

The Department of Civil and Structural Engineering at Aalto University School of Engineering is organizing an intensive postgraduate course on damping and control of flexible structures. The course is a part of the program of the National Graduate School in Engineering Mechanics.

The course will be lectured by professor Harm Askes from the University of Sheffield. The lectures will be given at the Department of Civil and Structural Engineering, address: Rakentajanaukio 4A, Espoo.

All inquiries can be directed to Reijo Kouhia tel: +358(0)9 47023755, email: Reijo.Kouhia@aalto.fi. Registrations for the course will be taken care by the course secretary Elsa Nissinen-Narbro tel: +358 (0)9 47023701, or fax: +358 (0)9 47023758, email: Elsa.Nissinen-Narbro@aalto.fi.

Course program

Monday: 9.15—12.00, R1
Tuesday: 9.15—12.00, R3
Wednesday: 9.15—12.00, R3
Thursday: 9.15—12.00, R1

Lecture halls at Rakentajanaukio 4A:
R1 ground floor
R3 first floor

Content

Session 1: introduction

- linear systems and constraints
- direct imposition, Lagrange multipliers and penalties
- variational principles
- physical interpretation

Session 2: convergence and boundedness of penalty methods

- positive and negative stiffness penalties
- positive and negative inertia penalties
- time domain versus frequency domain
- alternating sign algorithm

Session 3: inertia penalties, micro-inertia and mass scaling

- inertia penalties for relative constraints
- introduction to micro-inertia
- introduction to mass scaling
- comparison and interpretation of parameters

Session 4: bi-penalty methods

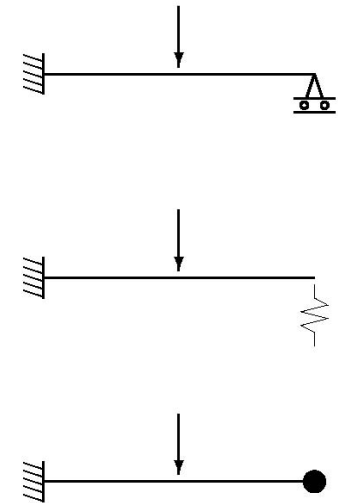
- critical time steps in explicit dynamics
- stability of the bi-penalty method
- accuracy of the bi-penalty method
- calculation of critical penalty ratios



Graduate school of Engineering Mechanics
Ph.D. course on

Penalty Methods in Computational Mechanics

7th – 10th November, 2011



A course given by

Harm Askes

*Department of Civil and Structural Engineering
The University of Sheffield*

Background

Numerical simulations are an important tool in many areas of engineering. Often, a system of linear equations must be solved, and certain constraint conditions may have to be added to these. For instance, in structural mechanics the system of equations is in terms of a stiffness matrix, a vector of nodal displacements and/or rotations, and a vector of forces. The constraints can be support conditions, periodicity conditions and/or contact conditions. Penalty methods are a popular method to impose constraints. Penalty methods are intuitive to understand and very simple to implement. This course will treat basic and advanced formulations of penalty methods. First of all, standard penalty methods for structural mechanics will be reviewed, including their implementation and their physical interpretation. Next, some aspects of accuracy will be covered with guidelines on how to choose the penalty parameters. The second half of the course will focus on dynamic computations, where time step stability is often an issue. Two relatively recent developments will be treated, namely the use of mass penalties and the combination of mass penalties with stiffness penalties. The course will give an insight in the fundamentals of penalty methods but also cover the practical aspects of implementation and use in simulations.

Further reading

H. Askes and S. Ilanko (2006), 'The use of negative penalty functions in linear systems of equations,' *Proceedings of the Royal Society A* 462, pp. 2965--2975

J. Hetherington and H. Askes (2009), 'Penalty methods for time domain computational dynamics based on positive and negative inertia,' *Computers and Structures* 87, pp. 1474-1482

Participants

The participants are assumed to have a background in continuum and structural mechanics. Some background in the finite element method is also desirable.

Requirements and credits (ECTS)

Attending lectures and successful completion of home exercises will give 5 credit points.

Further information

The lectures will be given in the Department of Civil and Structural Engineering, Rakentajanaukio 4A, Espoo. (Number 4 in the map below).

Up to date information available at:
<http://buildtech.tkk.fi/en/current/news/>

Arriving to Otaniemi

Buses from the centre of Helsinki
102, 102T, 103 (Line T via Lauttasaari)
194, 195 via Munkkiniemi
From the centre of Tapiola
2, 4, 4T, 10, 15, 52, 194, 195, 505, 510, 512, 550

Bus 103 stops at the library (24) on Otaniementie and both 194 and 195 stops opposite the library on Vuorimiehentie. Bus 102 stops on Otaniementie and Otakaari.

Aikataulut/Timetables <http://www.ytv.fi/>

