Preliminary syllabus

Finite element method – Nonlinear systems FHLN20 – Division of Solid Mechanics –

(7.5 credits, study period 2HT, 2019)

Course aim

The course deals with modeling and analysis of nonlinear structures and solids. The main emphasis is on the modeling aspect, i.e. the justification and properties of the theory, and the development of the theory in a form suitable for computational analysis. The idea is to present the theory and the corresponding numerical methods as a gradual development, from simple bar and truss systems via finite rotations over beams and shells to nonlinear kinematics and material behavior of solids. Care is taken to explain why as well as how.

Course content

· Introduction to nonlinearity, exact theory of truss structure and numerical implementation.
· Finite deformation continuum mechanics and finite deformation elements.
· Quasi-static and dynamic numerical solution methods.
· Theory of large rotations, and large displacement. (Overview)

The theory is supported by a set of functions written by the student, by which the student will familiarize himself with the numerical implementation when providing his own illustrations of the theory.

Finite element method – Nonlinear systems:

The course consists of lectures and exercises. Course material will be provided during the course.

Course text:

Steen Krenk: *Non-Linear Modelling and Analysis of Structures and Solids*, Cambridge, 2009, pp. 350. Exists also as an Ebook (use www.ub.lu.se, select “Författare” and search for “Steen Krenk”)

(Not distributed by the department)

Course chapters (lectures will be given in a different order, and for some only an overview will be given):

*Introduction to non-linearity.
    Chapter 1: Introduction.
*Exact theory of truss elements.
    Chapter 2: Non-Linear Bar Elements.
*Theory of finite rotations.
    Chapter 3: Finite Rotations.
*Large displacement beam theory.
    Chapter 4: Finite Rotation Beam Theory.
*Continuum mechanics of solids.
    Chapter 6: Deformation and Equilibrium of Solids.
*Numerical solution techniques.

Chapter 8: Numerical Solution Techniques.
*Dynamics and time integration and energy conserving algorthim.
Chapter 9: Dynamic effects and Time Integration

Additional notes may be included in the course.

Lectures: Matti Ristinmaa

Monday 13-15 MA 5, week 45, and 13-15 MA6 week 46
Tuesday 13-15 MA 6
Wednesday 10-12 MA 6

Problem/ computer sessions: Anders Ericsson/Alex Henningsson

Group 1:
Wednesday 13-15 M:Ina3
Fridag 13-15 M:Ina3

Group 2:
Thursday 8-10 M:Ina3
Friday 10-12 M:Ina3

Exercises: (Most exercises require use of MATLAB.)

Exercises can be found on the homepage www.solid.lth.se.

Projects

Two projects will be carried out during the course. Each project is presented in a written report, and the report is graded with respect to the technical content; MATLAB code should be included. The structural and linguistic qualities of the presentations may also have an influence on the final grade --- positive or negative. The project work is carried out in groups of maximum two students.

The following system for grading will be used:

Project 1: Maximum of 10 points can be obtained and at least 5 points are required to pass.
Report handed in 2019 2/12, 10.00 to Anders Ericsson, both as a printed copy and electronically to anders.ericsson@solid.lth.se

Project 2: Maximum of 20 points can be obtained and at least 10 points are required to pass.
Report handed in 2020 13/1, 10.00 to Anders Ericsson, both as a printed copy and electronically to anders.ericsson@solid.lth.se

The grading is then found as: 15-20 points result in grade 3, 20.1-25 points result in grade 4, 25.1-30 result in grade 5. Note that in addition to the two projects it will be required that you solve all the exercises on the homepage to pass the course, report to the problem session tutor when an exercise is finalized.

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