Module 5R14:

Nonlinear Solid Mechanics

Leader: Dr Fehmi Cirak

Timing: Michaelmas Term

Prerequisites: This module is available to first year research students (PhD or MPhil).

Structure: 11 afternoon lectures (two per week) and 2 lab sessions.

Mode of Assessment: Coursework.

AIMS

The main objective of this module is to introduce students to aspects of large-deformation analysis of solids and structures with geometric and material nonlinearities. The focus is on formulations that are of interest in application of finite elements to solid and structural mechanics. The module includes a hands-on component based on a commercial software (Abaqus) for introducing students into the complexities and pitfalls of nonlinear analysis. The target audience are new students who will develop or use nonlinear finite elements as part of their research.

SYLLABUS

Truss Mechanics (3 lectures and a lab session)
- Equilibrium equations
- One-dimensional nonlinear strain measures
- Finite element discretisation
- Elasto-plastic behaviour

Continuum Mechanics (4 lectures and a lab session)
- Vector and tensor algebra
- Nonlinear kinematics of deformation
- Stress and equilibrium equations
- Equilibrium equations in weak form
- Hyperelastic material models

Nonlinear Finite Elements (4 lectures)
- Review of the basic finite element method
- Discretisation of the nonlinear equilibrium equations in weak form
- Linearization and Newton-Raphson iteration

COURSEWORK

- During the term, three sets of homework assignments; one of these will be on computational analysis of a selected nonlinear mechanics problem.
- At the end of the term, a presentation on a research paper relevant to the course content (15 minutes talk + 5 minutes discussion).

ASSESSMENT

Each homework assignment will comprise 25% of the final mark. The presentation will contribute the remaining 25%.