

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
Syllabi for Ph.D Credit Courses
Metallurgy

Subject Code: 14M1

MATERIAL SCIENCE

UNIT-I

Introduction, classification of materials, dislocation, types, Burgers' Vector, dislocation movement by climb and cross slip, dislocation sources, dislocation - point defect interaction and pileups.

UNIT-II

Plastic deformation of single crystals, deformation by slip, CRSS for slip, deformation of single crystal, deformation by twinning, stacking faults, hot working, cold working. Recovery, recrystallization and grain growth. Grain size, Hall-Petch equation.

UNIT-III

Mechanical properties, tensile stress - strain diagrams, proof stress, yield stress diagrams, modulus of elasticity. Hardness Testing, Rockwell, Brinell and Vickers.

UNIT-IV

Impact toughness, Charpy V-Notch, fracture, ductile, brittle, Griffith criteria for brittle failure.

UNIT-V

Creep, creep mechanisms, Creep curve, Factors effecting creep, , fatigue, mechanism, factors to improve fatigue resistance.

Text books:

1. Introduction to Material Science - V Raghavan
2. Mechanical Metallurgy - GE Dieter
3. Material Science- William D Callister Jr

References:

1. Material Science for Engineers- LH Van Vlack
2. Material Science for Engineers- James F Shackelford

**Subject Code: 14M2 NON-DESTRUCTIVE EVALUATIONS OF
MATERIALS**

UNIT-I

BASIC CONCEPTS AND SURFACE INSPECTION

Concepts of Non-Destructive testing-relative merits and limitations. Types of defects. Visual inspection, Liquid penetrant inspection - principles, practice, applications, advantages and limitations. Principles, applications and instrumentation of thermal inspection, Infrared Thermography. Industrial Computed Tomography (ICT).

UNIT-II

RADIOGRAPHY

X-rays and Gamma rays. Properties of X-rays relevant to NDE. Absorption of rays, scattering, types and use of filters, screens, geometric factors, inverse square law, film type and processing, characteristics of films - density, speed, contrast, Characteristic curves, Penetrameters, Exposure charts, radiographic equivalence, Gamma ray sources, characteristics of Gamma rays, Fluoroscopy, Xero – radiography, Radiography of pipes, welds and castings. Safety with X-rays and Gamma rays.

UNIT-III

ULTRASONICS

Types of ultrasonic waves, principles of wave propagation, characteristics of ultrasonic waves, attenuation, Production of ultrasonic waves, Ultrasonic probes, couplants. Inspection methods-Pulse echo, Transmission and Resonance techniques. Types of scanning. Immersion testing, thickness measurement. Test block. IIW Standard and reference blocks, calibration in UT. Ultrasonic testing of welds and castings.

UNIT-IV

MAGNETIC PARTICLE AND EDDY CURRENT INSPECTION

Principles, applications, Magnetisation methods, magnetic particles. Dry technique and wet technique, demagnetization. Eddy current testing – principles, impedance diagrams, test coils and probes, inspection methods and applications.

UNIT-V

OTHER TECHNIQUES

Holography and Acoustic emission technique. Pressure and leak testing. Condition monitoring of machines, Wear monitoring, Spark testing.

TEXT BOOKS

1. Barry Hull and Vernon John, “Non-Destructive Testing”, ELBS/Macmillan,UK, 1988.
2. Baldev Raj, Jayakumar T. Thavasimuthu M, “Practical Non-Destructive testing”, Narosa Publishing House, NewDelhi, 1997.

REFERENCES

1. McGonnagle.W.T, “Non-Destructive testing”, McGraw-Hill Book Co, USA, 1988
2. ASM Metals Hand Book, “Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park ,Ohio, USA, 1989.

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Subject Code: 14M3 MATERIALS CHARACTERIZATION

UNIT –I

Introduction: Scope of subject, classification of techniques for characterization, macro and micro-characterization structure of solids.

UNIT -II

Bulk averaging techniques: Thermal analysis, DTA, DSC, TGA, dilatometry, resistivity/conductivity.

UNIT –III

Optical & X-ray spectroscopy: Atomic absorption spectroscopy, X-ray spectrometry, infrared spectroscopy and Raman spectroscopy.

Metallographic techniques: Optical metallography, image analysis, quantitative phase estimation.

UNIT –V

Diffraction methods: X-ray diffraction (crystal systems and space groups, Bravais lattices, direct and reciprocal lattice, Bragg law, powder diffraction and phase identification, single crystal diffraction, structure factor, X-ray crystal structure determination).

Electron optical methods: Scanning electron microscopy and image formation in the SEM.

TEXT BOOKS

1. The Principles of metallography laboratory practices –George L.Khel-Eurasia publishing house (Pvt Ltd)
2. Transmission electron Microscopy of metals –Garet Thomas.-John wiley and sons.

REFERENCES:

1. Modern Metallographic Techniques & their application – victor phillips.
2. Physical Metallurgy, Part – I – RW Chao and P. Haasan.
3. Experimental Techniques in Physical Metallurgy – VT Cherepin and AK Mallik.
4. Electron Microscopy in the study of materials –P.J.Grundy.

Subject Code: 14M4

**MECHANICAL BEHAVIOUR AND
TESTING OF MATERIALS**

UNIT-I

ELASTIC AND PLASTIC BEHAVIOUR

Elastic behavior of Materials - Hook's law, Plastic behaviour: Dislocation theory - Burger's vectors and dislocation loops, dislocations in the FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, dislocation climb, intersections of dislocations, Jogs, dislocation sources, multiplication of dislocations, dislocation pile-ups, Slip and twinning.

UNIT-II

TENSION AND HARDNESS TESTING

Engineering stress and engineering strain curve, true stress and true strain curve, instability in tension, effect of strain rate and temperature on flow properties, tensile specimens and testing machines. Notch tensile test, Anisotropy of tensile properties.

Brinell, Vickers, Rockwell, Rockwell superficial, Rebound, Micro hardness tests and testing machines. Hardness conversion.

UNIT-III

FRACTURE AND FRACTURE MECHANICS

Types of fracture, basic mechanism of ductile and brittle fracture, Griffith's theory of brittle fracture, Orowan's modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, determination of DBTT.

Fracture mechanics-introduction, modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of K_{IC} , introduction to COD, J integral.

UNIT-IV

FATIGUE BEHAVIOUR AND TESTING

Fatigue: Stress cycles, S-N curves, effect of mean stress, factors affecting fatigue, structural changes accompanying fatigue, cumulative damage, low cycle fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines.

UNIT-V

CREEP BEHAVIOUR AND TESTING

Creep curve, stages in creep curve and explanation, structural changes during creep, creep mechanisms, metallurgical factors affecting creep, high temperature alloys, stress rupture testing, creep testing machines, Parameter methods of extrapolation.

TEXT BOOKS

1. George. E. Dieter, "Mechanical Metallurgy", McGraw-Hill, New York, SI Edition, 1995.
2. Davis.H.E., Troxell G.E., Hauck.G.E.W., "The Testing of Engineering Materials", McGraw-Hill, 1982.

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REFERENCES

1. Wulff et al Vol. III “Mechanical Behavior of Materials”, John Wiley and Sons, New York, USA, 1983.
2. Honeycombe R.W.K., “Plastic Deformation of Materials”, Edward Arnold Publishers, 1984.
3. Suryanarayana, “Testing of Metallic Materials”, Prentice Hall India, New Delhi, 1979.

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Subject Code: 14M5 ENGINEERING MATERIALS

UNIT-I

Engineering alloys, low carbon steels, mild steels, medium carbon steels, high strength structural steels, tool steels, stainless steels, high temperature alloys,

UNIT-II

Cast irons. the light alloys, copper and its alloys, bearing alloys.

UNIT-III

Composites, introduction, matrix materials, reinforcements, mechanical behaviour of composites, metal matrix composites, polymer matrix composites, ceramic matrix composites, carbon fiber composites.

UNIT-IV

Ceramics, silicate ceramics, imperfections in ceramics, diffusion in ionic materials, brittle fracture, stress-strain behaviour, fabrication and processing of ceramics, powder pressing, refractories, abrasives and advanced ceramics.

UNIT-V

Polymerization, cross linking, classification of polymers. Uses of polymers.

Text Books:

1. Introduction to Physical Metallurgy-SH Avner
2. Materials Science and Engg: An introduction –William D Callister Jr
3. Composite Materials-Krishma K Chawla

Reference Books:

1. Introduction to Ceramics – Kingery, Bowen and Uhlmann
2. ASM Handbook Volume 21: Composites