TIME TABLE

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
	July 12	July 13	July 14	July 15	July 16
9.00 - 9.45	Registration	Berdichevsky	Berdichevsky	Francfort	Carcaterra
9.45 - 10.30	dell'Isola	Berdichevsky	Berdichevsky	Francfort	Francfort
11.00 - 11.45	Berdichevsky	Gavrilyuk	dell'Isola	dell'Isola	dell'Isola
11.45 - 12.30	Berdichevsky	Gavrilyuk	dell'Isola	dell'Isola	Discussion
14.30 - 15.15	Francfort	Francfort	Carcaterra	Carcaterra	
15.15 - 16.00	Gavrilyuk	Francfort	Carcaterra	Carcaterra	
16.30 - 17.15	Gavrilyuk	Carcaterra	Gavrilyuk	Gavrilyuk	
17.15 - 18.00	Discussion	Discussion	Discussion	Discussion	

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 not included), hot beverages, on-line/downloadable lecture notes and wi-fi internet access.

A limited number of participants from universitites 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 **May 14, 2010** 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.

The Deutscher Akademischer Austausch Dienst (DAAD) and the Deutsche Forschungsgemeinschaft (DFG) offer support to German students. Please contact:

DAAD, Kennedyallee 50, 53175 Bonn
tel. +49 (228) 882-0
e-mail: postmaster@daad.de
web site: http://www.daad.de/de/kontakt.html

DFG, Kennedyallee 40, 53175 Bonn
tel. +49 (228) 885 2655
e-mail: ing4@dfg.de
web site: http://www.dfg.de

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

For further information please contact:

CISM
Palazzo del Torso - Piazza Garibaldi 18
33100 Udine (Italy)
tel. +39 0432 248511 (6 lines)
fax +39 0432 248550
e-mail: cism@cism.it

Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

ACADEMIC YEAR 2010

The Lippmann Session

VARIATIONAL MODELS AND METHODS IN SOLID AND FLUID MECHANICS

Advanced School
coordinated by

Francesco dell'Isola
Università di Roma
Italy

Sergey Gavrilyuk
University of Aix-Marseille
France

Udine, *July 12 - 16,* 2010

VARIATIONAL MODELS AND METHODS IN SOLID AND FLUID MECHANICS

"For this would be agreed by all: that Nature does nothing in vain nor labours in vain".
Olympiodorus, Commentary on Aristotle's Meteora translated by Ivor Thomas in the Greek Mathematica Works Loeb Classical Library

"La nature, dans la production de ses effets, agit toujours par les voies les plus simples".
Pierre de Fermat

Variational formulation of the governing equations of solid and fluid mechanics is a classical but a very challenging topic. Variational methods give an efficient and elegant way to formulate and solve mathematical problems that are of interest for engineers. This formulation allows us an easier justification of the well-posedness of mathematical problems, the study of stability of particular solutions, a simpler implementation of numerical methods. Often, mechanical problems are posed in a variational context by their nature. Hamilton's principle of stationary (or least) action is the conceptual basis of practically all models in physics. The variational formulation is also useful for obtaining simpler approximate asymptotical models.

In this course, three fundamental aspects of the variational formulation of mechanics will be presented: physical, mathematical and applicative ones.
The first aspect concerns the investigation of the nature of real physical problems with the aim of finding the best variational formulation suitable to those problems. A deep knowledge of the physical problems is needed to determine the Lagrangian function of the system and the nature of the admissible variations. In many problems of mechanics and physics, the functionals being minimized depend on parameters which can be considered as random variables. Variational structure of such problems brings considerable simplifications in their study.
The second aspect is the study of the well-posedeness of those mathematical problems which need to be solved in order to draw previsions from the formulated models. Often, the emphasis is put on integrable non-linear equations. It is worth to notice that most non-linear systems of continuum mechanics represent non-integrable systems. However, their variational formulation implies a special structure of the governing equations which should be used for their mathematical study.
The third aspect is related to the direct application of variational analysis to solve real engineering problems. A Rayleigh-Hamilton principle is used to establish boundary conditions at discontinuity surfaces in porous media. New variational models of fracture mechanics are presented and solved. Continuous structures to which are attached special sets of resonators (discrete as well as continuous) that generate amplitude decays in its impulse response are also treated.

The course is addressed to doctoral students, young and senior researchers and engineers interested in this field.

PRELIMINARY SUGGESTED READINGS

J. Salençon Mécanique des milieux continus Les Editions de l'École polytechnique Paris 2005.

Bedford A., Drumheller D.S.: A variational theory of immiscible mixtures. Arch. Rational Mech. Anal. 68, 37-51 (1978).

F. dell'Isola, A. Madeo, P. Seppecher. "Boundary Conditions in Porous Media: A Variational Approach". Int. Journal of Solids and Structures Vol. 46, (2009), 3150-3164.

A. Carcaterra, A. Akay, "Theoretical foundation of apparent damping and energy irreversible energy exchange in linear conservative dynamical systems", Journal of Acoustical Society of America, vol. 121, 1971-1982 (2007).

G.K. Vallis. Atmospheric and Oceanic Fluid Dynamics: Fundamentals and Large-scale Circulation. Cambridge University Press, Cambridge, 2006.

S. Gavrilyuk, N. Favrie and R. Saurel, Modelling Wave Dynamics of Compressible Elastic Materials, J. Computational Physics, v. 227, 2941-2969 (2009).

B. Bourdin, G.A. Francfort & J.-J. Marigo, The variational approach to fracture, J. Elasticity, 91, 1-3, 2008, 1-148 (also appeared as a Springer book: ISBN: 978-1-4020-6394-7).

D.D. Holm, J.E. Marsden, and T.S. Ratiu. The Euler-Poincaré equations in geophysical fluid dynamics. In J. Norbury and I. Roulstone, editors, Large-Scale Atmosphere-Ocean Dynamics 2: Geometric Methods and Models, pages 251-299. Cambridge University Press, Cambridge, 2004.

V. Berdichevsky, Variational Principles of Continuum Mechanics, Springer, 2009.

INVITED LECTURERS

Francesco dell'Isola - Università "La Sapienza" di Roma, Italy
6 lectures on: VARIATIONAL METHODS IN CONTINUUM MECHANICS FOR HETEROGENEOUS MEDIA. To prove the effectiveness of variational methods an extended Hamilton-Rayleigh principle is used to determine the evolution equations for systems in which fluid flow occurs in deformable porous matrices. An introduction of the application of variational methods to continuum mechanics will also be done.

Sergey Gavrilyuk - University Aix-Marseille, Marseille, France
6 lectures on: VARIATIONAL MODELS FOR MULTIPHASE FLOWS. The aim of the lectures is to use the Hamilton principle as a tool for building new models of complex media. The difficulty in using such an approach is in the construction of the Lagrangian describing various physical systems. The multiphase variational approach will also be applied to diffuse solid-fluid interfaces.

Victor Berdichevsky - Wayne State Univesrity, Detroit, MI, USA
6 lectures on: STOCHASTIC VARIATIONAL PROBLEMS IN SOLID MECHANICS. The applications of the methods of stochastic calculus of variations to the problems of solid mechanics will be discussed. The special attention will be paid to homogenization problems and modeling of microstructures and their evolution.

Gilles A. Francfort - L.P.M.T.M. Un. Paris Nord, Villetaneuse, France
6 lectures on: BRITTLE FRACTURE REVISITED will present a variational model which does away with many of the obstacles of the classical theory of fracture while departing as little as feasible from Griffith's theory. The focus will be on the mathematical state of the art for this model, and on its impact upon crack kinking.

Antonio Carcaterra - Università "La Sapienza" di Roma, Italy
6 lectures on: NEW CONCEPTS IN DAMPING GENERATION AND CONTROL: THEORETICAL FORMULATION AND INDUSTRIAL APPLICATIONS. The course is focused on a new class of dynamical problems where the energy initially conferred to a system undergoes a principle of irreversible energy confinement into a small region. The analysis includes also applications to engineering problems.

LECTURES

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

VARIATIONAL MODELS AND METHODS IN SOLID AND FLUID MECHANICS

Udine, July 12 - 16, 2010
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 05418 - SWIFT AMBPIT2M - IBAN CODE IT83Z 05418 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 www.cism.it.

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

Date _____ Signature _____