SOLID MECHANICS

PROF. AJEET KUMAR
Department of Mechanical Engineering
IIT Delhi

PRE-REQUISITES : 1st year engineering mechanics

INTENDED AUDIENCE : Any Interested Learners

COURSE OUTLINE :
This is the first course where deformation of solid bodies and the underlying concepts are introduced to undergraduate students. The course begins by building foundation of the concepts of stress and strain in three-dimensional deformable bodies. It further uses these concepts to study extension, torsion and bending of beams. The one-dimensional theory of beams are also introduced. We also discuss various theories of failure which are critical for design of machine elements in industry.

ABOUT INSTRUCTOR :
Prof. Ajeet Kumar is currently working as a Professor in the Department of Applied Mechanics at IIT Delhi. He received his PhD from the Department of Theoretical & Applied Mechanics at Cornell University. He primarily works in the field of solid mechanics. His key topics of research are: Theory of continuum and nano rods, Finite deformation elastoplasticity, Computational Mechanics, Molecular modeling, Fluid-structure interaction, etc.

To known more about him, please visit his webpage: http://web.iitd.ac.in/~ajeetk/

COURSE PLAN :

Week 1: Mathematical preliminaries and notation; Concept of Traction vector; Concept of Stress tensor

Week 2: Stress tensor and its representation in Cartesian coordinate system; Transformation of stress matrix; Equations of equilibrium; Symmetry of stress tensor;

Week 3: State of stress in simple cases ; Principal stress components and principal planes; Maximizing shear component of traction; Mohr's circle

Week 4: Stress invariants; Octahedral Plane; Decomposition of stress tensor; Concept of strain and strain tensor;

Week 5: Longitudinal, shear and volumetric strains; Local infinitesimal rotation; Strain compatibility condition

Week 6: Linear stress-strain relation for isotropic bodies; Relation between material constants

Week 7: Stress and strain matrices in cylindrical coordinate system; Equations of equilibrium in cylindrical coordinate system

Week 8: Axisymmetric deformations: combined extension-torsion-inflation of a cylinder

Week 9: Bending of beams having symmetrical and non-symmetrical cross-section

Week 10: Shear center, Shear flow in thin and open cross-section beams; Euler Bernouli and Timoshenko beam theories; beam buckling

Week 11: Energy methods, Reciprocal relations, Castigliano's theorem, Deflection of straight and curved beams using energy method

Week 12: Various theories of failure and their application