M. Tech in MATERIALS ENGINEERING
(Duration: 2 Years, 64 credits)

Hard core (8 credits)

MT 202  3:0   Thermodynamics and Kinetics
MT 241  3:0   Structure and Characterization of Materials
MT 243  0:2   Laboratory Experiments in Materials Engineering

Soft core (9 credits): Any three out of the following six courses

MT 203  3:0   Materials Design and Selection
MT 209  3:0   Defects in Materials
MT 213  3:0   Electronic Properties of Materials
MT 220  3:0   Microstructural Engineering of Structural Materials
MT 252  3:0   Science of Materials Processing
MT 253  3:0   Mechanical Behaviour of Materials

Project (32 credits)

MT 299  0:32  Dissertation Project

Electives (15 credits): At least 9 credits must be taken from the courses offered by the Department.

MT 201 (JAN) 3:0  
Phase Transformations

Overview of phase transformations, nucleation and growth theories, coarsening, precipitation, spinodal decomposition, eutectoid, massive, disorder-to-order, martensitic transformations. crystal interfaces and microstructure. topics in the theory of phase transformations: linear stability analysis, elastic stress effects, sharp interface and diffuse interface models of microstructural evolution.

C Srivastava

Prerequisites: Basic courses on crystallography, thermodynamics, phase diagrams and diffusion.


MT 202 (AUG) 3:0  
Thermodynamics and Kinetics

Classical and statistical thermodynamics,Interstitial and substitutional solid solutions, solution models, phase diagrams, stability criteria, critical phenomena, disorder-to-order transformations and ordered alloys, ternary alloys and phase diagrams, Thermodynamics of point defects, surfaces and interfaces. Diffusion, fluid flow and heat transfer.

T A Abinandanan

MT 203 (AUG) 3:0
Materials Design and Selection

After an overview of microstructures, processing and properties in engineering materials, the students will focus on procedures for materials selection and design. The students will explore materials selection charts, and the course will involve case studies, projects as well as software packages for materials design and selection over a wide range of conditions.

A H Chokshi


MT 206 (AUG) 3:0
Texture and Grain Boundary Engineering

Concepts of texture in materials, their representation by pole figure and orientation distribution functions. Texture measurement by different techniques. Origin and development of texture during material processing stages: solidification, deformation, annealing, phase transformation, coating processes, and thin film deposition. Influence of texture on mechanical and physical properties. Texture control in aluminum industry, automotive grade and electrical steels, magnetic and electronic materials. Introduction to grain boundary engineering and its applications.

S. Suwas

M. Hatherly and W. B. Hutchinson, An Introduction to Texture in Metals (Monograph No. 5), The Institute of Metals, London
V. Randle, and O. Engler, Introduction to Texture Analysis: Macrotexture, Microtexture and Orientation mapping, Gordon and Breach Science Publishers
F. J. Humphreys and M. Hatherly, Recrystallization and Related Phenomenon, Pergamon Press
P. E. J. Flewitt, R. K. Wild, Grain Boundaries

MT 208 (JAN) 3:0
Diffusion in Solids

Fick’s first and second law, Interdiffusion, Intrinsic diffusion and Integrated diffusion coefficient, Relation with tracer diffusion coefficient, Growth Kinetics, Matano-Boltzmann analysis, History and development of the Kirkendall effect, Darken analysis, Stable, unstable and multiple Kirkendall planes. Concept of velocity diagram construction, Role of the Kirkendall effect on morphogenesis, Physico-chemical approach.

A Paul

P. Shewmon: Diffusion in Solids

MT 209 (AUG) 3:0
Defects in Materials


S Karthikeyan

MT 213 (JAN) 3:0
Electronic Properties of Materials

Introduction to electronic properties; Drude model, its success and failure; energy bands in crystals; density of states; electrical conduction in metals; semiconductors; semiconductor devices; p-n junctions, LEDs, transistors; electrical properties of polymers, ceramics, metal oxides, amorphous semiconductors; dielectric and ferroelectrics; polarization theories; optical, magnetic and thermal properties of materials; application of electronic materials: microelectronics, optoelectronics and magnetoelectrics.

S. Dasgupta

R. E. Hummel, Electronic Properties of Materials
S. O. Kasap, Principles of Electronic Materials and Devices
S. M. Sze, Semiconductor devices: Physics and Technology
D. Jiles, Introduction to the electronic properties of materials

MT 218 (AUG) 2:1
Modeling and Simulation in Materials Engineering

Importance of modeling and simulation in Materials Engineering. nd numerical approaches. Numerical solution of ODEs and PDEs, explicit and implicit methods, Concept of diffusion, phase field technique, modelling of diffusive coupled phase transformations, spinodal decomposition. Level Set methods, Celula Automata,: simple models for simulating microstructure,. Finite element modelling,: Examples in 1D, variational approach, interpolation functions for simple geometries, (rectangular and triangular elements); Atomistic modelling techniques,: Molecular and Monte-Carlo Methods.

A N Choudhury

David V. Hutton, Fundamentals of Finite Element Analysis

MT 220 (JAN) 3:0
Microstructural Engineering of Structural Materials

Role of microstructure on properties; Elements of microstructure (geometric, texture, composition, order, topology); Review of crystal defects; Methods of controlling microstructures: materials processing routes, heat treatments and phase transformations; Survey of phase transformation mechanisms; Control of grain size and orientation in single phase microstructures with case studies in Al and Ti alloys, oxide systems for sensors, electrical steels, epitaxial microstructures, ferromagnetic materials, processing of nanostructured materials, processing of single crystals; Control of multiphase microstructures with case studies in precipitate strengthened alloys (Al alloys, Ni-base superalloys),hierarchical microstructures (alpha-beta Ti alloys), composites; adaptive microstructures (shape memory alloys, zirconia, TRIP steels).

S Karthikeyan, A N Choudhury, D Banerjee

**MT 235 (AUG) 3:0**
**Corrosion Technology**

Basic electrochemical principles governing corrosion. Types and mechanisms of corrosion. Advances in corrosion engineering and control. Anodic and Cathodic control-Biocorrosion, mechanisms and microbiological aspects. Corrosion under sub-soil and sea water conditions: Marine biofouling and biocorrosion with respect to industrial conditions. Methods of abatement.

**K A Natarajan**

Borenstein: Microbiologically Influenced Corrosion Handbook.

**MT 241 (AUG) 3:0**
**Structure and Characterization of Materials**

Bonding and crystal structures, Direct and Reciprocal lattice, Stereographic projection, Point and Space Group, Point defects in crystals, Diffraction basics, X-ray powder diffraction and its applications, Scanning and Transmission electron microscopy.

**R Ranjan**

A. R. West: Solid State Chemistry and its Applications, John Wiley
B. D. Cullity: Elements of x-ray Diffraction.
A. Kelly and G. W. Groves: Crystallography and Crystal Defects, Longman
M. D. Graef and M. E. Henry: Structures of Materials, Cambridge

**MT 243 (JAN) 0:2**
**Laboratory Experiments in Materials Engineering**

Experiments in Metallographic techniques, heat treatment, diffraction mineral beneficiation, chemical and process metallurgy, and mechanical metallurgy.

**Faculty**

**MT 245 (AUG) 3:0**
**Transport Processes in Process Metallurgy**


**Govind S Gupta**

Research papers
MT 248 (JAN) 3:0
Modelling and Computational Methods in Metallurgy

(Prerequisite: Knowledge of transport phenomena, program language) Assignments will be based on developing computer code to solve the given problem.

Basic principles of physical and mathematical modelling. Similarity criteria and dimensional analysis. Detailed study of modelling of various metallurgical processes such as blast furnace, induction furnace, ladle steelmaking, rolling, carburizing and drying. Finite difference method. Solution of differential equations using various numerical techniques. Convergence and stability criteria.

Govind S Gupta


MT 250 (JAN) 3:0
Introduction to Materials Science and Engineering

Compulsory for M.E. students who do not have BE Metallurgy; Compulsory for research students without materials background


Subodh Kumar

W.D. Callister, Materials Science & Engineering – An Introduction, John Wiley & Sons, Inc.

MT 252 / PD 214 (JAN) 3:0
Science of Materials Processing


Satyam Suwas and Satish Vasu Kailas


MT 253 (AUG) 3:0
Mechanical Behaviour of Materials


Subodh Kumar

**MT 255 (JAN) 3:0**

**Solidification Processing**

Advantage of solidification route to manufacturing, the basics of solidification including fluid dynamics, solidification dynamics and the influence of mould in the process of casting. Origin of shrinkage, linear contraction and casting defects in the design and manufacturing of casting, continuous casting, Semi-solid processing including pressure casting, stir casting and thixo casting. Welding as a special form of manufacturing process involving solidification. Modern techniques of welding, the classification of different weld zones, their origin and the influence on properties and weld design. Physical and computer modeling of solidification processes and development of expert systems. New developments and their possible impact on the manufacturing technology in the future with particular reference to the processes adaptable to the flexible manufacturing system.

*A N Choudhury*


**MT 256 (JAN) 3:0**

**Fracture**


*V Jayaram*


**MT 258 (JAN) 3:0**

**Mechanical Behavior of Thin Films**

Short description of common thin film deposition techniques; Origin of residual stresses; Determination of stress state in thin films deposited on substrate; Stress relaxation processes, including hillocking and whiskering, grain boundary sliding, and interface governed phenomenon, such as dewetting, buckling, interfacial fracture, interfacial sliding, etc.; Size effects; Mechanical testing of thin films, including nanoindentation.

*Praveen Kumar*


**MT 261 (Aug) 3:0**

**Organic Electronics**


*P C Ramamurthy*
MT 262 (JAN) 3:0


