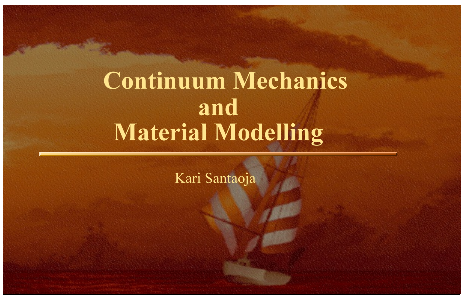
Continuum Mechanics and Material Modelling 2022

MEC-E8002 P (5 cr)

General

The main topics of this course are continuum mechanics, (its extension) continuum thermodynamics with internal variables, the validation of material models, the determination of values for material parameters from experimental data and the implementation of material models in the Abaqus finite element code.

The beginning of the course covers areas such as the application of tensor notation and the derivation of tensor equations. The basic laws and axioms of continuum mechanics and continuum thermodynamics are evaluated. The local forms of these basic laws and axioms are derived from their global forms. The description of material models by means of continuum thermodynamics is practised with several constitutive equations. The Levenberg-Marquardt method is used for determining the values of material parameters from the experimental data. By the end of the course the implementation of material models in the Abaqus program is examined with the use of examples.



On this course, participants learn to read publications written in tensor notations. By the end the course, the student will be able to produce his or her own text in tensor notations. Students will be familiar with the laws of nature in the field of continuum mechanics and the general principles derived from these. The students will understand how continuum thermodynamics extends the view of continuum mechanics to cover material models. During the course, student will study how to test material models by the theory of internal variables. Upon completing the course, the student will be able to use the Levenberg-Marquardt method in determining the values of the material parameters from the experimental data. He or she will also understand the foundations of mechanics of materials, be able to implement a material model in the Abaqus finite element program, and determine the values of the material parameters. During the course thermodynamic validation and implementation of the creep model proposed by Le Gac and Duval will be practised.

Course Material

The two lecture books in this course are written by Kari Santaoja. The book *Lecture Notes on Continuum Thermodynamics 2022* is more extensive than the content of the present course. If there are no students interested in fluid mechanics, fluid mechanics is not studied, for example. The price of this book is 35 €. The price of the book *Extended Levenberg-Marquardt Method for Determination of Values for Material Parameters* is 10 €. Besides these two books some material will be given for free. Solutions to the weekly homework assignments are included in the course material as well. The course lecturer will sell the books. More information will be given in MyCourses.

Lectures

Lectures will be given on Mondays from noon to 2 pm and on Thursdays from 10:15 to noon remotely in Microsoft Teams. You can download Teams from: https://www.aalto.fi/en/services/microsoft-teams . The first lecture will be held on Monday January 10 and the last one will be on Thursday February 17. The link to the Microsoft Teams is in MyCourses. You can test your Teams connection on Friday January 7 between noon and 1 pm.

Weekly homework assignments

There are 5 rounds of weekly homework assignments. On Fridays starting January 14 from 10:15 to noon the calculation hour will be held remotely as well. The assistant will help students to solve the weekly homework assignments. The correct answers to the problems can be obtained from the table close to lecture room K1 150 on the ground floor of the building K1 (see the document "Where is the A4 material?"). The students have to solve the problems by themselves and they must upload them to MyCourses. The deadline for the home assignments is Wednesday noon. Worksheets will be available in the PDF-format in the MyCourses. The students who cannot come to Otaniemi to take the course books and/or the A4 material are asked for making contact with Kari

Santaoja.

The assistant of the course will evaluate the solutions by the students and gives 0-6 points for every round of assignments. The points will be posted on the MyCourses. Besides the weekly exercises the students can give comments for the enhancement of the course or for the course material.

Deviations from the normal time table

None else than remote teaching.

Prerequisites

Good knowledge of material mechanics, mechanics, structural mechanics or thermodynamics. The course material covers all the information needed to pass the course. Therefore, some previous knowledge of the topics mentioned above is adequate for passing this course with excellent marks.

Registration and announcements

Registration is done by WebOodi. Students who cannot use WebOodi can send an email to Kari Santaoja. Announcements are made through MyCourses.

Passing the course

This course will be passed by solving acceptably the weekly homework assignments and passing the examination. Before entering the examination students have to solve the obligatory weekly assignments and obtain at least 40% of the maximum points altogether. Thus, with the 5 rounds of the weekly homework assignments one has to score at least 0.4x5x6= 12 points. The homework points beyond the minimum are reduced and added to the examination points so that the maximum points give 3.5 additional points. Students can make comments and suggestions for enhancing the course material. The comments can give up to 2 additional points in the examination.

The maximum result in the examination is 24 points. The student has to pass the examination before additional points will be taken into account. The first examination will be held on Thursday February 24 at 13-17 in K1 215 and the second on Thursday June 2. The following examinations will be held on request.

The allowed material in the examination is: stationery, a copy of section 2 and a collection of the appendices of the book *Lecture Notes on Continuum Thermodynamics 2022*. This material will be copied and distributed to the students.

Passing this course requires an active attitude. The course material covers everything that is needed to understand the foundations of the small deformation theory in continuum mechanics and continuum thermodynamics with internal variables. Furthermore, the course can be seen as a first step towards studying the finite deformation theory.

What to read for examination

Selected parts of the books, additional written documents, solutions to the homework and what was presented during the lectures. More updated information will be given before the examination. The problems to be solved in the examination follow the concepts of those in the weekly homework.

People responsible for the course

	Name	Office	Phone	Appointment	e-mail
Lecturer	Kari Santaoja	K1 139	050 432 6623	Send email	Kari.Santaoja@aalto.fi
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