In addition to ROSE School students, a maximum of 20 external participants may be accepted to the course, under the payment of a 500€ fee. Special financial conditions are, however, in place for University researchers or students, to whom a fee of not more than 300€ is requested.

Those wishing to attend the Course should contact the ROSE School Secretariat.

ROSE **SCHOOL**

c/o EUCENTRE
Via Ferrata, 1 - 27100, Pavia, Italy
Tel./Fax: +39.0382.516933
E-mail: secretariat@roseschool.it
Web-site: www.roseschool.it

Education and Culture

Erasmus Mundus

The European Commission has approved and financed an Erasmus Mundus Masters on Earthquake Engineering and Engineering Seismology (MEEES), coordinated by the ROSE School and featuring also the participation of the University of Grenoble Joseph Fourier (France), the University of Patras (Greece) and the Imperial College of London (UK), as project partners, as well as of Joint Research Centre (Ispra, Italy) and the Italian Institute for Geophysics and Vulcanology (Italy) as satellite participants. Within the framework of this prestigious Erasmus Mundus programme, which aims to enhance quality in European higher education and to promote intercultural understanding through co-operation with third countries, a relatively large number of scholarships are available for both non-European as well as European students. Interested applicants are invited to visit the MEEES website (www.meees.org) for detailed information and instructions on financial conditions and application procedures.

Grafica Eucentre - Pavia Italy

Università degli Studi
di Pavia

ROSE
School

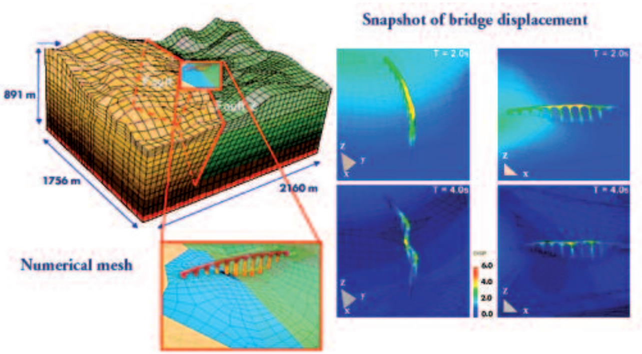
IUSS
Sapere Aude

Istituto Universitario
di Studi Superiori
Pavia

Short Course on

Advanced Computational Methods in Earthquake Engineering and Engineering Seismology

Pavia, March 10-14 2008



• THE SHORT COURSES AT ROSE

In addition to its masters and doctorate programmes, the Centre for Post-Graduate Training and Research in Earthquake Engineering and Engineering Seismology (ROSE School) organises also a series of short courses, with the general aim of providing advanced education in the field of earthquake engineering and engineering seismology. These short courses are characterised by their brief duration (1-2 weeks), with respect to the traditional modules taught at the ROSE School (4-5 weeks) and a focus on a rather specific topic.

• OBJECTIVES OF THE COURSE

Objective of the course is to introduce earthquake engineers, seismologists and geophysicists to state-of-the-art, advanced numerical methods in computational elastodynamics and their application to the solution of a selected number of problems in engineering seismology and earthquake engineering.

The course is organized in four independent technical moduli devoted to the following subjects: stochastic finite elements with applications in computational dynamics, spectral and boundary element methods in engineering seismology and earthquake engineering, substructuring techniques and domain reduction methods in the solution of soil-structure interaction problems. Other advanced topics that are treated include NURBS, SPH and meshless techniques.

For each method the theoretical foundations are first introduced followed by a thorough description of the capabilities and limitations in the solution of initial, boundary-value problems of interest in seismic engineering and geophysics. The effectiveness of the techniques are illustrated through several examples and real case studies. The discussion will be complemented by a detailed investigation of the convergence and stability of the numerical algorithms.

The course is structured to offer an optimum trade-off between the formal development of the theories and their practical implementation through specific numerical codes always emphasizing their range of applicability and possible extensions. It is believed that the course will offer the participants a unique opportunity to be exposed to advanced topics in computational elastodynamics in a unified framework within the context of earthquake engineering and engineering seismology.

The course is fully organised by Prof. *Ferdinando Auricchio* (University of Pavia) and Dr. *Carlo G. Lai* (EUCENTRE). Lectures will be delivered by an international team of renown, first-class specialists in the field of advanced computational mechanics. Among others they are Prof. G. Novati, Prof. A. Frangi, Prof. F. Perotti, Prof. R. Paolucci and Prof. F. Nobile from Politecnico di Milano (Italy), Prof. A. Quarteroni from Ecole Polytechnique Fédérale de Lausanne (Switzerland), Prof. J.F. Semblat from Ecole Polytechnique de Paris (France), Prof. M. Schanz from Technische Universität Graz (Austria), Prof. M. Papadrakakis from National Technical University of Athens (Greece).

• Course Schedule: March 10-14, 2008

Monday 10	**Introduction and solution of dynamic SSI problems**
09:00-11:00	Introduction to the finite element method for elasto-static and elasto-dynamic problems.
11:00-13:00	Formulation of eigenvalue problems. Basic integration algorithms for the dynamical problem.
14:00-16:00	Formulation of dynamic equilibrium equations for discretized soil-structure systems under seismic excitation. The case of large structures under multiple-support excitation.
16:00-18:00	Simplified solutions of the soil-structure interaction problem. The finite element method in structural dynamics. Some modelling issues.
Tuesday 11	**Spectral element method: theory and applications**
09:00-11:00	Introduction of the spectral element method for partial differential equations. Theoretical aspects: stability and accuracy.
11:00-13:00	Algebraic aspects: conditioning, preconditioning, parallelism, efficient iterative solution techniques. Preliminary application to elliptic equations and wave propagation phenomena.
14:00-16:00	Main features of the spectral element code Geo-ELSE (Geo-ELastodynamics by Spectral Elements). Implementation in parallel computing architectures and performance.
16:00-18:00	Case studies: near-fault ground motion in the Grenoble Valley. Earthquake-induced ground strains: the case of the Duzce, Turkey earthquake. Train-induced ground vibrations.
Wednesday 12	**Stochastic finite elements: theory and applications**
09:00-11:00	Representation of random fields. Karhunen-Loeve and Polynomial chaos expansions.
11:00-13:00	Stochastic finite element method: Galerkin formulation and spectral approximation. Collocation formulation and sparse grids. Theoretical foundations and algorithmic aspects.
14:00-16:00	Stochastic field representation of uncertain parameters. Derivation of stochastic stiffness matrices. Solution of stochastic dynamic problems with Monte Carlo simulation.
16:00-18:00	Random eigenvalue analysis. Response variability and system reliability. Reliability-based seismic design of structures. Stochastic dynamic response of structures.
Thursday 13	**Boundary elements methods in elastodynamics**
09:00-11:00	Introduction to the boundary element method (BEM) for linear elastostatics. Derivations of boundary integral equations. Fundamental solutions. Discretization.
11:00-13:00	Unbounded domains. Collocation versus Galerkin approach. Application of the method in the presence of displacement discontinuities (cracks, faults, etc.). Example problems; BEM-FEM coupling approaches.
14:00-16:00	Frequency-domain BEM in elastodynamics: formulation, solution procedures and applications.
16:00-18:00	Analysis of seismic site amplification effects through the boundary element method.
Friday 14	**Boundary elements methods and other techniques**
9:00-11:00	Direct boundary element method in time domain elastodynamics: formulations and solution of example problems.
11:00-13:00	Formulation based on the convolution quadrature method; dual reciprocity method.
14:00-17:00	Isogeometric discretizations in structural dynamics and wave propagation problems, NURBS, T-Splines, SPH and meshless methods.