



**An ECCOMAS
Advanced Course
on
Computational
Structural
Dynamics**

Institute
of Thermomechanics
Academy of Sciences
of the Czech Republic

Prague
Czech Republic

June 13-17, 2016

Lecturers

Prof. K.C. Park

University of Colorado,
Boulder, USA

Prof. Roger Ohayon

Conservatoire National
des Arts et Métiers, Paris, France

Prof. Alain Combescure

Institut National des Sciences
Appliquées, Lyon, France

Prof. Adnan Ibrahimbegovic

Université de Technologie
Compiègne/ Sorbonne Universités,
France

Prof. Miloslav Okrouhlík

Institute of Thermomechanics,
Prague, Czech Republic

Dr. Jiří Plešek

Institute of Thermomechanics,
Prague, Czech Republic

Prof. Jaroslav Kruis

Czech Technical University in Prague,
Czech Republic

Prof. José González

Universidad de Sevilla, Spain

Dr. Anton Tkachuk

University of Stuttgart, Germany

Dr. Radek Kolman

Institute of Thermomechanics,
Prague, Czech Republic

Topics:

The course covers topics relating to modern and recent numerical methods in *computational structural dynamics*, finite element method in linear and nonlinear dynamic cases, wave propagation in solids and its numerical solution, numerical methods in dynamic crack propagation problems, modern methods for direct time integration and partitioned analysis (domain decomposition methods, FETI, etc.), modal and spectral analysis, coupled problems in mechanics (e.g. fluid-structure interaction), vibroacoustic problems and many others.

The short course is organized under

- European Community on Computational Methods in Applied Sciences
- Central European Association for Computational Mechanics
- Czech Society for Mechanics
- Institute of Thermomechanics, Academy of Sciences of the Czech Republic

Fee of short course:

Early fee (up to March 15, 2016)*

400 EUROS - for students and post-docs (confirmation needed)

500 EUROS - for junior and senior researchers

600 EUROS - for industry and private sector

Regular fee (deadline April 30, 2016)*

500 EUROS - for students and post-docs (confirmation needed)

600 EUROS - for junior and senior researchers

700 EUROS - for industry and private sector

**Course fees for ECCOMAS, CEACM and CSM members are reduced by 5%.*

Short course fees include hard copy of lectures, coffee breaks, social program.

Venue: CTU campus, Prague, Dejvice

WWW: shortcourse2016.it.cas.cz

E-mail: shortcourse2016@it.cas.cz

Contact person: Dr. Radek Kolman
(Institute of Thermomechanics,
Academy of Sciences of the Czech
Republic; kolman@it.cas.cz)

Program of the short course:

Monday

1. Basics of dynamics

(M. Okrouhlik)

Historical background

Newton's laws

Newtonian, Lagrangian and Hamiltonian mechanics

2. Continuum mechanics I

(J. Plešek)

Kinematics of deformations

Strains and stresses

Governing equations

Strong form and boundary conditions

3. Continuum mechanics II

(J. Plešek)

Constitutive equations for small and large deformations

Elasticity and plasticity theory

Thermodynamics of continuum mechanics

4. Continuum mechanics III

(R. Ohayon)

Variational formulations in linear dynamics and vibrations

Modal analysis

Rayleigh quotient, Hamilton's principle

5. Dynamics of multibody systems

(A. Ibrahimbegovic)

Governing equations

Constraints

Lagrange equations and Lagrange multipliers

Numerical methods in multibody dynamics

Tuesday

6. Finite element method I

(J. González)

Basics of FEM and discretization

Weak formulation, stiffness matrix and assembling

Application of boundary conditions

Convergence properties of FEM

7. Finite element method II

(A. Ibrahimbegovic)

Shape functions and higher order FEM

Isoparametric formulation

Numerical integration

Hybrid and mixed formulation, inf-sup condition

8. Finite element method III

(A. Tkachuk)

Locking phenomena and hourglass effect

Assumed strain, enhanced strain FEM, B-bar formulation

Reduced integration and stabilization

9. Finite element method IV

(J. Kruis)

Linear solvers in FEM

Matrix factorization

Sparse solvers, Krylov methods (especially conjugate gradient method)

10. Finite element method V

(A. Ibrahimbegovic)

FEM for nonlinear problems

Solvers for nonlinear static problems - NR, BGFS, semi-Newton methods, etc.

Convergence criteria

Wednesday

11. Finite element method VI

(J. Kruis)

FEM in vibration problems, mass matrix

Spectral and modal analysis

Numerical methods for eigen-value problem (subspace iteration, etc)

Convergence of FEM in eigen-value problem

Dynamic steady state response

12. Direct time integration in dynamics I

(R. Kolman)

FEM in linear dynamics, formulation of dynamic problems

Lumping for mass matrices

Introduction into direct time integration -

basic methods (Newmark method and central difference method)

Stability, order and accuracy

13. Finite element method VI

(A. Ibrahimbegovic)

Dynamic problems

Solving of nonlinear time-depend problems

14. Finite element method VII

(A. Combescure)

Basics of shell theory

FEM shell models

FEM for shells in dynamics

Mass matrices for shells

15. Direct time integration in dynamics II

(A. Tkachuk)

Time step size estimates – global/local estimate in FEM

Treatment of time step size – mass scaling, bi-penalty, etc

Application in crash problems

Thursday

16. Modal reduction and reduction methods in dynamics

(R. Ohayon)

Variational analysis of dynamic sub-structuring

Substructuring analysis in discretized case

Hurty and Craig-Bampton methods

17. Partitioned analysis I

(K.C. Park)

Theory of Lagrange multipliers

Basic theory of partitioned analysis

Equations of motion for partitioned systems

18. Dynamic contact problems

(A. Tkachuk)

FEM in contact problems

Penalty method

Augmented Lagrangian method

Mortar methods

19. Partitioned analysis II

(K.C. Park)

Domain decomposition methods

Finite element tearing and interconnect

(FETI)

Coupling of FEM/FEM

20. Finite element method VII – wave propagation

(R. Kolman)

Theory of wave propagation in elastic solids

Wave speeds in solids

Dispersion and frequency analysis of FEM

Spurious oscillations and improving of standard methods

Friday

21. Modern methods of direct time integration

(A. Combescure)

Generalized time schemes

Asynchronous and variational schemes

Sub-cycling methods, coupling of different time schemes

22. Coupled problems –

Fluid-structures interactions

(K.C. Park)

Variational formulation

Methods of discretizations

Staggered analysis

23. Boundary element method

(J. González)

Theory of BEM

Numerical aspects of BEM

Coupling FEM/BEM

24. Numerical Methods for dynamic crack propagation

(A. Combescure)

Extended finite element method (XFEM)

Meshless methods and Level-set methods

Cohesive models in FEM

25. Vibro-acoustic/elasto-acoustic modelling

(R. Ohayon)

General local equations of vibroacoustic problem

Choice of unknown fields and variational formulations of the problem

Finite element discretization and reduced

order models for the interior problem