# TIME TABLE

(registration on Monday at 8.30)

<table>
<thead>
<tr>
<th>TIME</th>
<th>Monday</th>
<th>Tuesday</th>
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<tr>
<td>October 15</td>
<td>Carrera</td>
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<td>9.00 - 9.45</td>
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<td>11.00 - 11.45</td>
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## ADMISSION AND ACCOMMODATION

Applicants must contact CISM Secretariat at least one month before the beginning of the course. Application forms should be sent online through our website: [http://www.cism.it](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.

The 700.00 Euro registration fee includes a complimentary badge, four fixed menu buffet lunches (Friday not included), hot beverages, on-line/downloadable lecture notes and Wi-Fi internet access.

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**Centre International des Sciences Mécaniques**

International Centre for Mechanical Sciences

**ACADEMIC YEAR 2012**

**The Nowacki Session**

**THEORIES AND COMPUTATIONAL MODELS FOR MULTILAYERED COMPOSITE STRUCTURES**
The course deals with structural models of laminated beams, plates and shells. It describes some of the most significant computational methods that have been introduced to describe the mechanics of multilayered structures. Structural modelling, failure analysis and computational techniques of composite structures are the main topics addressed in the course. Classical and advanced theories are considered. Closed form solutions, finite element methods, boundary element formulations will be discussed and compared. Static and dynamic response as well as failure mechanisms along with some optimization problems will be considered.

The course is first devoted to the description of possible approaches to beam, plate and shell structures. 3D approaches, continuum based methods, axiomatic and asymptotic two-dimensional theories, classical and mixed formulations, equivalent single layer and layer wise variable descriptions are considered (the number of the unknown variables is considered to be independent of the number of the constitutive layers in the equivalent single layer case). Complicating effects that have been introduced by anisotropic behaviour and layered constructions, such as high transverse deformability, zig-zag effects and interlaminar continuity, are discussed in detail and summarized by the acronym C^{0,0,0}--Requirements. So-called zig-zag theories are largely discussed. A complete and detailed overview has been conducted for this type of theory which relies on an approach that is entirely originated and devoted to layered constructions. A Unified Formulation is referred as a tool to derive in a concise form both weak and strong form of governing differential equations and finite element matrices for classical, advanced and mixed theories. A software is used to highlight and compare various composite structures modelling. Developments of finite elements for layered plates and shells are given. Including discussion of membrane and shear locking mechanism in laminated structures. FEs based on various theories are discussed along with those approaches which consist of a specific application of finite element techniques, such as hybrid methods, so-called global/local and component-wise techniques.

Know theories for the failure analysis (starting to Tsai-Wu criteria to the most recent Puck and LaRC techniques) are overviewed. Advantages and pitfalls of using FEM for progressive failure modeling of advanced composite materials and composite structures are discussed. Scale effects are introduced.

The analysis of meshless methods in composite structures is part of this course. Strong and weak form formulations. Element-free Galerkin methods. Collocation with radial basis functions, beam, plate and shell meshless formulations for laminated structures. Implementation of Unified Formulation in meshless methods for the analysis of laminated plates and shells. Formulations based on PVD (Principle of Virtual Displacements) - Equivalent single-layer and layer-wise formulations for laminated composite, functionally graded and sandwich plates and shells. The most advanced contributions of boundary element method applied to composite are finally introduced and discussed. Anisotropic static and dynamic fundamental solutions are proposed. Multidomain approach is discussed. The dual boundary element method is shown and applied to BEM and to damage analysis.

Course lecturers are well-known scientists among the most recognized leaders in the field of modeling of composite structures. The course is addressed to PhD students, research scientists and to attendees coming from both academic and industrial areas that would like to know both basics and the most advanced computational models that are known for modeling of beams, plates and shells structures.

Preliminary Suggested Readings


Invited Lecturers

Erasmo Carrera - Politecnico di Torino, Italy
8 lectures on:

Antonio J.M. Ferreira - Universidade do Porto, Portugal
8 lectures on:

Alberto Milazzo - Università degli Studi di Palermo, Italy
4 lectures on:

Olivier Polit - Université Paris Ouest, Nanterre, La Defense, France
8 lectures on:

Tony Waas - University of Michigan, Ann Arbor, MI, USA
8 lectures on:
Computational versus experimental analysis of laminates structures. Failure mechanisms of laminates structures. The most common failure criteria. Scale effects.

Lectures

All lectures will be given in English. Lecture notes can be downloaded from CISM web site, instructions will be sent to accepted participants.
**THEORIES AND COMPUTATIONAL MODELS**  
FOR MULTILAYERED COMPOSITE STRUCTURES  
Udine, October 15 - 19, 2012  
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 of Euro 700,00 includes IVA/VAT tax and excludes bank charges
- Payment will be made to CISM - Bank Account N° 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, cash or VISA Credit Card (Mastercard/Eurocard, Visa, CartaSì)

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

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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 http://www.cism.it/courses/privacy_statement/

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

Date __________________ Signature ___________________