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
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Prof. Roger Ohayon
Conservatoire National
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Prof. Alain Combescure
Institut National des Sciences
Appliquées, Lyon, France
Prof. Adnan Ibrahimbegovic
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Prof. Jaroslav Kruis
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Prof. José González
Universidad de Sevilla, Spain
Dr. Anton Tkachuk
University of Stuttgart, Germany
Dr. Radek Kolman
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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. Okrouhlík)
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
Constrains
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

Thuersday

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)
Varionational formulation
Methods of discetizations
Staggered analysis

23. Boundary element method
(J.González)
Theory of BEM
Numerical aspects of BEM
Coupling FEM/BEM

24. Numercial 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 inerior problem