue engineering. Standardization problems on biomaterials and related products. Assessment of reliability and safety of biomedical materials and man-machine systems. Product liability of biomaterials and related products. Bioengineering and materials technology as applied to decontamination against environmental problems.

1. References
2. 1. Bioengineering Materials R.S.Sharma
3. 2. Engineering Materials R.L.Timings.

**EM532 NUCLEAR MATERIALS**

Structure of a power plant, requirements of reactor materials, fuel materials, plutonium uranium and thorium and their alloys and compounds, magnesium and its alloys, zirconium and its alloys, austenitic stainless steel materials for reactor vessel and other components, copper alloys, titanium and its alloys, coolants used in reactors, radiation embrittlement , corrosion of reactor materials,

**EM533 AEROSPACE MATERIALS**

Carbon- carbon composites, production, properties and applications, inter metallic matrix composites, ablative composite based on polymers, ceramic matrix, metal matrix composites based on aluminum, magnesium, titanium and nickel based composites for engines, super alloys, aluminum alloys, magnesium alloys and titanium alloys, materials for plasma engines, inter-metallic aluminides, ceramics and polymeric materials.

**EM 534 POLYMER ENGINEERING**

Automotive applications of plastic, Environmental considerations, Structure of the molecule, Viscoelasticity, Polymer composites, FRP, reinforced rubbers, Forming, flow properties of polymers melts, cooling and solidification, extrusion. Mechanical, Electrical and Barrier Properties, Conducting polymer, High temperature polymer, Rheological behaviour of polymer. Design and Analysis, materials selection, designing for manufacture, designing for stiffness, strength, testing of polymers.

References

1. Engineering Polymer R.W. Dyson
2. Principles of Polymer Engg. N.G. McCrum

**EM535 CORROSION ENGINEERING**

Electrochemical and thermodynamic principles, stress corrosion cracking, intergranular corrosion, corrosion fatigue, fretting corrosion and high temperature oxidation; causes and remedial measures, susceptibility tests for IGC, Corrosion prevention by design improvements, metallic, non-metallic and inorganic coatings, mechanical and chemical methods and various corrosion inhibitors.

References

1. An Introduction to Metallic Corrosion and its Prevention Raj Narayan
2. Corrosion Engineering Fontana M. G., Greene N. D.
3. Denny Jones, "Principles and Prevention of Corrosion", Prentice Hall of India, 1996

**EM536 METAL FORMING**

Classification of metal forming processes, effect of temperature, strain rate and microstructural variables; residual stresses, experimental techniques, yielding theories, Classification of forging processes, forging equipment, forging defects, Classification of rolling processes, rolling mills, cold rolling, hot rolling, Types of extrusion, process variables, wire, rod, and tube drawing, lubrication processes, stretch forming, deep drawing.

References

1. Mechanical Metallurgy Dieter G. E,
2. Engineering Metallurgy, Volume II, Higgins R.A,
3. Mechanical Working of Metals-Theory and Practice Harris J.N



### **EM-537 THEORY OF PLASTICITY**

Nature of plasticity, Differential equations of equilibrium, 3D stress analysis, Von Mises, Tresca's and anisotropic yield criteria, halgh-Westerguard stress space representation of yield criteria, Elastic and Plastic stress strain relations and stress strain rate equations, Prandtle-Reuaa equations, Generalised plastic stress strain relations, Anisotropy and instability. Plane plastic flow, Slip-Line field, Plain plastic stress and pseudo plane stress analysis and its applications, Extremum principle for rigid perfectly plastic material, surfaces of stress and velocity discontinuity, Upper bound and lower bound theorems and applications.

1. References
2. 1. The Mathematical Theory of Plasticity R Hill
3. 2. Applied Plasticity Chakrabarty
4. 3. Plasticity theory Jacob Lubliner

**EM538 ADVANCED MATERIALS**

Nanomaterials: Carbon nanotubes, structure and properties, chemistry of carbon nanotubes, graphite whiskers, cones and polyhedral crystals, nanocrystalline diamond, carbide derived carbon nanotubes in multifunctional polymer nano composites, Composites processing, micromechanics, shape memory alloys (SMAs), metallic foam, Plastics, polymeric materials (molecular viewpoint), microstructures in polymers, mechanical properties (macro view point) chemical and physical properties (macro view point), designing with plastics,, thermoplastic materials (commodity plastics), thermoplastic materials (engineering plastics), thermoset materials, elastomeric (rubber) materials, related processes, Environmental aspects of plastics.

References

1. Materials, their Nature, Properties and Fabrication Sukh Dev Sehgal, Lindberg R.A.
2. Light alloys: Metallurgy of Light Metals Polmear I. J.

**EM539 PRODUCT DESIGN AND DEVELOPMENT**

Forecasting and market research for a new product, Identification of needs of the customers, concept generation, selection, testing, product architecture, design for manufacturing, environment, prototyping. Robust design, development of IPR copyright, patents, design.

References

1. Product design and development by Karl Ulrich and Steven Eppinger

**EM541 INTELLECTUAL PROPERTY RIGHT**

Introduction to IPR, Patents and methods of application of patents, Trade secret copyrights, Trademarks. Legal implications, Intellectual Property Issues in Cyber Space, Cyber laws, Law of Digital Contracts, Role and Function of Certifying Authorities, Legal implications. Trade secret copyrights, Trademarks, Copyright and related rights under existing and prospective treaties and conventions (particularly Berne, WIPO Treaties, TRIPs), WTO, dispute settlement and TRIPs.

### **EM542 FRACTURE AND FAILURE OF MATERIALS**

Application of fracture mechanics in analysis of fracture, elastic – plastic fracture mechanics, plain strain fracture toughness test, crack opening displacement test, Ductile – brittle transition, method of determination of transition temperature, factors affecting ductile – brittle transition temperature. Objectives of Failure Analysis, non destructive testing, mechanical testing, microscopic examination of fracture surface, scanning electron microscopy. Fracture modes: Shear mode, cleavage mode, other fracture modes, factors affecting, the ductile-brittle relationship, stress systems related to fracture of ductile and brittle metals: Pure loading systems, Tension loading, Torsion loading, Compression loading, Bending, Fatigue, effect of stress concentration, study of fractograph of some common metals. Determination of fracture type : Ductile and brittle fracture, Fatigue fracture, Distortion failure, Creep and stress rupture failures.

References:

1. Fundamentals of Fracture Mechanics J.F. Knott
2. Mech. Behaviour of Materials K.K. Chawla
3. Elements of Fracture Mechanics Prashant Kumar

### **EM543 COMPOSITE MATERIALS**

Types of Composites, Reinforcements, Whiskers, Laminar composites, Flake composites, Filled composites, Particulate reinforced composites, Cremates, Micro-spheres, Solidification of composites. Economics of Composites and Reinforcements, Design of Composite Materials, Mechanics of composites, Applications of Composites, Laminated metal composites, Ceramic materials, Ceramic-metal systems, Ceramic glass system, Ceramic-ceramic systems, Metal Matrix Composites, Reinforcement, Reinforcement selection, Matrix selection, effects of reinforcements, Properties, Fabrication, Whisker reinforcement, Whisker composite properties. Alcomposite foam, functionally gradient composite materials. Composite material for automobile, aerospace and general Engineering applications. Ceramic Matrix Composites: Particulate reinforced composites, Continuous fiber reinforced composites, Chopped fiber and whisker reinforced composites, Fabrication processes, Properties.

Reference :

1. Composite Materials Lawrence J. Broutman;
2. Composite Materials R.M. Jones

**OPEN ELECTIVE**

**EM551 ADVANCED MECHANICS OF MATERIALS**

Principal Stresses and Principal Strains, Strain Energy Formulations, Concept of Distortion Energy, Theories of Failure with applications, Strain Measurements and Strain Gauges.

Rotating Rings, Discs and Cylinders, Disc of Uniform Strength, and Temperature Stresses in Uniform Disc.

Bending of Curved Bars of Small Initial Curvature, Piston Ring Analysis, Stresses in Bars of Large Initial Curvature, Deflection of Curved Bars by Direct Method and Castigliano's Theorem, and Design of Crane Hooks.

Statically Indeterminate Torsional Members, Torsion of Noncircular Prismatic Shafts, Thin - walled Tubes.

Stress Concentration, Residual Stresses, Repeated Loading, Fatigue, Creep, and associated failures.