MECHANICAL BEHAVIOR OF MATERIALS

PROF. S. SANKARAN
Department of Metallurgical and Materials Engineering
IIT Madras

INTENDED AUDIENCE : Students undergoing any degree course in the branches of Metallurgical/Materials/Mechanical/Materials Science or its allied discipline

INDUSTRY SUPPORT : Automotive and metal forming industries

COURSE OUTLINE :

This course deals with fundamentals of mechanical behavior of broad class of materials. The primary focus is on the load bearing ability, types of loading and respective failure modes. The course also addresses mechanical properties sensitive as well as insensitive to the microstructure of the materials. The course attempts to capture the microstructure mechanical behavior correlations in materials.

ABOUT INSTRUCTOR :

Prof. S. Sankaran is presently Professor in the department of Metallurgical and Materials Engineering, IIT Madras. His research interests are deformation processing of materials, mechanical behavior of materials and electron microscopy. He is also presently the faculty in-charge of central electron microscopy of IIT Madras.

COURSE PLAN :

Week 1: Introduction, overview of the subject and fundamentals of the atomic structure and types of bonding in different classes of materials and its relation to the physical and mechanical properties

Week 2: Elasticity - Analysis of stress, State of stress at a point, Normal and shear stress components, Stress components on an arbitrary plane, Principal stresses, Plane stress & amp; Plane strain,

Week 3: Generalized Hooke’s law, Atomic equivalent of Hooke’s law, Elastic behavior of anisotropic and isotropic materials.

Week 4: Plastic deformation in single & amp; polycrystalline, semi crystalline materials, strengthening mechanisms in solids, Work hardening

Week 5: Solid solution strengthening, Grain boundary strengthening, Particle hardening, High temperature deformation of amorphous; crystalline materials

Week 6: Mechanical testing- A review, Common states of stress in real life, Tension, Indentation, Compression, Torsion, Bending.

Week 7: Fracture of solids/Fracture mechanics - Linear elastic stress field in cracked bodies – Crack deformation modes, - Singular stress field and displacement fields

Week 8: Stress intensity factor solutions - Crack growth based on energy balance - Griffith’s criterion for brittle fracture - Strain energy release rate, Stress intensity factor equivalence - Crack stability, R curves & amp;

Week 9: J integral concepts – Critical stress intensity factor fracture criterion -Fracture criterion - Experimental determination of fracture toughness (K IC)- Non-linear fracture - Toughening mechanisms (in ceramics).

Week 10: Creep, mechanisms of creep, Creep of pure metals, solid solutions, MMCs, Creep of ceramics and polymers, creep asymmetry. Superplasticity in materials

Week 11: Fatigue of engineering materials - Characteristics of fatigue fracture -Fatigue crack propagations laws , Strain controlled fatigue

Week 12: Fatigue failure models - Fatigue life calculations, High cycle fatigue design- Surface fatigue failure models- dynamic contact