



*Graduate course*

# ***Mechanics of Large Deformations***

**December 8th – 9th 2022**

**Nonlinear Solid Mechanics  
Faculty of Engineering Technology  
University of Twente**

# General

Equilibrium of forces and moments—or the equations of motion in dynamics—must be considered in the deformed configuration—the current state. Even for materials with linear stress–strain relations, the equilibrium equations are fundamentally nonlinear. In many practical cases only small errors are made if these equations are linearized, but for large deformations this is not valid. For large displacements and rotations and especially for large deformations, concepts like strain and stress, known from small deformation mechanics must be redefined to remain meaningful.

This course provides the mathematical and physical basis for a proper analysis of large deformation problems. Equilibrium conditions and stress and strain measures are derived with respect to the deformed and undeformed configuration. Special consideration is given to the formulation in finite element technology with a total or updated Lagrangian approach or with an Arbitrary Lagrangian–Eulerian (ALE) formulation.

## Local organization

The course is organized by the Nonlinear Solid Mechanics group of the Faculty Engineering Technology at the University of Twente. The local organizing committee is composed of

- Dr. Javad Hazrati

## Lecturers

- Dr. Semih Perdahcioğlu
- Dr. Javad Hazrati
- Dr. Celal Soyarslan

## Lecture notes

Lecture notes and course material will be distributed at the start of the course.

# Prerequisites

Participants are expected to have basic familiarity with:

- linear continuum mechanics;
- linear finite element analysis;
- nonlinear solution techniques.

# Contents

The course covers the following topics:

- 1) *An introduction to geometrical nonlinearity*
  - a. Limitations of geometrical linear theory
  - b. Geometrically nonlinear equations for a simple truss structure
  - c. Nonlinear solution techniques (refresher)
- 2) *Kinematics*
  - a. Position vectors and coordinate systems
  - b. Deformation tensor
  - c. Strain tensors
  - d. Deformation rates
- 3) *Stresses and balance laws*
  - a. Equilibrium in deformed and undeformed configuration
  - b. Energy conjugated stress definitions
  - c. Objectivity requirements
  - d. Incremental objectivity and corotational formulations
- 4) *Finite element formulations*
  - a. Total Lagrange
  - b. Updated Lagrange
  - c. Arbitrary Lagrangian–Eulerian

# Fee/Registration

The course is free for registered members of the graduate school Engineering Mechanics and for the research members of the contributing research groups. The course fee for non EM members is € 100 for students and € 400 for other participants. They will receive an invoice after accepted registration.

Participants need to register by completing the online registration form, which can be found at <https://engineeringmechanics.nl/2021/12/03/2022-mechanics-of-large-deformations/> **before December 2<sup>nd</sup>, 2022** to the Secretariat of the Graduate School Engineering Mechanics, Eindhoven University of Technology. Members of the Graduate School Engineering Mechanics receive priority in case of over-subscription.

## Location/date

The course will take place on the campus of the University of Twente on December 8–9, 2022. The course language is English.

## Further information

For hotel accommodation on the campus of the University of Twente see <https://www.uparkhotel.nl/en/>. Participants are required to make reservations at the hotel directly.

It is requested that at least 50% of the participants brings a laptop with MATLAB or OCTAVE installed to perform exercises in small groups.

For more information on the contents of the course, contact:

Dr. Javad Hazrati

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For information on the organization of the course, contact:

Ms. Tjerkje Dijkstra - van der Veen

[t.j.dijkstra-vanderveen@utwente.nl](mailto:t.j.dijkstra-vanderveen@utwente.nl)

Further information about the educational programme and other activities of the Graduate School on Engineering Mechanics can be found at: <https://engineeringmechanics.nl/>