

## TIME TABLE

TIME	Monday July 27	Tuesday July 28	Wednesday July 29	Thursday July 30	Friday July 31
9.00 - 9.45	Registration	Shaw	Pfeiffer	Shabana	Shaw
9.45 - 10.30	Pfeiffer	Shaw	Pfeiffer	Shabana	Shaw
11.00 - 11.45	Bremer	Wriggers	Raous	Pfeiffer	Pfeiffer
11.45 - 12.30	Bremer	Wriggers	Raous	Raous	Pfeiffer
14.00 - 14.45	Shabana	Bremer	Shaw	Wriggers	
14.45 - 15.30	Shabana	Bremer	Shaw	Wriggers	
16.00 - 16.45	Raous	Shabana	Wriggers	Bremer	
16.45 - 17.30	Raous	Shabana	Wriggers	Bremer	

## ADMISSION AND ACCOMMODATION

The registration fee is of 575,00 Euro + VAT taxes\*, where applicable (bank charges are not included).

The registration fee includes a complimentary bag, four fixed menu buffet lunches (Friday subject to numbers), hot beverages, downloadable lecture notes and wi-fi internet access.

Applicants must apply at least one month before the beginning of the course. Application forms should be sent on-line through our web site: <http://www.cism.it> or by post.

A message of confirmation will be sent to accepted participants. If you need assistance for registration please contact our secretariat.

Applicants may cancel their course registration and receive a full refund by notifying CISM Secretariat in writing (by email) no later than two weeks prior to the start of the course.

If cancellation occurs less than two weeks prior to the start of the course, a Euro 50,00 handling fee will be charged. Incorrect payments are subject to Euro 50,00 handling fee.

A limited number of participants from universities and research centres who are not supported by their own institutions can be offered board and/or lodging in a reasonably priced hotel or students' dormitories, if available.

Requests should be sent to CISM Secretariat by **May 27, 2015** along with the applicant's curriculum and a letter of recommendation by the head of the department or a supervisor confirming that the institute cannot provide funding. Preference will be given to applicants from countries that sponsor CISM.

Information about travel and accommodation is available on our web site, or can be mailed upon request.

\* Italian VAT is 22%.

*For further information please contact:*

CISM  
Palazzo del Torso  
Piazza Garibaldi 18  
33100 Udine (Italy)  
tel. +39 0432 248511 (6 lines)  
fax +39 0432 248550  
e-mail: [cism@cism.it](mailto:cism@cism.it)

Centre International des Sciences Mécaniques  
International Centre for Mechanical Sciences



ACADEMIC YEAR 2015  
The Nieuwstadt Session

## THE ART OF MODELING MECHANICAL SYSTEMS

CISM-AIMETA Advanced School  
coordinated by

**Friedrich Pfeiffer**  
Technical University of Munich  
Germany

**Hartmut Bremer**  
Johannes Kepler Universität Linz  
Austria

Sponsored by



Udine July 27 - 31 2015

# THE ART OF MODELING MECHANICAL SYSTEMS

Engineering and Physics cannot be thought of without models; models, which represent the real world to the best of our knowledge. And, before starting with any mathematical description, we must establish something like a phenomenological picture, a symbolic map of the real world's structures with elements like masses, springs, dampers, fluid system, thermodynamic elements and so forth and with elements of interconnections.

This first step of mechanical modeling is mostly underestimated, but it decides very substantially about the success of all following activities like mathematical modeling, numerical algorithms and finally computer codes. Therefore, it is worth looking at that more systematically, in spite of the fact that there do not exist systematic approaches to these problems. Establishing models includes very strong phenomenological issues.

Models should be as simple as possible and so complex as necessary, not more and not less. And all this is still more an art than a science.

Good modeling requires a deep insight into the performance of the real world's objects, may it be a machine, a building, an airplane or human walking. We must understand how it works, in terms of operations, functions, dynamics, kinematics, stability and deformation, noise and wear under given leading conditions. But this is only one important precondition. Other aspects are the goals and requirements of models.

Firstly, very simplified models might nevertheless represent the main features of a problem in such a way that they provide some physical insight, especially with regard to parameter influences. Secondly, we may establish models by considering as many details as

possible. Such models are large, costly and sometimes leading to cloudy results. But done in a skillful way such models are the basis for physical understanding and for improving design. Thirdly, we may find models with similar features as our real world case, but only in a more qualitative sense. This might help sometimes to understand the physical background of a problem.

From all this we know, that modeling mechanical systems requires insight and intuition. The course concerned with such a topic aims at presenting some rules for mechanical models in a more general systematic way, always in combination with small and large examples, many from industry, able to illustrate the most important features of modeling. It will be not a course presenting mathematical solution algorithms, but discussing the best way to a good solution. The course has a strong focus on the art of modeling.

The course is addressed to researchers and engineers from academia and from industry, to doctoral students and to postdocs, working in the fields of mechanical, civil and electrical engineering as well as in fields like applied physics or applied mathematics.

## INVITED LECTURERS

**Hartmut Bremer** - Johannes Kepler Universität Linz, Austria  
*6 lectures on:*

Fast moving robots: stationary, mobile, redundant: Modelling the physical world of robots: Ingredients and mathematical description (rigid and/or elastic bodies; holonomic and/or non-holonomic variables; which strategies are most effective?); Modelling the control plant: justifiable neglects; Simulation and experimental verification (towards industrial knowledge transfer).

**Friedrich Pfeiffer** - Technical University of Munich, Germany  
*6 lectures on:*

On problems of modeling large dynamical systems, choice of the DOF, neglects, reduction, industrial examples: models – from a real world to a virtual world; the problem of small and large models; simplifications and neglects; typical examples.

**Michel Raous** - Lab. de Mécanique et d'Acoustique, Marseille, France  
*5 lectures on:*

Art of modeling in contact mechanics; choosing a model : complexity (contact, friction, adhesion, ...), scales (and multi-scales), discrete and continuous approaches, identification and sensitivity to the parameters, numerical simulation and computations, regularization and consequences ; constructive aspects of mathematical analysis regarding an experiment, an industrial problem or a simulation.

**Ahmed Shabana** - University of Illinois at Chicago, IL, USA  
*6 lectures on:*

Considering of flexible bodies, method for developing flexible body models, fundamental differences between different approaches: flexible multibody system dynamics, introduction; small deformation problem; large deformation problem; computational geometry (CG), finite element (FE), and Multibody System (MBS) algorithms; future MBS algorithms.

**Steven Shaw** - Michigan State University, East Lansing, MI, USA  
*6 lectures on:*

General area: modeling for nonlinear behavior in dynamic systems: when should one account for nonlinear behavior in vibrating systems; modeling and scaling for asymptotic analysis; the curse of modeling for dissipation: damping and friction; modeling with symmetry: systems of order-tuned torsional vibration absorbers; multi-physics modeling of Micro Electro-Mechanical Systems (MEMS) resonators; the connection between dissipation and noise in micro- and nano-scale resonators.

**Peter Wriggers** - Leibniz Universität Hannover, Germany  
*6 lectures on:*

Art of modeling in solid mechanics: examples of engineering problems in civil and mechanical engineering; classical modeling using reduced models, the art of engineering; use of modern simulation tools: advantages and possible drawbacks; automatic reduction of complex models.

## LECTURES

All lectures will be given in English. Lecture notes can be downloaded from the CISM web site, instructions will be sent to accepted participants.

## PRELIMINARY SUGGESTED READINGS

Bremer, Hartmut  
Elastic Multibody dynamics, Springer Verlag London Berlin Heidelberg, 2008.

Brogliato, Bernard  
Nonsmooth Mechanics, Springer Verlag London Berlin Heidelberg, 1999.

Magnus, Kurt, Popp, Karl  
Schwingungen, Teubner Studienbücher Mechanik, B.G.Teubner Stuttgart 1997.

Nayfeh, Ali, Balachandran, Balakumar  
Applied Nonlinear Dynamics, Wiley Series in Nonlinear Science, John Wiley & Sons, Inc., New York, 1995.

Pfeiffer, Friedrich  
Mechanical System Dynamics, Springer Berlin Heidelberg, 2008.

Martins, João A.C., Raous, Michel (Eds),  
Friction and instabilities, CISM Courses and Lectures, Springer Verlag, n°457, Wien-New York, 2002.

Shabana, Ahmed, A.  
Dynamics of Multibody Systems, Cambridge University Press, Cambridge, New York, 2005.

Wriggers, Peter  
Computational Contact Mechanics, 2nd edition, Springer, 2006.  
Nonlinear Finite Element Methods, Springer, 2008.

**THE ART  
OF MODELING MECHANICAL SYSTEMS**

**Udine, July 27 - 31, 2015**

**Application Form**

(Please print or type)

Surname \_\_\_\_\_

Name \_\_\_\_\_

Affiliation \_\_\_\_\_

Address \_\_\_\_\_

\_\_\_\_\_

E-mail \_\_\_\_\_

Phone \_\_\_\_\_ Fax \_\_\_\_\_

**Method of payment upon receipt of confirmation (Please check the box)**

*The fee is 575,00 Euro + 22% Italian VAT taxes, where applicable (bank charges are not included).*

I shall send a check of Euro \_\_\_\_\_

Payment will be made to CISM - Bank Account No. 094570210900,  
VENETO BANCA - Udine (CAB 12300 - ABI 05035 - SWIFT/BIC  
VEBHIT2M - IBAN CODE IT46 N 05035 12300 09457 0210900).  
Copy of the receipt should be sent to the secretariat

I shall pay at the registration counter with check or VISA Credit Card  
(Mastercard/Eurocard, Visa, CartaSi)

**IMPORTANT: CISM is obliged to present an invoice for the above sum.  
Please indicate to whom the invoice should be addressed.**

Name \_\_\_\_\_

Address \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

C.F.\* \_\_\_\_\_

VAT/IVA\* No \_\_\_\_\_

(\* Only for EU residents or foreigners with a permanent business activity in Italy.)

**Only for Italian Public Companies**

I ask for IVA exemption (ex law n. 537/1993 - art. 14 comma 10).

**Privacy policy:** I understand that data received via this form will be used only to provide information about CISM and its activities, within the limits set by the Italian legislative decree no. 196/2003 and subsequent amendments.

Complete information on CISM's privacy policy is available at [www.cism.it](http://www.cism.it).

I have read the "Admission and Accommodation" terms and conditions and agree.

Date \_\_\_\_\_ Signature \_\_\_\_\_