Program

Monday, 14 May 2007

1. Variational formulations in nonlinear solid mechanics (AI)
- Strong, weak and variational forms of 1D BVP in linear and nonlinear elasticity
- Basic solution methods: Gauss elimination and Newton iterations
- 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
- Macro command programming language
- Programming in FEAP environment

3. FEM technology for 2D/3D BVP in elasticity (AI)
- 2D/3D models: thermal and mechanics problems
- Isoparametric elements and numerical integration
- Non-conventional interpolations and solid elements with drilling degrees of freedom

4. Enhancing FEM performance – element technology (RLT/FA)
- Structural models: plates and shells
- Hybrid and mixed models
- Enhanced strain models

Tuesday, 15 May 2007

5. Theoretical foundation of mixed interpolation methods (FB)
- Locking phenomena
- Inf-sup condition
- Stabilization techniques

6. Inelastic constitutive behavior at small strains (AI)
- Thermomechanics with internal variables
- Refined constitutive models of plasticity, damage and coupled damage-plasticity
- Solution of weak form with internal variables

7. Implementation and performance of nonlinear constitutive models in FEM framework (RLT)
- Integration of evolution equations
- Operator split method and consistent tangent modulus
- Locking problems in plasticity
- Choice of element type

8. Solution techniques and element performance for non-linear problems (RLT)
- Nonlinear problem solution techniques
- Explicit vs. implicit integration schemes
- Generalized a-scheme and schemes for stiff equations
- Solution techniques with computer code FEAP

9. Advanced costitutive models (FA)
- Refined constitutive models of plasticity
- Inelastic models for solid phase transitions

Wednesday, 16 May 2007

10. Discontinuous Galerkin methods (FB)
- Introduction to DG methods
- DG methods for nearly incompressible materials
- DG methods for Reissner-Mindlin plates

11. Nonlinear solid mechanics problems at large displacements (AI)
- Kinematics and strain measure at large displacement
- Piola-Kirchhoff first and second stress tensors
- Finite element interpolations; Consistent linearization

12. Nonlinear constitutive models for large displacements (AI)
- Nonlinear elasticity and poly-convexity conditions
- Constitutive law at large deformations: plasticity
- Lagrangian and Eulerian formulations

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

14. Solution techniques for non-linear transient problems (RLT)
- Nonlinear heat transfer, nonlinear dynamics
- Explicit vs. implicit integration schemes
- Generalized a-scheme and schemes for stiff equations

Thursday, 17 May 2007

15. Nonlinear structural mechanics / I (AI)
- Computational aspects of large 3D rotations
- Geometrically exact beam model of Reissner and Simo
- Locking problems for structures

16. Nonlinear structural mechanics / II (AI)
- Geometrically exact shell models with or without drilling rotations
- Locking problems in shells
- Dynamics and time-integration schemes for shells

17. Flexible multibody system dynamics (RLT)
- Formulation of multibody systems: holonomic and non-holonomic constraints
- Modeling of flexible multibody systems and cost reduction: rigid component approximation

18. Instability of structures and systems (AI)
- Geometric instability: (buckling) vs. material instability (localization)
- Solution of problems in presence of critical points
- Dynamic instability problems

19. Advanced aspects of multi-physics problems (AI)
- Modeling of nonlinear multi-physics problems
- Thermomechanical coupling: isothermal and adiabatic operator split

Friday, 18 May 2007

20. Mathematical considerations on advanced FE techniques (FB)
- Contact problems
- Post-processing and solution recovery

21. Advanced aspects of multi-scale problems (AI)
- Multi-scale models of inelastic behavior
- Microstructure representation
- Heterogeneities of real materials and probability approach

22. Solution methods for coupled and interaction problems (RLT)
- Experience with large-scale nonlinear problems
- Software architecture and code coupling
- Remarks on computer code development

Lecturers

Franco Brezzi is professor of Mathematical Analysis at the IUSS (Istituto Universitario di Studi Superiori) of Pavia, Italy, Member of the Scientific Committee of the Italian Society for Industrial and Applied Mathematics (SIMAI), President of the UMI (Italian Mathematical Union), President of the CNR-University of Pavia joint Committee and Coordinator of the IUSS Ph.D. Program. He is the Director of the Institute for Applied Mathematics and Information Technologies of the italian National Research Council (CNR), Member of the Kuratorium of the Johann Radon Institute for Computational and Applied Mathematics (RICAM) of the Austrian Academy of Sciences and Member of the Conseil Scientifique of the National Center for Scientific Researches (CNRS) of France.
His pioneering research activity on the finite element method in various application fields has made Pavia with his numerous students a worldwide renowned mathematical school on this subject.

Adnan Ibrahimbegovic obtained his engineering education in Sarajevo (winner of 1986 Fulbright Grant), PhD at the University of California at Berkeley, USA and Habilitation at the University of Pierre and Marie Curie (Paris VI), France. He has held professorships and research positions at four different universities (including UC Berkeley, EPFL in Switzerland, UTC, France and currently ENS-Cachan in France). He is the past Chairman of ENS-Cachan Civil Engineering Department, Master Program MaiSE and Head of Civil Engineering Division of LMT-Cachan, the largest French laboratory in mechanics. He has received a number of international distinctions, including IACM Fellow Award, Humboldt Prize for senior researchers for Germany and International Fellow NSERC Award for Canada. He has published over 100 papers in scientific journals and an advanced textbook in French on nonlinear computational solid mechanics.

Robert L. Taylor 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 the Professor at the 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.

Ferdinando Auricchio obtained his PhD at the University of California at Berkeley, USA in 1995 and is professor of Solid Mechanics at the School of Engineering of the University of Pavia, Italy since 1998. He is Research Associate at the Institute for Applied Mathematics and Information Technologies of the italian National Research Council (CNR). His main research topics span over constitutive modeling of innovative materials, biomechanics and finite element methods. He is the President of the Italian local ECCOMAS Association (GIMC). He is also Member of the scientific committee of the IUSS (Istituto Universitario di Studi Superiori) of Pavia, member of the “Lagrange laboratory” and professor at the “European School for Advanced Studies on Seismic Risk Reduction”. He has published more than 60 papers in international refereed journals and has been invited to give about 30 seminars at international and national institutions.

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 FE based numerical models 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, and their coupling with thermal fields. It will illustrate the difficulties (and their solutions), which appear in a number of applications from mechanical, aerospace, or civil engineering and material science.
All the sources of nonlinear behavior are present in a systematic manner, related to kinematics, equilibrium, constitutive equations, or boundary and coupling conditions. Special attention is paid to dealing with a class of problems with nonlinear constitutive behavior of materials, large deformations, and rotations of structures, contact and instability problems with either material (localization) or geometric (buckling) nonlinearities, which are needed to fully grasp any weakness of a particular structural design near the ultimate limit state. In addition, multi-physics models will be addressed, with a special emphasis of thermal coupling and fluid-structure interaction.
The course will also provide insight into the practical aspects of the Finite Element Method, related to making the choice of a particular element type, the constitutive model, or integration scheme among those available in advanced computer codes. Our second objective is thus to provide the participants with a solid basis for using the FEM based models and software in trying to achieve the optimal design, and/or to carry out a refined analysis of nonlinear behavior of structures or multibody systems. The course finally provides a basis to account for any pertinent 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, survey papers by the lecturers, recent manuscripts not yet in press and lecture notes. The copies of computer codes Finite Element Analysis Program (FEAP), written by Prof. Robert L. Taylor at UC Berkeley, and the complete volume of notes will be made available to all attendees. Two advanced textbooks edited by A. Ibrahimbegovic on "Multi-physics and multi-scale computer models for nonlinear analysis and optimal design of engineering structures", 2005 and on "Extreme man-made and natural hazards in dynamics of structures", 2007 will be made available with a full fee subscription (for participants from industry).

Organizing Committee

- Prof. Ferdinando Auricchio (auricchio@unipv.it)
- Dr. Edoardo Artioli (artioli@imati.cnr.it)
- Dr. Alessandro Reali (alessandro.reali@unipv.it)

Secretariat

NL07 Secretariat c/o IMATI – CNR
Via Ferrata,1 - 27100 Pavia, Italy
☎ + 39 0382 548229 🖷 + 39 0382 548300
e-mail: NL07@imati.cnr.it
web: http://www.imati.cnr.it/nl07/

Location

The course will be held at IMATI - C.N.R (Institute of Applied Mathematics and Information Technologies) in Pavia.

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 (NL07@imati.cnr.it). Course fees are established as follows:

- Participants from industry: 1500.00 €
- Faculty members: 1000.00 €
- PhD, post-doc, students: 750.00 €

Payment should be transferred to:
Dipartimento di Meccanica Strutturale
Banca Regionale Europea SpA – Agenzia Strada Nuova – Pavia
account: 467
IBAN: IT02C0690611301000000000467
SWIFT: BLOPIT22XXX.
with mention "NL07 course fee" and indication of attendee's name.
For attendees who register prior to February 28th 2007 a reduction of 300.00 € will be applied. The fee comprises fixed-menu lunches, coffee breaks and electronic copies of transparencies. Full fee subscribers (participants from industry) will be given also two advanced textbooks by Adnan Ibrahimbegovic. For cancellations comunicated prior to April 15th 2007, the 70% of the registration fee will be refunded. No refund will be made for cancellation after that date.

Accomodation

Participants are advised to make their own hotel reservation. A list of hotels in Pavia is provided for convenience.

Moderno Hotel Pavia ★★★★
27100 Pavia (PV) - Viale Vittorio Emanuele, 41
☎ + 39 0382 303401 🖷 + 39 0382 25225
www.hotelmoderno.it
info@hotelmoderno.it

Hotel Rosengarten ★★★
27100 Pavia (PV) - Piazza Golgi, 21/23
☎ + 39 0382 526312 🖷 + 39 0382 525186
www.rosengarten.pv.it
rosengartenpv@tin.it

Excelsior Hotel ★★★
27100 Pavia (PV) - Piazzale Stazione, 25
☎ +39 0382 28596 🖷 +39 0382 26030
http://www.hotelrizpavia.com
info@excelsiorpavia.com

Hotel Ariston ★★★
27100 Pavia (PV) - Via Scopoli, 10
☎ + 39 0382 34334 🖷 + 39 0382 25667
www.aristonpavia.it
ariston@aristonpavia.it

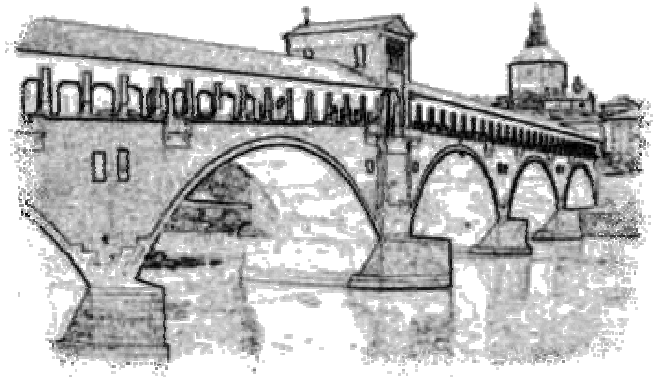
Department of Structural Mechanics
Facoltà di Ingegneria
Università degli Studi di Pavia

NONLINEAR COMPUTATIONAL SOLID & STRUCTURAL MECHANICS

Theoretical formulation, FEM technology and computations

Pavia

May 14-18, 2007



sponsored by

imati

EUCENTRE