



Short Course on  
**Non-linear Finite Element  
Analysis with particular Focus  
on Time-Dependent Problems**



21-23 February 2017 Poznań, Poland

**Instructor: Prof. Stefan Hartmann**

Institute of Applied Mechanics

Faculty of Mathematics/Computer Science and Mechanical Engineering

Clausthal University of Technology, Germany

<https://www.itm.tu-clausthal.de/en/institut/personal/professoren/prof-dr-ing-stefan-hartmann/>

The three-day course on **Non-linear Finite Element Analysis with particular Focus on Time-Dependent Problems** is organized by the Polish Association for Computational Mechanics together with the Commission of Mechanical and Civil Engineering Sciences of the Polish Academy of Sciences, Poznań Branch, and will take place at the **Poznan University of Technology** in Poznań on **21 – 23 February 2017**.

### Course Objective

The numerical treatment of incorporating constitutive models of solid materials in finite element programs is already known. This course, however, treats the interpretation of the entire space and time integration, where the results of spatial discretization using finite elements will yield, depending on the underlying problem, systems of algebraic, ordinary differential or even their combinations, i.e. differential-algebraic equations (DAE). The solution of these systems, particularly, of time-dependent problems (models of viscoelasticity, rate-independent plasticity, viscoplasticity, and thermo-mechanically coupled problems) is treated.

### Course Outline (9 x 2 hours)

1. Recapitulation of 3D small strain elasticity
2. Viscoelasticity, rate-independent plasticity, viscoplasticity
3. Principle of virtual displacements and its discretization using finite elements
4. Temporal discretization using the Backward-Euler method to solve DAEs
5. Newton-Raphson method versus Multilevel-Newton method
6. Higher order time discretization using diagonally-implicit Runge-Kutta methods
7. Time-adaptivity
8. Extension to finite deformations
9. Thermo-mechanics
10. (Thermo-)Dynamics

### Reference Texts (recommended):

- Ellsiepen, P. and Hartmann, S. (2001). Remarks on the interpretation of current non-linear finite-element analyses as differential-algebraic equations. *International Journal for Numerical Methods in Engineering* **51**:679–707.
- Hartmann, S. (2002). Computation in finite strain viscoelasticity: finite elements based on the interpretation as differential-algebraic equations. *Computer Methods in Applied Mechanics and Engineering* **191**(13-14):1439–1470.
- Hartmann, S. (2005). A remark on the application of the Newton-Raphson method in non-linear finite element analysis. *Computational Mechanics* **36**(2):100–116.

- Grafenhorst, M., Rang, J., Hartmann, S. (2017): Time-adaptive finite element simulations of dynamical problems for temperature-dependent materials, *Journal of Mechanics of Materials and Structures* **12**(1), 57 – 91.

A manuscript on *Theory of Materials* will be provided.

### Who Will Benefit

Researchers in (thermo)mechanics and computational mechanics or those which are interested in the background of implicit finite element programs.

**Course Fees:** 200 €(800 PLN) will include course notes, coffee breaks, dinner and certificate.

For details on payment, please see the website: <http://www.ptmkm.pl/course/node/75>

### Biographical sketch of Instructor



Professor Hartmann's research interests are experimental mechanics for solid materials, constitutive modelling, finite elements of coupled problems with the focus on high order time integration, and material parameter identification. He published 50 journal papers, 80 scientific contributions, and 2 books on applied mechanics. He also (co-)edited 6 books/journal special issues and co-organized numerous meetings. Prof. Hartmann is member of the Association of Applied Mathematics and Mechanics (GAMM) and the German Association of Computational Mechanics (GACM), Chairman of the national section of the GAMM (DeKoMech), and Vice-President of the Clausthal Association of Applied Mechanics (CFAM).

### Accommodation

List of PUT dormitories (0.2 km, room prices: 50-160 PLN):

#### DS1

ul. Jana Pawła II 28  
61-139 Poznań  
tel.: +48 61 6652536  
email: DS-1@put.poznan.pl

#### DS2

ul. Jana Pawła II 26  
61-139 Poznań  
tel.: +48 61 6652513  
email: DS-2@put.poznan.pl

#### DS3

ul. Kórnicka 5  
61-132 Poznań  
tel.: +48 61 6652626  
email: DS-3@put.poznan.pl

List of hotels:

#### Hotel Ibis Poznań Centrum (0.5 km)

ul. Kazimierza Wielkiego 23, 61-863 Poznań  
tel.: +48 61 8584400, fax: +48 61 8584444  
email: H3110@accor.com

#### Novotel Poznań Malta (2 km)

ul. Termalna 5, 61-028 Poznań  
tel: +48 61 6543114, fax: +48 61 6543195  
email: H0525-RE@accor.com

#### Hotel Park Poznań (1.7 km)

abpa A.Baraniaka 77, 61-131 Poznań  
tel.: +48 61 8741153, fax: +48 61 87 41 200  
email: hppoznan@hotelepark.pl

#### IBB Andersia Hotel (1.7 km)

plac Andersa 3, 61-894 Poznań  
tel.: +48 61 6678100, -110  
email: rezerwacja@andersiahotel.pl

In order to book a room please contact the hotel directly.

### Contact

#### Polish Association for Computational Mechanics

ul. Piotrowo 5, 61-138 Poznań  
tel.: +48 61 6652454, 6652457, fax: +48 61 8766116, 6652059  
email: towarzystwo@ptmkm.pl  
www: [www.ptmkm.pl/course](http://www.ptmkm.pl/course)