Program at a glance

Tuesday 12th February

08:00 – 09:00 ***Welcome breakfast***
09:30 – 12:30 **Modeling I : a brief history**
12:30 – 14:00 ***Lunch***
14:00 – 16:00 **Modeling II : scaling approaches**
16:30 – 18:30 **Modeling III : time domain models and outdoor sound propagation**

Wednesday 13th February

08:00 – 10:00 **Characterization techniques I : inverse approaches**
09:30 – 12:30 **Characterization techniques II : direct approaches**
12:30 – 14:00 ***Lunch***
14:00 – 16:00 **Experience feedback I : material production**
16:30 – 18:30 **Experience feedback II : material assembling**

Thursday 14th February

08:00 – 10:00 **Numerics I – FEM approaches : theories**
09:30 – 12:30 **Numerics I – FEM approaches : implementations**
12:30 – 14:00 ***Lunch***
14:00 – 16:00 **Numerics II – Other approaches**
16:30 – 18:30 **Numerics II – Hybrid approaches**

Recommended readings

- **Zwikker, C. and Kosten, W., Sound absorbing materials, Elsevier, New-York, 174, (1949)**
- **Innovative Applications of Materials for Acoustic Purposes, Innovative Applications of Materials for Acoustic Purposes, Applied Acoustics, Special Issue, Vol. 66 (6), (2005)**
- **Allard, J.-F. and Atalla, N., Propagation of sound in porous media: modelling sound absorbing materials, Wiley, (2009)**
- **Auriault, J. L. and Boutin, C. and Geindreau, C., Homogenization of Coupled Phenomena in Heterogenous Media, ISTE Ltd and John Wiley & Sons Inc. (2009)**
- **Acoustics of Porous Materials: Recent Advances Relating to Modelling, Characterization and New Materials, Acta Acustica united with Acustica, Special Section, Vol. 96 (2), (2010)**

Lectures' contents

Modeling I : a brief history

It is often said that porous media theory started with Biot's series of papers in 1956. Actually, earlier works also brought fundamental insights into the physics of porous material research. In addition, some models, might there be analytical or numerical, may have been unfairly mistaken or misunderstood. This first talk will attempt to draw the global history of the research in the field of acoustical porous media. As an introduction of the seminar, the talk will cover theoretical models, characterization techniques, numerical methods. The aim of this talk is to pave a common background for attendees which are coming with various tuitions and experiences.
Lecture given by L. Jaouen

Modeling II : scaling approaches

Porous media research inherently involves various scales of observation. From the micro-scale related to the pore size and skeleton morphology, one gains the information about the dissipation mechanisms implied in the material behaviour. From the arrangement of the pores and the distribution of the sizes, global performance of the material may be retrieved. Other intermediate scales may also be considered to account for heterogeneities or porosity networks. This talk will aim at presenting the different techniques which exist to go from one scale to the other. Acoustics, mechanics and flow in porous media will be considered. Keywords for this talk comprise homogenisation, micro-macro approaches and morphological modelling.
Lecture given by C. Boutin

Modeling III : time domain models and outdoor sound propagation

Due to the dissipative nature of porous media, it is convenient to adopt frequency domain models. However, this type of representation poses difficulties when directly translating to a time-domain representation. Time domain modelling has become in recent years a mature numerical technique in acoustics, and is most useful to simulate moving sound sources, in noise control applications involving a broad spectrum like road traffic noise, to include non-linear effects, etc. The time-domain calculation schemes most often used nowadays in outdoor sound propagation (FDTD, PSTD, TLM) are briefly reviewed. The main focus will be on the finite-difference time-domain technique, and detailed information will be provided concerning numerical accuracy, stability and computational cost. The characteristics largely change when the sound propagation medium is moving, which is often an importance influence in outdoor sound propagation applications due to the presence of wind. The different ways of including porous materials into these models will be discussed, with their pro's and contra's. Hybrid modelling between time-domain and frequency-domain models, with the purpose of reducing computational cost, will also be discussed.
Lecture given by T. Van Renterghem

Characterization techniques I : direct approaches
Characterization techniques II : inverse approaches

The relevance and accuracy of the input information related to porous materials is critical. A wide range of techniques have been designed to access the parameters which populate the predicting models. A first category includes direct approaches where a single or a set of parameters are directly measured. Measurement techniques involve techniques among ultrasonics, acoustics, mechanics and fluid dynamics. The second category comprises inverse techniques which consist in assuming a behaviour model of the porous material and determining the set of parameters which best fit measured data. These two categories are complementary and will be presented and discussed alongside.
Lectures given by R. Panneton

Experience feedback I : material production
Experience feedback II : material assembling

From theory to practice may summarize these two talks. How these tools could serve the material manufacturing while coping with mounting constraints, package assembling, production limitations ? These lectures will present how predicting models and characterization techniques could be used in an industrial context. Each of these talks will be given by the research group leaders of two worldwide leading material manufacturers. Examples will address applications sound packages comprising fibrous materials, felts, foams, granular materials, a wide range in the context of noise control in Buildings, Automotive, Railway, Aircraft and Aerospace, Domestic appliances, Equipment.
Lectures given jointly by S. Berger & A. Duval

Numerics I – FEM : theories
Numerics I – FEM : implementations

With ever increasing computational capabilities, finite element models are now matured enough to be directly involved in the design process of porous materials and sound packages. This talk aims at presenting the basis of the finite element method dedicated to porous media modelling. Classical models together with alternate representations will be discussed. Some basic implementations and practical examples will be proposed to the attendees. Special attention will be paid to convergence and stability criteria, and numerical efficiency of the implemented models.
Lectures given by P. Göransson

Numerics II – Other approaches

Recently, a number of approaches have been proposed as robust alternatives to purely finite element models. Among these, one could quote the Transfer Matrix Method (TMM), the Wave Based Method (WBM), the Discontinuous Galerkin Methods (DGM) and the Statistical Energy Analysis (SEA), as the most renown. In addition, hybrid models combining finite element models with analytical approaches have proved to be accurate and numerically efficient. This talk will present the principles of several alternates approaches together with practical examples of successful applications of this type of models.
Lectures given by O. Dazel

Invited lecturers

Luc Jaouen • Dr. Luc Jaouen is co-founder and co-manager of MATELYS (France). He is also co-founder of SAPEM cycle of conferences. He has a broad experience of porous media theory. His works cover experimental techniques for both acoustical and mechanical parameter characterization and theoretical modeling of multi-scale materials. From his work at MATELYS, he has a unique experience of the application of porous media research to address industrial concerns. He is also the founder of the APMR website (Acoustical Porous Media Recipes) which is consulted worldwide. MATELYS has been awarded the Research Gold Decibel in 2011 in France and Industry Award from the French Acoustical Society in 2012.

Claude Boutin • Claude Boutin holds a Professor position at ENTPE (France). He is widely renown as a specialist of the so-called homogenisation approaches and up-scaling techniques. He is involved in pioneer works related to double porosity media and morphological modelling both from analytical and numerical approaches. His works have found applications in a wide range of fields, from seismic wave propagation and high rise buildings to micro-porous mechanics and double porosity sound absorbers.

Timothy Van Renterghem • Timothy Van Renterghem has a long-term experience with time domain approaches and is known in the community as a specialist of this type of implementation. Being Professor in the Acoustic group of Gent Univ. (Belgium), he is author or co-author of about 30 peer-reviewed journal publications. He is associate editor for Acta Acustica united with Acustica, the journal of the European Acoustic Association in the field of atmospheric acoustics. He teaches courses on environmental noise, instrumentation, and numerical acoustics at Ghent University in Belgium.

Raymond Panneton • Raymond Panneton is Professor at GAUS lab (Univ. de Sherbrooke-Canada), known among the world's specialists of characterisation techniques for acoustical porous media. He has proposed several techniques which are now commonly used by the community. He has supervised over twenty Master and PhD works related to porous material characterisation. His works spans direct and indirect approaches for the determination of the acoustical, elastical and damping parameters.

Sylvain Berger • Dr. Sylvain Berger is in charge of the acoustic R&D at Saint-Gobain Isover and involved in the acoustic transverse program of Saint Gobain group, which brands (Isover, Eurocoustic, St Gobain Glass, Gypse, ADFORS …) comprise Buildings, Automotive, Railway, Aeronautics, Marine, Domestic appliances applications. He will bring his critical view about the gap crossing from characterisation techniques, predicting models and performance achievement in a highly competitive context and ever shorter time-to-market demands.

Arnaud Duval • Ing. Arnaud Duval is the innovation and research director at Faurecia Acoustic and Soft Trim Division, which is a major automotive supplier working with leading automotive manufacturers. He has lead several cutting edge innovations to industrial standards. He co-authored a dozen of patents related to materials manufacturing and assembling and more than 25 engineering papers. He has been nominated official "Senior Expert" in the field of acoustics for the Faurecia group.

Peter Göransson • Peter Göransson is Professor at the Marcus Wallenberg lab at KTH (Sweden) and is recognized as a world's specialist of the finite element method. He has collaborated to pioneer works related to convergence criteria and proposed several improvements of the numerical efficiency of porous media models. He is daily collaborating with leading manufacturing companies for Automotive, Railway, Aeronautics and Aerospace applications. His talk will be closely coordinated with that of Dr. Olivier Dazel related to numerical techniques other than purely finite element methods.

Olivier Dazel • Olivier Dazel, assistant professor at LAUM (Univ. du Maine-France), has a long track record of successful applications of advanced mathematical techniques for the implementation of porous numerical models. His work is long devoted to the improvement of the efficiency, convergence and accuracy of computational approaches dedicated to porous media. He is also a leading actor for the development of advanced teaching techniques for vibro-acoustics. He will present the numerical methods which are not purely finite element implementations, namely statistical energy analysis (SEA), transfer matrix method (TMM), wave based method and other hybrid approaches. His talk will be closely coordinated with that of Prof. Peter Göransson about purely finite element methods.

Registration form

to be sent by
email : ws-porous.celya@matelys.com
or fax : +33(0)9-81-38-13-80

before January, 14, 2013

First Name:	**Last Name:**
Title:	**Birth Date:**
Organization, University, Company:	**Address (Street Address,City, State, ZIP, Country):**
Phone:	**E-mail Address:**

For a convenient, practical and nice stay, we highly recommend that participants stay at the hotel of the seminar venue.

http://www.valpre.com

Are you applying for free accommodation (only a limited number of participants will be selected, with priority given to young international academics):	**yes**	☐
	no	☐
Date and signature:		

Admission

Applicants are asked to send an application form to ws-porous.celya@matelys.com **before the January 14, 2013**; it should comprise

- the attached registration coupon,
- a motivation letter,
- a short CV,
- a letter of recommendation signed by the head of department or supervisor for PhD students.

There are no registration costs. Lunches and coffee breaks will be offered to all participants during the duration of the winter school.

The total number of participants is limited to 40.

Accommodation

We recommend all participants stay at the Valpré conference center (http://www.valpre.com) where the winter school will take place. Rooms will be automatically booked when registering, unless specifically stated otherwise by the applicant.

A limited number of participants will be offered free accommodation (including the nights of Monday 11th and Thursday 14th) – priority is given to young international academics.

Information about travel and access to the winter school site is available at
http://www.valpre.com/rubriques/haut/acces-contact/acces
http://www.valpre.com/rubriques/haut/acces-contact/plan-dacces-valpre-v.-english-.pdf

Information & Contact

Winter school homepage :

http://apmr.matelys.com/WinterSchool2013

Any special request or information should be sent to :

François-Xavier Bécot, MATELYS

ws-porous.celya@matelys.com

February 12-13-14, 2013

Winter School on the

Acoustics of Porous Media

The study of porous materials has recently received a new - critical – attention because of the urge of preserving our fossil resources. Porous materials are indeed at the heart of innovative solutions for better insulating products and lighter treatments in our transportation.

More specifically, acoustics for porous media have found new perspectives with emerging applications in the field of e.g. seismology, medicine or infrastructure monitoring. To the point where it becomes essential for future leading researchers to have deeper insights into the dissipation mechanisms of porous materials.

The thread of this seminar will try to propose guidelines for selecting the appropriate models and associated characterization techniques together with the modeling tool suited to meet the desired degree of accuracy. Moreover, the experience feedback will assess the relevance of these tools to address industrial problems.

The aim of this winter school is to bring to the attendees the tools to observe, to identify, to predict, to elaborate and to assess the vibro-acoustic properties of porous materials. Free of registration charge, it will gather a selected international audience of young researchers, engineers and PhD students having a broad range of experiences. Lectures will be given by world specialists of each sub discipline of this field of research in a cozy, studious atmosphere.