MTPC2006 DEFORMATION BEHAVIOUR OF MATERIALS (3-0-0)

Course Objective: To obtain knowledge of the stress response of materials, load-bearing ability, and elastic and plastic deformation. To obtain insight about different mechanical properties of materials under engineering applications.

Module I (6 Hrs)
Introduction: Elastic, plastic and visco-elastic deformation.
Continuum mechanics: Concepts of stress and strain in 2D and 3D stress and strain tensor, principal stresses and strains and principal axes, mean stress, stress deviator, maximum shear, equilibrium of stresses, yield criteria.

Module II (6 Hrs)
Plastic response of materials: classification of stress-strain curves, stress-strain curves of fcc, bcc and hcp materials.
Plastic deformation of single crystals: Deformation by slip, slip in a perfect lattice, critical resolved shear stress, strain hardening of single crystal.

Module III (6 Hrs)
Lattice Defects: lattice defects
Dislocation Theory: Elements of dislocation theory, movement of dislocation, elastic properties of dislocation, intersection of dislocation, dislocation reactions in different crystal structures, origin and multiplication of dislocations, dislocation pile-ups.

Module IV (6 Hrs)
Plastic deformation of polycrystalline materials: Role of grain boundaries in deformation, strengthening by grain boundaries, yield point phenomenon, strain ageing, strengthening by solutes, precipitates, dispersoids and fibres.
Tension test: Engineering & true stress-strain curves, evaluation of tensile properties, Tensile instability, Effect of strain-rate & temperature on flow properties.

Module V (6 Hrs)
Fracture: Types of fracture in metals, theoretical cohesive strength of metals, Griffth theory of brittle fracture, fracture of single crystals, metallographic aspects of fracture.
Fatigue: Stress cycles, the S-N Curve, Effect of Mean Stress on fatigue, Cyclic Stress-Strain curve, Low and High Cycle fatigue.
Creep and Stress Rupture: Creep Curve, Stress-Rupture Test, structure change during creep, mechanism of creep deformation.

Course Outcome:
CO1: Use simple continuum mechanics and elasticity principles to determine the stresses, strains and displacements in a loaded structure.
CO2: Understand and analyze strain hardening and plastic theory in metals.
CO3: Understand and analyzedislocation theory in metals.
CO4: Understand the basic strengthening mechanisms that can improve the mechanical properties of materials.
CO5: Use fracture mechanics to quantitatively estimate failure criteria and life prediction strategies for both elastic and plastically deforming structures.Understand fatigue and creep failures and how they affect the structural lifetimes of components.

Text Books:

1. Mechanical Metallurgy by G. E. Dieter, McGraw-Hill.
2. Deformation and Fracture Mechanics of Engineering Materials by R.W.
3. Hertzberg, John Wiley.
4. Mechanical Behaviour of Materials by M. A. Meyers and K. K. Chawla
5. Mechanical Behaviour of Materials by T.H. Courtney