

PROGRAM

Monday

1. Variational formulations in linear solid mechanics (RLT)

- Strong, weak, variational forms of 1D BVP in linear elasticity
- FEM technology in 1D problems: truss-bar element

2. Numerical implementation in FEM code FEAP (RLT)

- FEM technology in 1D structural problems: Euler-Bernoulli and Timoshenko beam models
- Locking numerical evidences
- Command programming language for problem solution
- Programming in FEAP environment

3. FEM technology for 2D/3D BVP (FA)

- 2D/3D models: thermal and mechanical problems
- Isoparametric elements and numerical integration

4. Enhancing 2D/3D FEM performance – element technology (MB)

- Incompressibility / near incompressibility
- Hybrid and mixed FE
- Enhanced strain FE

5. Structural finite elements (MB)

- Dimensional reduction
- Beam, plate and shell models
- Finite elements for thin-walled structures

Tuesday

6. Enhancing structural FEM performance (MB)

- Shell theory and finite elements
- Assumed strain and enhanced strain FE
- Reduced integration plus stabilization

7. Theoretical foundation of mixed interpolation methods (GS)

- Locking phenomena
- Inf-sup condition

8. Inelastic constitutive behavior at small strains: part I (RLT)

- Inelasticity and plasticity models
- Solution schemes (return map)
- Integration of evolution equations
- Operator split method and consistent tangent modulus
- Locking problems in plasticity
- Choice of element type

9. Inelastic constitutive behavior at small strains: part II (FA)

- Advanced constitutive models (shape-memory alloys)
- Solution schemes (return map)

10. Solution techniques for non-linear dynamical problems (RLT)

- Nonlinear problem solution techniques
- Explicit vs. implicit integration schemes
- Generalized alpha-scheme and schemes for stiff equations
- Solution techniques with computer code FEAP

Wednesday

11. Nonlinear solid mechanics problems at large displacements (FA)

- Kinematics and strain measure at large displacement
- First and second Piola-Kirchhoff, Kirchhoff and Cauchy stress tensors
- Finite element interpolations; consistent linearization

12. Nonlinear constitutive models for large displacements (FA)

- Finite elasticity (stored energy function forms)
- Plasticity at large deformations
- Formulations in reference and current configurations

13. Nonlinear structural mechanics (MB)

- Non-linear structural models
- Solution methods, path following techniques

14. Instability of structures and systems (MB)

- Geometric (buckling) vs. material (localization) instability
- Solution of problems in presence of critical points
- Prebuckling analysis and non-linear stability analysis

15. Contact problems (RLT)

- Formulation of contact problems (penalty, augmented Lagrangian)
- Implementation of mortar method and stress computation
- Impact dynamics and contact

Thursday

16. Isogeometric modeling and analysis (AR)

- Introduction to Splines and NURBS
- Simple investigations

17. Isogeometric modeling and analysis (GS)

- Mathematical features
- Error estimates for NURBS approximations
- Numerical quadrature
- Stable NURBS discretization for incompressible materials

18. Isogeometric modeling and analysis (RLT)

- Computational technologies
- Implementation details for displacement and mixed forms
- Example applications for elastic and inelastic materials

19. Particle methods / SPH / Meshless schemes (AR)

- An introduction to meshless methods
- Smooth particle hydrodynamics and other approaches
- Some recent developments

20. Fluids (MB)

- Basic assumptions/equations, Newtonian Fluids, Euler/Navier Stokes
- Incompressible vs. compressible, laminar vs. turbulent flow, stationary vs. transient solutions
- Finite elements for fluids

Friday

21. Multi-scale problems: part I (RLT)

- Homogenization methods
- Scale bridging using representative volume elements (FE2)
- Parallel implementation details

- Example applications

22. Multi-scale problems: part II (GS)

- Stable methods for convection-dominated fluid problems (SUPG)
- Residual-free bubbles and variational multi-scale framework

23. Fluid-structure interaction (MB)

- Introductory remarks on coupled problems, monolithic vs. partitioned modeling, simultaneous vs. staggered solution
- Solving problems of fluid-structure interaction using finite element Discretization, Arbitrary Lagrangian Eulerian Formulation (ALE)

24. Solution methods for coupled and interaction problems (RLT)

- Experience with large-scale nonlinear problems
- Software architecture and code coupling
- Remarks on computer code development

25. Advanced mathematical/computational issues (GS)

- Instability issues
- Mimetic difference methods
- Locally enriched methods

SECRETARIAT

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Minor changes to the program and to the organization are possible. Interested people are urged to check web-site for updated informations.

REGISTRATION

Early registration is kindly recommended. Registration is transferable to another member of the same organization. Participants should communicate by e-mail a statement of participation to the Secretariat (email: nl10@eucentre.it). Course fees are established as follows:

Participants from industry:	1500 €
Faculty members:	1000 €
PhD, post-doc, students:	800 €

The methods of payment are by credit card through the conference website or by bank transfer to:

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indicating as purpose of payment: "NL10" and the attendee's name. For attendees who register prior to December 31st 2009 a reduction of 200.00 € will be applied. The fee comprises fixed-menu lunches, coffee breaks and electronic copies of transparencies. For cancellations communicated prior to March 1st 2010, the 70% of the registration fee will be refunded. No refund will be made for cancellation after that date.

ORGANIZING COMMITTEE

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COURSE OBJECTIVES

The main objective of this course is to provide engineers who use computer codes, graduate students, and researchers with an extensive review of advanced numerical techniques and solution algorithms for nonlinear mechanics. It presents the current state-of-the-art in finite element modeling of nonlinear problems in solid and structural mechanics. It will illustrate difficulties (and possible solutions), which appear in a number of applications.

All sources of nonlinear behavior are presented in a systematic manner. Special attention is paid to deal with a class of problems with nonlinear constitutive behavior of materials, large deformations, rotations of structures, contact and instability problems with either material (localization) or geometric (buckling) nonlinearities, which are needed to fully grasp weaknesses of structural design. In addition, multi-physics models will be addressed, with a special emphasis of fluid-structure interaction.

The course will also provide insight both on advanced mathematical aspects as well as into the practical aspects of several computational techniques, such as Finite Element Method, isogeometric approximation, meshless technique, mimetic difference. Our second objective is thus to provide the participants with a solid basis for using the computational tools and software in trying to achieve the optimal design, and/or to carry out a refined analysis of nonlinear behavior of structures.

The course finally provides a basis to account for multi-physics and multi-scale effects, which are likely to achieve a significant break-through in a number of industrial applications.

The course material will consist of copies of transparencies from the lectures and survey papers. Copies of Finite Element Analysis Program (FEAP) computer codes, written by Prof. Robert L. Taylor at UC Berkeley, and the complete volume of notes will be made available to all attendees on CD.

LECTURERS

Robert L. Taylor (RLT) obtained his PhD in Engineering in 1963 at the University of California at Berkeley, USA. Subsequently, he was appointed professor in mechanics at the Department of Civil Engineering, where he currently holds the appointment of Professor at UC Berkeley Graduate School. He has become a member of US National Academy of Engineers in 1992, and since has received a number of distinctions (including the von Neumann Medal of IACM) and honorary doctorates, such as the ones from University of Wales at Swansea, UK and University of Hannover, Germany. The scientific contribution of Prof. Taylor count more than 200 papers in scientific journals, co-authorship with Prof. Olek Zienkiewicz of the most well-known books on finite element method, as well as the finite element computer program FEAP.

Manfred Bischoff (MB) obtained his PhD at the University of Stuttgart, Germany, in 1999. Since 2006 he is Full Professor and head of the Institute of Structural Mechanics at the University of Stuttgart. In 2000 he won the EUROMECH European Young Scientist Award and in 2008 the IACM Young Investigator Award. Since 2008 he is elected member of the executive council of the German Association of Computational Mechanics (GACM). His main research topics span over nonlinear computational structural mechanics, theory of shells, modeling and analysis of shells with finite elements, finite element technology, structural optimization, multifield and multiscale problems, contact problems and computational material modeling.

Ferdinando Auricchio (FA) obtained his PhD at the University of California at Berkeley, USA in 1995 and is Full Professor of Mechanics of Solids at the University of Pavia, Italy since 1998. He is Research Associate at the Institute for Applied Mathematics of CNR. His main research topics span over constitutive modeling of innovative materials, biomechanics and finite element methods. He is Member of IUSS (Istituto Universitario di Studi Superiori) CeSNA scientific committee (directed by Brezzi) and Professor at the "European School for Advanced Studies on Seismic Risk Reduction". He has published more than 80 papers in international refereed journals and has been invited to give about 50 seminars at international and national institutions.

Giancarlo Sangalli (GS) received his Laurea degree (1997) in Mathematics at the University of Pavia and his PhD (2001) in Mathematics at the University of Milano. Since 2001 to 2005 he was Researcher at the Institute for Applied Mathematics of CNR, and he is currently Associate Professor at the Mathematics Department at the University of Pavia. His main research interests are isogeometric analysis, numerical methods for the domain decomposition, multiscale numerical methods, analysis of the linear diffusion-convection-reaction operator and of its discretizations.

Alessandro Reali (AR) received his Laurea degree (2001) in Civil Engineering at the University of Pavia and his MSc (2004) and PhD (2005) in Earthquake Engineering at the ROSE School (IUSS and University of Pavia). Since 2005 he worked as a Post-doctoral Fellow at the Department of Structural Mechanics, University of Pavia, where he is currently Assistant Professor of Mechanics of Solids (since 2008). His main research interests are isogeometric analysis, advanced material constitutive modeling, mixed finite elements, and numerical techniques for fast dynamics.

COURSE SCHEDULE

9.00-10.00	Lecture 1	14.00-15.00	Lecture 4
10.00-10.15	Coffe break	15.00-15.15	Coffe break
10.15-11.15	Lecture 2	15.15-16.15	Lecture 5
11.15-12.15	Lecture 3	16.15-17.00	Open discussion
12.15-14.00	Lunch		

LOCATION

The course will be held at IMATI-CNR (Institute of Applied Mathematics and Information Technologies) in Via Ferrata,1 - 27100 Pavia.

ACCOMMODATION

Participants have to proceed with personal reservations. A list of possible hotels in Pavia is provided for convenience.

Hotel Moderno Pavia ****	www.hotelmoderno.it
Hotel Cascina Scova ****	www.cascinascova.it
Hotel Rosengarten ***	www.rosengarten.pv.it
Excelsior Hotel ***	www.hotelrizpavia.com
Hotel Aurora **	www.albergoaurora.com



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