Graduate course

NONLINEAR MATERIAL MECHANICS

November 6th – 8th 2017
November 13th – 15th 2017

Hosted by:
Faculty of Engineering Technology
University of Twente

TU Delft
Technische Universiteit Delft

UNIVERSITY OF TWENTE.

General

This course is an initiative of the Dutch graduate school Engineering Mechanics. The course is part of the 3TU Engineering Mechanics training programme for PhD students. As part of this programme a series of graduate courses is organized, related to the following research themes:

- Computational and Experimental Mechanics of Materials
- Structural Dynamics and Control
- Reliability and Optimization
- Linear and Nonlinear Material Theory

Objective

Reliable simulation tools in engineering and design require accurate material models. Nonlinear material behaviour plays an essential role in many applications of engineering mechanics. The engineering response of materials essentially results from the physics and mechanics of their underlying microstructure. The distinction between materials science and mechanics is becoming more and more diffuse. Multi-phase structures, voids, grains, interfaces and the presence of additional phases play an intrinsic role. Using proper knowledge from mechanics and advanced computational tools one can reach an improved understanding of the mechanical behaviour and properties of commonly applied and new materials.

This course focuses on a presentation of the fundamental aspects of the modelling of nonlinear material behaviour. It includes large deformations and solution techniques. Applications include e.g. metals and multi-phase brittle and granular materials.

Attention will be given to kinematics, stress and balance laws, thermodynamics, hyperelasticity, plasticity, anisotropy, multi-phase materials, phase transitions and damage. On the numerical side, nonlinear solution techniques, higher order continua, and discontinuous models will be introduced. In addition to continuum theory and methodology, also particle methods and the micro-macro transition from particle methods to continuum theory will be introduced.

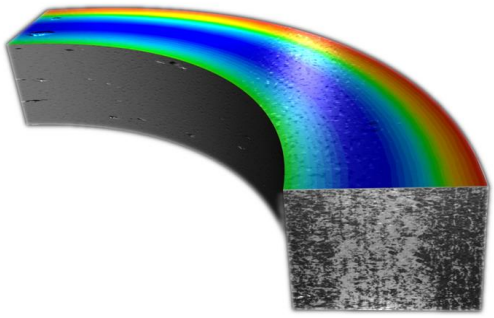
Local organization

The course is organized by the *Nonlinear Solid Mechanics* group and the *Multi-scale Mechanics* group, University of Twente, faculty of Engineering Technology, and the *Computational Mechanics* group, Delft University of Technology, Department of Civil Engineering and Geosciences.

Organizing committee:

- Ton van den Boogaard
- Stefan Luding
- Bert Sluys

Lecturers



- Remko Akkerman (UT)
- Ton van den Boogaard (UT)
- Bert Geijselaers (UT)
- Stefan Luding (UT)
- Vanessa Magnanimo (UT)
- Semih Perdahcıoğlu (UT)
- Angelo Simone (TUD)
- Bert Sluys (TUD)
- Anthony Thornton (UT)

Contents

- Vectors and tensors
- Kinematics (material coordinates, deformation & strain tensors, polar decomposition)
- Force and stress, Balance laws
- Fundamental concepts of constitutive equations (thermodynamics, frame indifference, elasto-viscoplasticity, yielding and hardening)
- Multi phase materials (phase transition, TRIP, composites, anisotropy)
- Plasticity models and continuum damage models (yield functions, damage loading functions, tangential formulation, return mapping, locking)
- Higher-order continua (non-local, gradient models, micro polar models)
- Deformation mechanics in composite laminates, extreme anisotropy and intraply shear locking
- Particle Methods (particle systems, molecular dynamics for particle systems, smooth particle hydrodynamics for continuum systems)
- Depth-averaged models (applied to granular systems)
- From Particle Systems to Continuum Theory (micro-macro transition methods, plastic flow models, higher order continua, advanced theories)
- Nonlinear solution techniques (Newton-Raphson methods, convergence criteria, Load-, displacement-, arc-length-control)
- Discontinuous models (weak/strong models (GFEM/XFEM), continuous-discontinuous models)

Lecture notes

Lecture notes will be distributed during the course.

Prerequisites

Basic undergraduate courses in Mathematics, Materials science, Mechanics of materials, Continuum Mechanics and the Finite Element Method.

Location/date

The course will take place at the University of Twente in two modules of three days each, i.e. November 6th- 8th and November 13th- 15th 2017, respectively. The course language is English.

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 €1000. They will receive an invoice after accepted registration. Participants need to register by completing the online registration form, which can be found at http://www.em.tue.nl/events/index.php/2/2017 and returning it **before October 21st, 2017** 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.

Further information

- On the contents of the course:
  Prof.dr.ir. A.H. van den Boogaard
  Tel.: +31- (0)53-4894785
  E-mail: a.h.vandenboogaard@utwente.nl

- On the organization of the course:
  Mrs. Debbie Zimmerman
  Tel.: +31-(0)53-4892460
  E-mail: d.b.vrieze-zimmerman@utwente.nl

Further information about the educational programme and other activities of the Graduate School on Engineering Mechanics can be found at: www.em.tue.nl.