TIME TABLE

Registration on Monday at 8.30

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
	September 17	September 18	September 19	September 20	September 21
9.00 - 9.45	Wiercigroch	Reynolds	Wiercigroch	Krommer	Krommer
9.45 - 10.30	Wiercigroch	Reynolds	Wiercigroch	Krommer	Krommer
11.00 - 11.45	Zulli	Wiercigroch	Zulli	Basu	Basu
11.45 - 12.30	Zulli	Wiercigroch	Zulli	Basu	Basu
14.00 - 14.45	Casciati	Reynolds	Casciati	Krommer	
14.45 - 15.30	Casciati	Reynolds	Casciati	Krommer	
16.00 - 16.45	Reynolds	Casciati	Zulli	Basu	
16.45 - 17.30	Reynolds	Casciati	Zulli	Basu	
18.00	Welcome Aperitif				

ADMISSION AND ACCOMMODATION

The registration fee is 600.00 Euro + VAT*, where applicable (bank charges are not included). The registration fee includes a complimentary bag, four fixed menu buffet lunches (on Friday upon request), 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 the following web site: http://www.cism.it. A message of confirmation will be sent to accepted participants. Applicants requiring assistance with the registration should contact the secretariat at the following email address cism@cism.it.

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

Cancellation requests received during the two weeks prior to the start of the course will be charged a 50.00 Euro handling fee. Incorrect payments are also subject to a 50.00 Euro handling fee.

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

Requests should be sent to CISM Secretariat by **July 17, 2018** 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 the web site www.cism.it, or can be mailed upon request.

* Italian VAT is 22%.

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ACADEMIC YEAR 2018
The Boley Session
Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

STABILITY AND SERVICEABILITY OF CONTROLLED STRUCTURES

Advanced School
coordinated by

Sara Casciati
University of Catania
Italy

Marian Wiercigroch
University of Aberdeen
UK

Udine *September 17 - 21* 2018

STABILITY AND SERVICEABILITY OF CONTROLLED STRUCTURES

The aim of this course is to discuss fundamental and practical concepts for assessing the stability and the serviceability of controlled engineering structures.
Pioneering works in applying control strategies to large-scale complex structures such as buildings and bridges have been mainly motivated by the protection of the built environment from earthquakes. Therefore, the uncontrolled structural systems are likely to have either approached or already entered the inelastic limit state. Recent advances in new material technologies enable to design highly flexible large-scale structures for which the limit states of stability and serviceability become of critical importance. It would be desirable that control solutions are developed in the design stage of these structures. Alternatively, retrofitting measures to introduce affordable control strategies together with their maintenance planning are typically required.

Structural stability is, in all cases, a key criterion in the design and service of most systems and structures where safety is paramount. Hence, there is a need to carefully assess the effects of the control devices on the global structural behaviour with respect to the stability limit state.
Vibration mitigation is often implemented to meet the serviceability requirement. Different solutions ranging from active to passive and semi-active control strategies are available but their feasibility and maintenance may be prohibitive. For these reasons, there is a need to preliminarily estimate their effects by investigating the serviceability of the controlled structures. In these studies, the testing of real-world large-scale structures is essential to support the validity of the approach.

The course will be structured into two series of three modules. Each module will consist of six one-hour lectures. The specific contents of the modules are summarized as follows. In the first module, a two-sided damping constraint control strategy for a quasi-zero-stiffness isolators is shown to improve the system stability. The second module is dedicated to the stability of passively controlled structures using either nonlinear energy sinks or piezoelectric devices. In the third module, thin plates and shells made of either piezoelectric materials or dielectric elastomers are embodied into smart structures as eigenstrain actuators to control stress and structural stability. In the fourth module, the serviceability assessment of controlled footbridges is discussed. The fifth module is dedicated to the recently developed control strategies for improving the vibration performance of floor structures. In the sixth module, the emerging trends in the vibration control of both onshore and offshore wind turbines are presented.

The course is addressed to doctoral students and postdocs in the fields of Civil and Mechanical Engineering, as well as Mechatronics, scientists, industrial researchers, and practicing engineers interested in the research areas of linear and nonlinear dynamics, stability and control.

PRELIMINARY SUGGESTED READINGS

Q. Cao, M. Wiercigroch, E. Pavlovskaia, J.M.T. Thompson and C. Grebogi. Piecewise linear approach to an archetypal oscillator for smooth and discontinuous dynamics. Philosophical Transactions of the Royal Society – Part A, vol. 366, 635–652, 2008.

Z. Hao, Q. Cao and M. Wiercigroch. Nonlinear dynamics of the quasi-zero-stiffness SD oscillator based upon the local and global bifurcation analyses. Nonlinear Dynamics, vol. 87, 987–1014, 2017.

A. Luongo and D. Zulli. Dynamic analysis of externally excited NES-controlled systems via a mixed Multiple Scale/Harmonic Balance algorithm. Nonlinear Dynamics, vol. 70(3), 2049-2061, 2012.

F. D'Annibale, G. Rosi, A. Luongo. Piezoelectric control of Hopf bifurcations: A non-linear discrete case study. International Journal of Non-Linear Mechanics, vol. 80, 160-169, 2016.

M. Krommer, Yu. Vetyukov, E. Staudigl. Nonlinear modelling and analysis of thin piezoelectric plates: Buckling and post-buckling behaviour. Smart Structures and Systems 18(1), 155-181, 2016.

E. Staudigl, M. Krommer, Yu. Vetyukov. Finite deformations of thin plates made of dielectric elastomers: Modeling, Numerics and Stability. Journal of Intelligent Material Systems and Structures, 2017.

F. Casciati, S. Casciati, L. Faravelli. A contribution to the modelling of human induced excitation on pedestrian bridges. Structural Safety 66, 51-61, 2017.

S. Casciati. Human induced vibration vs. cable-stay footbridge deterioration. Smart Structures and Systems 18(1), 17-29, 2016.

I. M. Díaz, E. Pereira, M. J. Hudson, P. Reynolds. Enhancing active vibration control of pedestrian structures using inertial actuators with local feedback control. Engineering Structures, 41, 157–166, 2012.

E. J. Hudson and P. Reynolds. Implications of structural design on the effectiveness of active vibration control of floor structures. Structural Control and Health Monitoring, 21(5), 685–704, 2014.

A. Staino and B. Basu. Emerging trends in vibration control of wind turbines: a focus on a dual control strategy. Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences, 373(2035), 20140069, 2015.

A. Staino and B. Basu. Dynamics and control of vibrations in wind turbines with variable rotor speed, Journal of Engineering Structures 56, 58 – 67, 2014.

INVITED LECTURERS

Biswajit Basu - Dublin Trinity College, Ireland
Subject: Vibration control of wind turbines
6 lectures on: wind turbines, fatigue load, vibration limits, pitch control, downtime, power curve.

Sara Casciati - Università degli Studi di Catania, Italy
Subject: Vibration controlled footbridges
6 lectures on: serviceability of footbridges, vibration control strategies, cable-stayed scheme, geometric nonlinearities, human induced loading, cable tension estimate, offline active control.

Michael Krommer - TU Wien, Austria
Subject: Stability and post-buckling behaviour of controlled smart structures
6 lectures on: controlled smart structures, piezoelectricity, dielectric elastomers, plates and shells, stability and post-buckling behaviour, stress and stability control.

Paul Reynolds - University of Exeter, UK
Subject: Vibration controlled floor structures
6 lectures on: floor vibration serviceability, vibration-sensitive equipment, passive control, active control, vibration isolation, floor damping.

Marian Wiercigroch - University of Aberdeen, UK
Subject: Dynamics, stability and control of the quasi-zero stiffness isolators
6 lectures on: nonlinear oscillators with quasi-zero-stiffness (QZS), bifurcation analysis, stability, dynamics and control, vibration isolation.

Daniele Zulli - Università degli Studi di l'Aquila, Italy
Subject: Stability of passively controlled structures using either nonlinear energy sinks or piezoelectric devices
6 lectures on: Nonlinear Energy Sinks (NES), Multiple Scale Harmonic Balance Method, optimization; piezoelectric-based passive control strategies, bifurcation scenario, Hopf bifurcations, Ziegler's column, principle of similarity, gyroscopic coupling.

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.