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, mathematical programming, convex approximation schemes and other methods)
- Computational issues (checkerboards, filters, robust design)
- Applications in structural and multi-physics problems (industrial examples, MicroElectroMechanical Systems (MEMS), 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 bring a poster on the topic of their Ph.D. research work.

Course homepage

http://www.dcamm.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

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 29 – July 5 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 or 2004, ISBN 3-540-42992-1.

Preparatory reading consists of Chapter 1 and Appendix 5.1.

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.dcamm.dk.

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:

Ask for a registration form from the DCAMM-course Secretariat, attn.: Kari Haugland, Department of Mathematics, Technical University of Denmark, Building 303S, DK-2800 Lyngby, Denmark. Tel.: (+45) 45253031, Fax: (+45) 45881399, E-mail: dcamm@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, 2011. You will receive confirmation 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). 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 Visit Copenhagen website at http://www.visitcopenhagen.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 29:
08.30-09.00 Registration and coffee and rolls.
09.00-09.15 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 30:
08.30-09.00 Coffee and rolls.
09.00–10.00 Projection filters and robust design. Lecturer: Mattias Schevenels.
10.30–12.00 Mathematical programming. Lecturers: Mathias Stolpe (MS) and Anton Evgrafov (AE).
13.30–14.30 Intro to Mathematical programming exercises.
14.30–17.30 Computer exercises.

Friday, July 1:
08.30-09.00 Coffee and rolls.
09.00 –10.30 Design of mechanisms, materials, and MEMS (OS)
11.00–12.00 Eigenvalue problems (JSJ)
13.30–14.30 A historical perspective: existence of solutions, composites and homogenization. Lecturer: Martin P. Bendsøe.
14.30–16.00 Computer exercises.
16.00–17.30 Poster session (by participants).

Saturday and Sunday, July 2 and 3:
Work on exercises (on your own).

Monday, July 4:
08.30-09.00 Coffee and rolls.
09.00–10.30 Design in vibration and wave propagation(JSJ)
11.00–12.00 Topology optimization in optics (JSJ)
13.30–14.30 Industrial applications.
             Lecturer: Claus B.W. Pedersen, FE-DESIGN.
16.15-18.00 Exercises.
19.30 Dinner in a local restaurant.

Tuesday, July 5:
08.30-09.00 Coffee and rolls.
09.00–10.30 Design of fluid systems. Lecturer: Casper Schousboe Andreasen.
11.00–12.00 Topology optimization of fluid domains using the lattice Boltzmann method (AE)
13.30-14.30 Course evaluation.
15.00-17.00 'Poster' presentations of exercise work.

The **Danish Centre 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.-programs 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 29 – July 5, 2011

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