Dipartimento di Ingegneria Strutturale e Geotecnica

Sapienza Università di Roma

Dottorato di Ricerca in Structural and Geotechnical Engineering

PhD Course

Variational methods for solid mechanics:

elasticity, plasticity and damage

Stefano Vidoli
Dipartimento di Ingegneria Strutturale e Geotecnica – Sapienza Università di Roma

Abstract

This course is designed to equip PhD students with advanced mathematical tools for the formulation and solution of complex problems in solid and structural mechanics. Building on the foundations of functional analysis, it introduces variational methods as a powerful framework to extend the notion of solutions beyond the limitations of classical partial differential equation theory. The course emphasizes variational formulations and their role in addressing challenging nonlinear phenomena, with particular focus on material damage and plasticity.

The lectures begin with an introduction to variational methods and the motivation for weak formulations, followed by a detailed treatment of classical elasticity within a variational setting. Key mathematical tools are developed, including functional spaces such as Banach, Hilbert, and Sobolev spaces, along with fundamental embedding and trace theorems. The course then addresses variational inequalities and their applications to nonlinear mechanics, particularly in modeling damage and plastic behavior.

Further topics include existence and uniqueness of solutions, well-posedness, and essential mathematical properties such as coercivity and continuity, together with numerical approximation techniques like the Galerkin method and the theoretical foundations of the finite element method. The course concludes with an analysis of numerical locking phenomena and an introduction to mixed variational methods, including stability conditions such as the inf-sup condition.

Bio

Stefano Vidoli is Full Professor in Mechanics of Solids and Strength of Materials at DISG, Sapienza University of Rome, and has been Visiting Professor at Institut d'Alembert, Sorbonne Universités, Paris. He has been the first recipient of the AIMETA Junior Prize 2009 for the "Structural Mechanics" field. His current research interests span from multistability of shells and thin structures till phase field approximations of Fracture Mechanics.

Date & Time

21 April 2026	22, 23 April 2026	5, 6, 7 May 2026
11:00 – 13:00	10:00 – 13:30	10:00 – 13:00

Location

Aula Caveau
Dipartimento di Ingegneria Strutturale e Geotecnica
Via Eudossiana 18, Roma

Contact

phd.sge@uniroma1.it