FSE3131 Constitutive Modeling 12.0 credits

Konstitutiv modellering

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for FSE3131 valid from Spring 2016

Grading scale

Education cycle

Third cycle

Specific prerequisites

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The course provides the foundation of constitutive modeling of deformable solid materials, where elastic and inelastic material responses at small and finite strains are addressed. Constitutive descriptions are developed within well-known continuum mechanical frameworks and their numerical implementation into FE software is detailed.

After the course, the participants should be able to

1. Understand the continuum mechanical basis of constitutive modeling of deformable solid materials
2. Model a particular engineering problems by selecting appropriate constitutive modeling assumptions
3. Understand the purpose, function, implication and limitation of constitutive modeling
4. Learn how to implement a constitutive model into FE software
5. Apply tools to verify and validate constitutive models and their implementation
6. Combine and integrate different solution strategies to address a constitutive modeling problem
7. Extract key constitutive phenomena from experimental observations and turn them into a constitute model.
8. Understand and discuss the published literature in the field of solid mechanics constitutive modeling.

Course contents

Disposition

The course consists of 19 lectures, 8 computational laboratory work tasks and 3 project work tasks. Details about the different course parts are given below and latest information is published at the course website at KTH Social. Course material is handed-out continuously during the course.

Course literature

- Hand-outs
- Nonlinear continuum mechanics for finite element analysis. J Bonet and RD Wood. Cambridge University Press, 1997.
- Classical and Computational Solid Mechanics. YC Fung & P Tong. World Scientific Publishing, 2001.
- Simo, J.C. and Hughes, T.J.R. (1998): ”Computational Inelasticity”, Springer Verlag, New York, Inc.
- TC Gasser, RW Ogden, GA Holzapfel. Hyperelastic modelling of arterial layers with distributed collagen fibre orientations Journal of the royal society interface 3 (6), 15-35
- FEAP User and Theory Manual

Examination

Based on recommendation from KTH’s coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Exam (TEN1; 6.0p)

The examination will take place at the Department of Solid Mechanics. The student must register his/her participation in the exam at least two weeks ahead.

The exam contains two parts.

Part 1: During part 1 the student has to answer a couple of theory questions that directly relate to the material presented during the lectures. This part takes two hours and is graded by pass or fail.

Laboratory work (LAB1; 6.0p)

The computational laboratory work takes place in “Solid Mechanics track students’ room” and is carried out by groups of two or three students. Different constitutive models are implemented into FEAP and an example roadmap (theory-> pseudocode->FORTRAN code->verification protocol) is detailed during the lectures. At the beginning of the course material for self-studying problems in FEAP is distributed, such that the students can get familiar with FEAP software. In order to pass the computational laboratory tasks the student group has to demonstrate the ability to implement the specific constitutive task and pass the particular verification protocol.

Comp. lab1: One dimensional constitutive models (linear/non-linear spring and dashpot device)

Comp. lab2: Saint-Venant Kirchhof model

Comp. lab3: Quasi-incompressible neoHookean model

Comp. lab4: Quasi-incompressible HGO and GOH model

Comp. lab5: Hyper-viscoelasticity (Prony series expansion of neoHookean model)

Comp. lab6: J2 plasticity model

Comp. lab7: Cohesive zone models (isotropic and anisotropic)

Comp. lab8: Microfiber model

Other requirements for final grade

In order to achieve the course grade pass, the student must have achieved the grade pass on both LAB1 and TEN1 below.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.