TIME TABLE

TIME	Monday June 9	Tuesday June 10	Wednesday June 11	Thursday June 12	Friday June 13
9.00 - 9.45	Registration	Sigmund	Paulino	Maute	Rozvany
9.45 - 10.30	Rozvany	Sigmund	Paulino	Maute	Rozvany
11.00 - 11.45	Sigmund	Svanberg	Paulino	Duysinx	Maute
11.45 - 12.30	Sigmund	Svanberg	Paulino	Duysinx	Maute
14.00 - 14.45	Paulino	Duysinx	Sigmund	Maute	
14.45 - 15.30	Svanberg	Duysinx	Sigmund	Maute	
16.00 - 16.45	Svanberg	Duysinx	Rozvany	Paulino	
16.45 - 17.30	Svanberg	Duysinx	Rozvany	Rozvany	

ADMISSION AND ACCOMMODATION

Applicants must apply 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 subject to numbers), hot beverages, 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 9, 2014** 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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Piazza Garibaldi 18
33100 Udine (Italy)
tel. +39 0432 248511 (6 lines)
fax +39 0432 248550
e-mail: cism@cism.it

TOPOLOGY OPTIMIZATION OF STRUCTURES AND CONTINUA – COMPUTATIONAL ASPECTS AND BACKGROUND

Advanced School
coordinated by

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Hungary

Glaucio H. Paulino
University of Illinois, Urbana
IL, USA

Udine *June 9 - 13* 2014

TOPOLOGY OPTIMIZATION OF STRUCTURES AND CONTINUA – COMPUTATIONAL ASPECTS AND BACKGROUND

Structural Topology Optimization is a relatively new, but rapidly expanding and extremely popular field of structural mechanics. Various theoretical aspects, as well as a great variety of numerical methods and applications have been discussed extensively in international journals and at conferences. At the last three World Congresses of Structural and Multidisciplinary Optimization, the ratio of papers on topology optimization was about 40, 40 and 50 per cent. The ratio has been similarly high in the journal Structural and Multidisciplinary Optimization (Springer). Such a level of interest in this field is due to the substantial savings that can be achieved by topology optimization in industrial applications. Moreover, structural topology optimization has interesting theoretical implications in mathematics, mechanics, multi-physics and computer science. The present proposal is for the fourth CISM Advanced Course on Structural Topology Optimization. The previous courses (1992, 1997 and 2012) were organized by the proponent of this one (Rozvany), the 2012 course jointly with T. Lewinski. Whilst the Advanced Course in 2012 mostly dealt with theoretical issues and exact analytical solutions, the present one is aimed at covering numerical (discretized) methods and computational aspects of structural topology optimization, including the mathematical background of these methodologies. Consequently, there is no overlap between the two courses. Numerical methods are more directly applicable to practical problems in the industry.

Each of the lecturers is a leading specialist in some aspects of numerical topology optimization, including the most eminent researcher in the field, Prof. Sigmund. All invited lecturers are full professors at prestigious universities in Europe or the USA. In an introductory lecture, the organizer (Rozvany) will explain the connections between exact analytical methods (reviewed in the 2012 course) and discretized, numerical algorithms, discussing the relative importance of both. Analytical solutions are extremely useful as reliable benchmarks for checking on the validity, convergence and accuracy of numerical solutions. Moreover, many numerical algorithms are actually discretized versions of exact analytical methods.

The 2012 course was highly successful in terms of the number of participants, but the one proposed for 2014 should be of even greater interest to researchers and practitioners in the field.

The main topic of the 2014 course is planned to be topology optimization of structures, i. e. stressed systems consisting of solids, but several lecturers (Profs. Sigmund, Maute and Paulino) intend to discuss problems concerning fluids, photonics, and also multi-physical applications. It is proposed that the mathematical background of topology optimization methods will be explained by a top mathematician in the field, Prof. Svanberg, who has created the most efficient, and therefore most popular, non-linear programming method (MMA) of structural optimization (and of topology optimization in particular).

Other aspects of the mathematical background will be reviewed by Prof. Duysinx, who will also look at particular classes of topology optimization problems (e. g. stress-based, eigenvalue type, multi-body and discrete material problems). Various techniques of numerical topology optimization, including density based (SIMP) and Level Set methods, as well as filtering, robust formulations and advanced discretization techniques will be reviewed in depth by Profs Sigmund and Maute. Polygonal discretization and multi-resolution topology optimization, with applications in solid and fluid mechanics, will be discussed in detail by Prof. Paulino, who will also show applications in architecture and medicine.

The advanced school is addressed to Ph.D. students and post-doctoral scholars in engineering, mathematics, computer-science and multi-physics, their supervisors, as well as practicing engineers and senior researchers.

SUGGESTED PRELIMINARY READINGS

Sigmund O., Maute K. 2013: Topology optimization approaches. Struct. Multidisc. Optim.

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

van Dijk N.P., Maute K., Langelaar M., van Keulen F., 2013: Level set methods for structural topology optimization: a review. Struct. Multidisc. Optim. 48:437-472.

Gain A.L., Paulino G.H., 2013: A critical comparative assessment of differential equation-driven methods for structural topology optimization. Struct. Mult. Optim. 48(4):685-710.

Rozvany G.I.N., Lewinski T., (2014): Topology optimization in structural and continuum mechanics. CISM Courses and Lectures. Vol. 549. Springer, Vienna.

Deaton J.D., Grandhi R.V., 2014: a survey of structural and multidisciplinary topology optimization: past 2000. Struct. Multidisc. Optim.

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

Sutradhar A., Paulino G.H., Miller M.J., Nguyen T.H. 2010: Topological optimization for designing patient-specific large craniofacial segmental bone replacements. Proceedings of the National Academy of Sciences (PNAS), 107(30):13222-13227.

Talischi C., Paulino G.H., Pereira A., Menezes I.F.M. 2012: PolyMesher: A general-purpose mesh generator for polygonal elements. Matlab. Struct. Multidisc. Optim. 45(3):309-328.

Talischi C., Paulino G.H., Pereira A., Menezes I.F.M. 2012: "PolyTop: a Matlab implementation of a general topology optimization framework using unstructured polygonal finite element meshes". Struct. Multidisc. Optim. 45(3):329-357.

INVITED LECTURERS

Ole Sigmund - Technical University of Denmark, Lyngby
6 lectures on: Introduction to density-based topology optimization. Filters and robust topology optimization formulations. Adjoint sensitivity analysis. Manufacturing constraints. Mechanism and multiphysics design. Applications in photonics.

Kurt Maute - University of Colorado at Boulder, CO, USA
6 lectures on: Advanced discretization schemes for topology optimization: discontinuous Galerkin Finite Element methods; Stabilized finite element methods, the extended finite element method. Topology optimization for multi-physics problems: algorithms and coupling methods. Iterative solvers for large scale topology optimization problems. Level set methods – Part I. Level set methods – Part II.

Krister Svanberg - Royal Instute of Technology, Stockholm, Sweden
5 lectures on: Introduction to finite-dimensional optimization. Linear- and quadratic optimization. The Karush-Kuhn-Tucker optimality conditions. Some solution methods for nonlinear optimization. Convex problems and duality concepts.

Pierre Duysinx - University of Liege, Belgium
6 lectures on: Methods based on convex separable approximation for structural optimization. Perimeter methods. Stress constrained topology optimization. Topology optimization for solving discrete material optimization problems. Topology optimization of structural components in multi-body dynamic systems. Topology optimization subject to stability constraints.

Glaucio H. Paulino - University of Illinois, Urbana, IL, USA
6 lectures on: Recent trends in topology optimization: from building design to reconstructive craniofacial surgery. Topology optimization on polytopes I: PolyMesher. Topology optimization on polytopes II: PolyTop. PolyFluid: Fluid flow topology optimization using polygonal discretization. Multiresolution topology optimization (MTop). Ground structure analysis and design (GRAND).

George Rozvany - Budapest University of Technology and Economics, Hungary
6 lectures on: Introduction to exact analytical theory of optimal structural topologies. Extensions of the exact optimal layout theory to multi-load topology optimization - Part I: Plastic design - Part II: Elastic design. Recent improvements of the SERA (modified BESO) method. Adaptive ground structure approach based on the interior point and active set methods. Practical aspects of topology optimization for industrial applications. (Co-authors of the last two lectures will be Tomasz Sokol and Ming Zhou).

LECTURES

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

**TOPOLOGY OPTIMIZATION OF STRUCTURES AND
CONTINUA – COMPUTATIONAL ASPECTS AND
BACKGROUND**
Udine, June 9 - 13, 2014
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 No. 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 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 www.cism.it.

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

Date _____   Signature _____