

Course Description

The course will concentrate on theory and practice of topology design. Topics include:

- Design parametrization (interpolation schemes, composites, etc.)
- Sensitivity analysis (direct and adjoint methods)
- Algorithms (OC-methods, convex approximation schemes and other methods)
- Computational issues (checkerboards, filters)
- Applications in structural and multi-physics problems (industrial examples, MEMS-MicroElectro MechanicalSystems, wave-propagation problems)

The course work includes study of preparatory reading material before course-start (see below).

An integral part of the course is computer exercises and preparing a poster for presentation on the last day of the course; exercise work is planned for the weekend.

All participants are also required to give a short presentation on the topic of their Ph.D. research work.

Course homepage

<http://www.dcammm.dk>

Organizers

Ole Sigmund, Department of Mechanical Engineering, Technical University of Denmark

Jakob Søndergaard Jensen, Department of Mechanical Engineering, Technical University of Denmark

Mathias Stolpe, Department of Mathematics, Technical University of Denmark

Anton Evgrafov, Department of Mathematics, Technical University of Denmark

This course is offered as part of the activities of the DCAMM International Graduate Research School, see www.dcammm.dk.

Participants

The course is designed for Ph.D.-students and final-year graduate students being familiar with the basic concepts of the finite element method. Knowledge corresponding to a course in FEM will be assumed, and some experience with programming (Matlab) is also advantageous.

Working Load

Approximately 100 hours in total, including work during the June 10 – 16 course period at DTU (lectures, exercises, discussions, seminars) as well as preparatory required reading before course start.

Study Material

The course textbook is:

Martin P. Bendsøe and Ole Sigmund (2003 and 2004), "Topology Optimization: Theory, Methods and Applications." Springer Verlag, 2003 and 2004, ISBN 3-540-42992-1.

Preparatory reading consists of Chapter 1 and Appendix 5.1.

Language

All lectures will be given in English

Evaluation and Diplomas

To pass the course, active participation in all activities is required; this includes the exercises, the poster session, and the student presentations.

Grades: Pass/Fail. ECTS points: 3.5

Registration to:

DCAMM-course secretariat, att.: Kari Haugland, Department of Mathematics, Technical University of Denmark, Building 303S, DK-2800 Lyngby, Denmark. Fax: (+45) 45881399, E-mail: K.Haugland@mat.dtu.dk

Registration fee:

There is no registration fee for students enrolled at universities and public research institutions. For researchers employed at universities and public research institutions the registration fee is 350 EURO. This covers hand-outs, coffee and social events. For all other participants the registration fee is 1050 EURO.

Deadline:

Applicants should submit a request for registration to be at the hands of the course secretariat no later than May 1, 2009. Information on enrollment will be posted within a week after this date.

Accommodation:

There are a limited amount of rooms available on the premises of the Technical University of Denmark (DTU) from 9th June to 16th June. These will be offered free of charge to students and otherwise at a cost of 25 EURO per night. Accommodation in hostels/hotels can also be arranged by the participants themselves, see the Wonderful Copenhagen website at www.woco.dk.

Scholarships:

For Ph.D.-students enrolled at non-Danish universities and research institutions outside the EU, we can offer a limited number of scholarships in order to facilitate participation, covering lodging (see above) and extra living costs with a per diem amount of 25 EURO. Travel expenses will not be covered. Your CV and a short letter of recommendation from your Ph.D.-supervisor should be sent in together with the application form.

Program outline (TENTATIVE):

Wednesday, June 10:

8.30-9.00 Registration and coffee and rolls.
9.00-9.15 Welcome - practicalities
9.15-12.00 The basics of topology optimization - the direct approach. Lecturer: O. Sigmund (OS).
13.30-17.30 Introduction to computer exercises.
Lecturer: J. Søndergaard Jensen (JSJ).
18.30 Pizza-get-together

Thursday, June 11:

8.30-9.00 Coffee and rolls.
9.00-12.00 Mathematical programming algorithms for topology design, I. Lecturer: M. Stolpe (MS) and M. Kocvara (MK).
13.30-15.00 Mathematical programming algorithms for topology design, II. Lecturer: MS and MK.
15.30-17.00 Computer exercises.

Friday, June 12:

8.30-9.00 Coffee and rolls.
09.00-10.30 Design of mechanisms, materials, and MEMS.
Lecturer: OS.
11.00-12.00 Computer exercises.
13.00-14.00 Eigenvalue problems, Lecturer: JSJ
14.30-16.00 Existence of solutions, composites and homogenization, free material design. Lecturer: M.P. Bendsøe
16.00-17.00 Computer exercises.

Saturday and Sunday, June 13 and 14:

Work on exercises (on your own).

Monday, June 15:

08.30-09.00 Coffee and rolls.
09.00-10.30 Design in wave propagation I. Lecturer: JSJ
11.00-12.00 Design of fluid systems. Lecturer: C.S. Andreasen.
13.30-14.30 Topology optimization of fluid domains using the lattice Boltzmann method. Lecturer: A. Evgrafov
14.30-16.00 Student presentations: TBA
16.15-18.00 Exercises.
19.30 Dinner in a local restaurant.

Tuesday, June 16:

08.30-09.00 Coffee and rolls.
09.00-10.00 Design in wave propagation II. Lecturer: JSJ.
10.30-12.00 Industrial applications. Lecturer: C.B.W. Pedersen, FE-Design, Karlsruhe.
13.30-14.30 Course evaluation.
15.00-17.00 'Poster' presentations of exercise work.

Internet Resources

For facts on the Technical University of Denmark and visitor's information: see <http://www.dtu.dk>. For information about teaching and research at the DCAMM departments: see <http://www.dcammm.dk>.

The **Danish Center for Applied Mathematics and Mechanics, DCAMM** is an informal framework for internationally oriented scientific collaboration between staff members at a number of departments at the Technical University of Denmark (DTU) and Aalborg University (AAU). The departments cooperating within DCAMM are:

- Dept. of Informatics & Mathematical Modelling, DTU
- Dept. of Mathematics, DTU
- Dept. of Mechanical Engineering, DTU
- Dept. of Civil Engineering, AAU
- Dept. of Mechanical Engineering, AAU

DCAMM is an informal construction. The day to day activities are coordinated by the secretary of the Center, while the formal governing body of DCAMM is the Scientific Council.

The **DCAMM International Graduate Research School** functions within the standard framework of the Ph.D.-education at the Technical University of Denmark (DTU) and at Aalborg University (AAU). Ph.D.-students associated to the School are full members of DCAMM through their departments and are enrolled in relevant Ph.D. programmes at DTU and AAU.

The School's role is to provide for an interdisciplinary framework for education of young researchers in an international research environment, and the activities are supported by Danish Agency for Research, Technology and Innovation (FUU).

DANISH CENTER FOR APPLIED MATHEMATICS AND MECHANICS

Ph.D.-course / Advanced school

Topology Optimization - Theory, Methods and Applications

at

Technical University of Denmark,
Lyngby, Denmark

June 10 – 16, 2009

Organized by:
Department of Mathematics
and
Department of Mechanical Engineering,
Technical University of Denmark,



TECHNICAL UNIVERSITY OF
DENMARK
UNIVERSITY OF AALBORG