

TIME TABLE

TIME	Monday September 28	Tuesday September 29	Wednesday September 30	Thursday October 1	Friday October 2
9.00 - 9.45	Registration	Altenbach	Daxner	Alexandrov	Tan
9.45 - 10.30	Altenbach	Altenbach	Daxner	Alexandrov	Tan
11.00 - 11.45	Altenbach	Daxner	Marsavina	Daxner	Tan
11.45 - 12.30	Altenbach	Daxner	Marsavina	Daxner	Altenbach
14.30 - 15.15	Öchsner	Marsavina	Öchsner	Marsavina	
15.15 - 16.00	Öchsner	Marsavina	Öchsner	Marsavina	
16.30 - 17.15	Alexandrov	Tan	Alexandrov	Öchsner	
17.15 - 18.00	Alexandrov	Tan	Alexandrov	Öchsner	

ADMISSION AND ACCOMMODATION

Applicants must apply at least one month before the beginning of the course. Application forms can be sent by post or on-line through our web site: <http://www.cism.it>. A letter of confirmation will be sent to accepted participants.

The registration fee is 600,00 Euro.

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 **July 28, 2009** together with the applicant's curriculum and a letter of recommendation by the head of the department or supervisor confirming that the institute cannot provide funding. Preference will be given to applicants from countries which sponsor CISM.

The Deutsche Forschungsgemeinschaft offers scholarships to German students (please contact Dr-Ing. Marcel Urban, DFG, Kennedyallee 40, 53175 Bonn, Germany, tel. +49 (228) 885 2655, e-mail: Marcel.Urban@dfg.de - web site: <http://www.dfg.de>).

Information about travel and accommodation are available at http://www.cism.it/cism/travel_reach.htm, or can be mailed upon request.

Please note that the Centre will be closed for summer vacation the first three weeks in August.

For further information please contact:

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 fax +39 0432 248550
 e-mail: cism@cism.it
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Centre International des Sciences Mécaniques
 International Centre for Mechanical Sciences

ACADEMIC YEAR 2009
 The Sobrero Session



CELLULAR AND POROUS MATERIALS IN STRUCTURES AND PROCESSES

*Advanced School
 coordinated by*

Holm Altenbach
 Martin-Luther-University Halle-Wittenberg
 Germany

Andreas Öchsner
 Technical University of Malaysia
 Malaysia

Udine, September 28 - October 2, 2009

CELLULAR AND POROUS MATERIALS IN STRUCTURES AND PROCESSES

Metallic and polymer foams and powders are widely used in modern industries, e.g., aircraft and automotive, but also with other application fields like biomechanics. Foams are very light and at the same time they have sufficient stiffness and strength so that the specific values make them an excellent material for application in lightweight structures such as sandwich panels. Metal powder technology is of great interest for modern industry as it provides an economic method of producing components from metal powders. Mechanical properties of the metal powder products compare favourably with those of wrought materials.

Engineering structures made of porous materials, especially metal foams and powders, have been used in different applications in the last decades. Metal foam is a cellular structure

consisting of a solid metal, for example aluminium, steel, copper etc., containing a large volume fraction of gas-filled pores. There are two types of metal foams: namely, closed-cell and open-cell foams. The defining characteristic is a very high porosity: typically well over 80%, 90% and even 98% of the volume consists of void spaces. Another example of perspective material is syntactic foam. They are composite materials synthesized by filling a metal, polymer or ceramic matrix with hollow particles. The course is devoted to cellular and porous materials, and the modelling of the material behaviour, but also the analysis of structures made of foams, the testing, processes, and applications will be discussed. The first question is on which scale one has to model the material. In materials modelling, a minimum of three

scales can be distinguished: namely, micromechanical, mesomechanical, and macromechanical scale. During the Lectures the advantages and disadvantages of each approach will be demonstrated.

The basics of the analysis of structures made of foams in metal powder technology are the continuum mechanics. Briefly are presented the foundation of the theory of elasticity. In addition, the introduction the theory of plasticity and viscoelasticity is given. Special attention will be paid to the yield criteria because foams and foams are pressure sensitive, anisotropic and have different behaviour in tension and compression.

Many structural elements made of foams can be presented by beam, plate or shell models. As an example, a special plate theory will be presented. One of the basic elements of this theory is the effective property concept.

Such a theory is suitable for the global analysis of plates (deflections, frequencies, etc.). It will be shown that in the case of foams classical approaches like the Kirchhoff's plate theory may result in wrong results.

How to improve theories will be demonstrated for three application cases: the bending problem, the eigenvibration problem, and the viscoelastic problem.

Specialised lectures cover in detail further advanced topics such as the finite element modelling, fracture mechanics and the impact behaviour. The course is addressed to graduate students, doctoral students, and scientists interested in entering or already working in the fields of cellular and porous materials. It is also targeted at those interested in the processing and applications of these materials.

PRELIMINARY SUGGESTED READINGS

1. N. Mills: Polymer Foams Handbook. Engineering and Biomechanics Applications and Design Guide, Butterworth-Heinemann, 2007, Amsterdam.

2. R. Kienzler, H. Altenbach, I. Ott (Eds) Theories of Plates and Shells, Springer, 2004, Berlin.

3. M.F. Ashby, A.G. Evans, N.A. Fleck, L.J. Gibson, J.W. Hutchinson, and H.N.G. Wadley: Metal foams: a design guide, Butterworth-Heinemann, 2000, Boston.

4. Böhm, H.J. (Ed.): Mechanics of Microstructured Materials, Springer, 2004, Wien.

5. B. Druyanov: Technological Mechanics of Porous Bodies, Clarendon Press, 1993, New-York.

6. W.-F. Chen, D.-J. Han: Plasticity for Structural Engineers, Springer, 1988, New York.

7. A. Öchsner, G.E. Murch, M.J.S. de Lemos (Eds): Cellular and Porous Materials Thermal Properties, Simulation and Prediction, Wiley, 2008, Weinheim.

INVITED LECTURERS

Sergei Alexandrov - Russian Academy of Sciences
Russia

6 lectures on:

Plasticity of Porous and Powder Metals

Holm Altenbach - Martin-Luther-Universität
Halle-Wittenberg, Germany

6 lectures on:

Thin-walled Structures Made of Foams

Thomas Daxner - Vienna University of Technology,
Austria

6 lectures on:

Finite Element Modelling of Foams

Liviu Marsavina - Politehnica University of Timisoara,
Romania

6 lectures on:

Fracture Mechanics of Foams

Andreas Öchsner - Technical University of Malaysia,
Malaysia

6 lectures on:

Plasticity of Three-dimensional Foams

Henry Tan - The University of Manchester, UK

5 lectures on:

Impact of Cellular Materials

LECTURES

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

**CELLULAR AND POROUS MATERIALS IN STRUCTURES
AND PROCESSES**

Udine, September 28 - October 2, 2009

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 600,00 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 _____

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 _____