TIME TABLE

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
	June 18	June 19	June 20	June 21	June 22
9.00 - 9.45	Registration	Jouve	Olhoff	Stolpe	Rozvany
9.45 - 10.30	Rozvany	Jouve	Olhoff	Stolpe	Rozvany
11.00 - 11.45	Jouve	Jouve	Maute	Stolpe	Lewiński
11.45 - 12.30	Jouve	Olhoff	Maute	Rozvany	Lewiński
14.00 - 14.45	Jouve	Olhoff	Stolpe	Rozvany	
14.45 - 15.30	Olhoff	Maute	Stolpe	Lewiński	
16.00 - 16.45	Olhoff	Maute	Stolpe	Lewiński	
16.45 - 17.30	Maute	Maute	Lewiński	Lewiński	

ADMISSION AND ACCOMMODATION

Applicants must contact CISM Secretariat at least one month before the beginning of the course. Application forms should be sent on-line through our web site: http://www.cism.it or by post.

A message of confirmation will be sent to accepted participants. If you need assistance for registration please contact our secretariat.

The 700,00 Euro registration fee includes a complimentary bag, four fixed menu buffet lunches (Friday not included), hot beverages, on-line/downloadable lecture notes and wi-fi internet access.

A limited number of participants from universities and research centres who are not supported by their own institutions can be offered board and/or lodging in a reasonably priced hotel. Requests should be sent to CISM Secretariat by **April 18, 2012** along with the applicant's curriculum and a letter of recommendation by the head of the department or a supervisor confirming that the institute cannot provide funding. Preference will be given to applicants from countries that sponsor CISM.

Information about travel and accommodation is available on our web site, or can be mailed upon request.

For further information please contact:

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Palazzo del Torso
Piazza Garibaldi 18
33100 Udine (Italy)
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Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

ACADEMIC YEAR 2012
The Cercignani Session

TOPOLOGY OPTIMIZATION IN STRUCTURAL AND CONTINUUM MECHANICS

Advanced School
coordinated by

George Rozvany
Budapest University of Technology
and Economics
Hungary

Tomasz Lewiński
Warsaw University of Technology
Poland

Udine, *June 18 - 22,* 2012

TOPOLOGY OPTIMIZATION IN STRUCTURAL AND CONTINUUM MECHANICS

Topology optimization is a relatively new but extremely rapidly expanding research field of structural and continuum mechanics. It has interesting theoretical implications in mathematics, mechanics, multi-physics and computer science, but also important practical applications in the manufacturing (in particular, car, aerospace and machine) industries, and is likely to have a significant role in micro- and nano-technologies. Topology optimization achieves much higher savings than cross-section or shape optimization. The proponent of this course was coordinator for two CISM courses on topology optimization in 1990 and 1996.

The objective of the course is to review new developments in structural topology optimization that occurred since the last CISM course on this subject. After revisiting briefly the earlier history of exact topology optimization, including the optimal layout theory, recent developments in the theory of Michell structures will be examined. This will cover the review of some errors in the classical literature, and difficulties in obtaining certain types of exact analytical solutions. Moreover, some general principles (symmetry, non-uniqueness, domain incrementation) will be discussed, and methods for verifying numerical solutions presented.

Further lectures on exact topology optimization will examine the basic properties of Michell-Hencky networks, with a number of applications to new classes of solutions for both plane and surface structures. Moreover, two-material optimization for plane stress, plate bending, shells, 3D bodies and sandwich plates will be discussed. Finally, free material optimization will be briefly reviewed.

Another series of lectures will show that, from a mathematical viewpoint, topology optimization problems are often ill-posed, even if this difficulty can be overcome by two methods. One is called “relaxation" and the main tool involved is the homogenization theory. It will be discussed in detail, both from theoretical and numerical points of view. The second approach consists of restricting the set of admissible solutions using the level set representation, that may be seen as a constraint on the set of admissible solutions. The level set algorithm will be explained extensively through various applications and examples.

Turning to numerically oriented topology optimization, the theory of band-gap structures will be presented. The problem of maximizing single and multiple eigenfrequencies and frequency gaps, as well as minimizing the dynamic compliance will also be examined. Finally, the bifurcation and post-buckling analysis of bi-modal optimum columns will be considered.

Yet another series of lectures will look into topology optimization using the Extended Finite Element Method (XFEM), diffusive transport problems, topology optimization of flows, as well as coupled multi-physics, meso-scale transport and nano-scale problems. These lectures will finally discuss topology optimization under uncertainty.

The lectures will also cover an alternative material interpolation scheme (RAMP), trajectories of penalization methods, some fundamental properties of discrete topology optimization problems, global topology optimization by branch-and-cut methods (algorithm and example) and global topology optimization by local branching.

This course is recommended to Ph. D. and post-doctoral scholars and other research staff who intend working on any aspect of topology optimization of structures and continua.

PRELIMINARY SUGGESTED READINGS

Allaire G., Bonnetier E., Francfort G., Jouve F. 1997: Shape optimization by the homogenization method. Num. Math., 76:27-68.

Allaire G., Jouve F., Toader A.-M. 2004: Structural optimization using sensitivity analysis and a level-set method. J. Comp. Phys., 194:363-393.

Bendsøe, M.P.; Sigmund, O. 2003: Topology optimization: Theory, methods and applications. Berlin: Springer.

Fries, T.P., Belytschko, T. 2010: The generalized/extended finite element method: An overview of the method and its applications. Internat. J. Numer. Methods Engrg. 84:253-304.

Rozvany, G.I.N. 2001: Aims, scope, methods, history and unified terminology of computer-aided topology optimization in structural mechanics. Struct. Multidisc. Optim. 21:, 90-108.

Rozvany, G.I.N. 2009: A critical review of established methods of structural topology optimization. Struct. Multidisc. Optim. 37: 217-237.

Seyranian, A.P.; Lund, E.; Olhoff, N. 1994: Multiple eigenvalues in structural optimization problems. Struct. Optim. 8:207-227.

Czarnecki, S., Lewiński, T., 2011: The stiffest designs of elastic plates. Vector optimization for two loading conditions. Comp. Meth. Appl. Mech. Engrg 200: 1708-1728.

INVITED LECTURERS

George Rozvany - Budapest Univ. of Technology and Economics, Hungary
5 lectures on: 1. Topology optimization in structural and continuum mechanics: An introduction. 2. The Prager-Rozvany (1977) layout theory. 3. Verification of numerical methods of topology optimization by extrapolation and comparison with exact solutions. 4. Fundamental principles of exact topology optimization: symmetry and non-uniqueness. 5. Fundamental principles of exact topology optimization: domain augmentation and reduction. 6. Errors in the topology literature and current difficulties in finding complete proofs for exact solutions.

Tomasz Lewiński - Warsaw University of Technology, Poland
6 lectures on: 1. Theory of elastic bar structures undergoing small deformations: frames, grillages and trusses - Minimum volume truss optimization problem. 2. Michell gridworks. 3. Two-material optimization. 4. Two material optimization of three dimensional bodies. 5. Two material optimization of the core layer of sandwich plates. 6. Free material optimization of elastic bodies.

François Jouve - University Paris Diderot (Paris 7), France
6 lectures on: 1. Introduction to shape optimization. 2. Homogenization method I. 3. Homogenization method II. Algorithms and numerical issues. 4. Domain variation. 5. Level set method I. 6. Level set method II.

Kurt Maute - University of Colorado at Boulder, CO, USA
6 lectures on: 1. Topology optimization using the extended finite element method. 2. Topology optimization of diffusive transport problems. 3. Topology optimization of flows: Stokes and Navier-Stokes models. 4. Topology optimization of coupled Multi-Physics problems. 5. Topology optimization of Meso-Scale transport problems and of Nano-Scale problems. 6. Topology optimization under uncertainty.

Niels Olhoff - Aalborg University, Aalborg East, Denmark
6 lectures on: 1. On optimum design of band-gap structures. 2. Topology optimization of vibrating continuum structures for maximum values of simple and multiple eigenfrequencies and frequency gaps. 3. Topological design for minimum dynamic compliance of continuum structures subjected to forced vibration. 4. Topological design for minimum sound radiation from bi-material structures subjected to forced vibration. 5. Discrete material optimization of vibrating laminated composite plates for minimum sound radiation. 6. Bifurcation and post-buckling analysis of bi-modal optimum columns.

Mathias Stolpe - Technical University of Denmark, Lyngby, Denmark
6 lectures on: 1. An alternative material interpolation scheme (RAMP). 2. Trajectories of penalization methods. 3. On some fundamental properties of discrete topology optimization problems. 4. Global topology optimization by branch-and-cut methods – Algorithm. 5. Global topology optimization by branch-and-cut methods – Example. 6. Global topology optimization by local branching.

LECTURES

All lectures will be given in English. Lecture notes can be downloaded from CISM web site, instructions will be sent to accepted participants.

TOPOLOGY OPTIMIZATION IN STRUCTURAL AND CONTINUUM MECHANICS

Udine, June 18 - 22, 2012
Application Form
(Please print or type)

Surname _____

Name _____

Affiliation _____

Address_____

_____

E-mail _____

Phone_____Fax_____

Method of payment upon receipt of confirmation (Please check the box)

The fee of Euro 700,00 includes IVA/VAT tax and excludes bank charges

❑ *I shall send a check of Euro _____*

❑ *Payment will be made to CISM - Bank Account N° 094570210900, VENETO BANCA - Udine (CAB 12300 - ABI 05035 - SWIFT/BIC VEBHIT2M - IBAN CODE IT46 N 05035 12300 09457 0210900).*
Copy of the receipt should be sent to the secretariat

❑ *I shall pay at the registration counter with check, cash or VISA Credit Card (Mastercard/Eurocard, Visa, CartaSi)*

IMPORTANT: CISM is obliged to present an invoice for the above sum. Please indicate to whom the invoice should be addressed.

Name _____

Address _____

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C.F.* _____

VAT/IVA* No_____

(*) Only for EU residents or foreigners with a permanent business activity in Italy.

Only for Italian Public Companies

❑ *I ask for IVA exemption (ex law n. 537/1993 - art. 14 comma 10).*

Privacy policy: I understand that data received via this form will be used only to provide information about CISM and its activities, within the limits set by the Italian legislative decree no. 196/2003 and subsequent amendments.
Complete information on CISM's privacy policy is available at http://www.cism.it/courses/privacy_statement/

I have read the "Admission and Accommodation" terms and conditions and agree.

Date _____ Signature _____