NOC:Variational Methods in Mechanics - Video course

COURSE OUTLINE

This course introduces calculus of variations for a comprehensive understanding of the subject and enables the student understand mechanics from this viewpoint. It also provides basic understanding of functional analysis for rigorous appreciation of engineering optimization. After taking this course, the student will be able to formulate many problems in mechanics using energy methods. The course also reinforces the understanding of mechanics and gives hands-on experience for using variational methods. Matlab programs are part of the course.

COURSE DETAIL

Week	Topics
1.	• Classification of optimization problems and the place of Calculus of Variations in it. • Genesis of Calculus of Variations • Formulation of Calculus of Variations problems in geometry and mechanics
2.	• Unconstrained minimization in n variables • Constrained minimization: KKT conditions • Sufficient conditions for constrained minimization
3.	• Mathematical preliminaries: function, functional, metrics and metric space, norm and vector spaces • Banach space, Cauchy sequence; function spaces, Inner product spaces; inner product; Hilbert space; Sobolev and Lebesgue norms; continuous and linear functionals. • First variation of a functional; Gâteaux variation; Frechét differential; and variational derivative

NP-TEL

NPTEL

http://nptel.ac.in

Mechanical Engineering

Pre-requisites:

Multi-variable calculus and familiarity with Matlab

Coordinators:

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4.	• Fundamental lemma of calculus of variations and Euler-Lagrange equations
5.	• Extension of Euler-Lagrange equations to multiple derivatives and multiple functions in a functional. • Calculus of variations in functionals involving two and three independent variables.
6.	• Variational (energy) methods in statics; principles of minimum potential energy and virtual work • Global constraints in calculus of variations. Local (finite subsidiary) constrains in calculus of variations.
7.	• General variation of a functional; transversality conditions. Broken extremals; Wierstrass-Erdmann corner conditions • Variational methods in dynamics: Hamilton's principle; D'Lambert principle • Invariants of Euler-Lagrange equations and canonical forms; Noether's theorem • Minimum characterization of Sturm-Liouville problems; Rayleigh quotient for natural frequencies and mode shapes of elastic systems
8.	• Stability analysis and buckling using calculus of variations • Formulating the extremization problem starting from the differential equation; self-adjointness of the differential operator; and methods to deal with conservative and dissipative system