Mechanics of Soft Materials - Web course

COURSE OUTLINE

Soft solid materials are the ones which have modulus upto ~10 MPa; they are elastic or viscoelastic and they deform easily when subjected to external forces.

Engineering materials, such as rubbers and thermoplastic elastomers, and soft biological tissues, such as skin, cartilage, liver and brain tissue, fall into this category.

Understanding the mechanical response of these materials is important in many engineering and biomedical applications.

The goal of this course is to expose the students and researchers of these diverse research interests to the principles of mechanics and its rich mathematical structure.

Contents:

Introduction of fluid mechanics; Fluid statics-Pressure distribution in a fluid.

Integral balances for a control volume - mass, energy and momentum balances.

Bernoulli equation; Differential balances (Navier-Stokes equations).

Viscous flow in a pipe, Friction factor, Introduction to turbulence, losses in pipe systems.

Flow meters, Flow past immersed bodies, Mixing and Agitation, Flow through packed and fluidized bed.

Filtration, Compressible flows, Pumps and Compressors, Centrifuges & Cyclones.

COURSE DETAIL

S.No	Topics	No. of Hours
1	**Brief Introduction:**	
	Definition of strain, strain tensor, stress, stress tensor, Saint Venant's principle.	1
	Hooke's law, stress equilibrium relations.	1
	One dimensional stretching of a rod	1
	Solid bodies in contact with and without interactions:	
	Line loading of an elastic half space, distributed loading.	1

NP-TEL

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Chemical Engineering

Pre-requisites:

1. Engineering mathematics: Differential and integral calculus, ordinary differential equations.

Coordinators:

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	Axisymmetric loading of an elastic half space.	1
2	Normal contact of elastic solids.	2
	Hertzian theory.	1
	Contact with adhesion, JKR theory.	3
	Compression of an elastic layer between two parallel plates.	1
3	**Equilibrium of rods and plates:**	
	Equations of equilibrium of rods.	2
	Euler's buckling instability.	1
	Twisting instability of rods.	1
	Equation of equilibrium for a thin bent plate.	1
	longitudinal deformation of plates.	1
	large deflection of plates.	1
	Application of bending plate geometry for solving problems related to contact mechanics and adhesion.	3
	Analysis of wrinkling instability.	1
	Elasticity of an interfacial particle raft.	1
4	**Nonlinear elasticity:**	
	Molecular approach to rubber elasticity.	1
	Neo-Hookean elasticity.	1
	Analysis of large deformation of an incompressible elastic material.	4
	Inflation of a balloon.	1
	Cavitation in crosslinked networks.	1

5	**Mechanics of cell wall:**	
	Entropic elasticity-stretching, bending and twisting, persistence length.	2
	Mechanics of cellular filaments; 2D and 3D networks in cell.	2
	Polymerization and the generated force.	2
	Biomembranes, membrane undulations.	2
	Total	40

References:

1. " Theory of Elasticity, 3rd edition" by Landau and Lifshitz. Course of theoretical physics, vol-7.
2. "A treatise on the mathematical theory of elasticity" by A. E. H. Love.
3. "Contact Mechanics" by K. L. Johnson.
4. "Stability problems in applied mechanics" by A. K. Mallik and J. K. Bhattacharjee.
5. "Mechanics of the cell" by David Boal.