Graduate course

Continuum Thermodynamics

12, 13 and 14 April 2021

Faculty of Aerospace Engineering
Delft University of Technology

Arrangements regarding COVID19:

Owing to the COVID19 outbreak, the university campus will be closed until further notice. For this reason, this edition of the Engineering Mechanics course "Continuum Thermodynamics" will be provided online. Further details about the online setup of this course will be communicated to the registered participants in due time before the start of the course.

General

In many technologically important applications, materials are subjected to large plastic deformations, experience damage or undergo phase transformations. In such cases, the analysis should be carried out using a thermodynamically consistent model. This topical course is intended to provide a comprehensive overview of the balance principles (mass, linear and angular momentum, energy) within the context of continuum mechanics, which is often referred to as continuum thermodynamics. Special attention will be given to the use of the second law of thermodynamics (entropy inequality) in the derivation of various constitutive theories in terms of affinities and fluxes (Onsager's approach). In particular, an overview will be given for thermo-elasticity, elasto-plasticity, martensitic phase transformations and damage mechanics. The purpose is to provide the participants of this course a unified understanding of all thermodynamically consistent material models.

Local organization

The course is organized by the Aerospace Structures and Computational Mechanics chair of the Faculty of Aerospace Engineering of Delft University of Technology in collaboration with the Mechanics of Materials chair of the Department of Mechanical Engineering of Eindhoven University of Technology and the Applied Mechanics and Design chair of the Department of the Built Environment of Eindhoven University of Technology.

- Dr. Sergio Turteltaub (for course content)
- Laura Chant (L.Chant@tudelft.nl) (for other local information)

Lecturers

- Dr. Sergio Turteltaub (TUD)
- Prof. Dr.ir. Akke Suiker (TU/e)
- Dr. Varvara Kouznetsova (TU/e)

Lecture notes

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

Prerequisites

Prerequisites for this topical course are undergraduate courses in solid and fluid mechanics and thermodynamics. A course in continuum mechanics is recommended.

Contents

5 Martensitic phase transformations and damage
- 5.1 Introduction
- 5.2 Martensitic phase transformations
  - Transformation kinematics and stress-strain response
  - Formulation in terms of the Helmholtz and Gibbs energy densities
  - Thermomechanical constitutive model
  - Kinetic relation for transformation
  - Heat conduction and latent heat
  - Summary of main model equations
- 5.3 Phase transformations with damage
  - Derivation of model equations from Helmholtz energy density
  - Driving forces for transformation and damage
  - Stress and conservative entropy
  - Kinetic law for damage

Although the emphasis in the present course is on solid materials, the general thermodynamical principles are valid for continuum media, including fluids (liquid and gases).

Fee/Registration

Participants need to register by completing the registration form, which can be found at the EM website on https://engineeringmechanics.nl/courses/#upcoming and submit it before **April 6th, 2021**

Location/date

The course will be provided online in three days. The course language is English.
Further details about the online setup of this course will be communicated to the registered participants in due time before the start of the course

Further information

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

On the contents of the course:
Dr. Sergio Turteltaub
E-mail: s.r.turteltaub@tudelft.nl

On the organization of the course:
Mrs. Rachel van Outvorst, TU/e,
E-mail: Engineering.Mechanics@tue.nl

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