

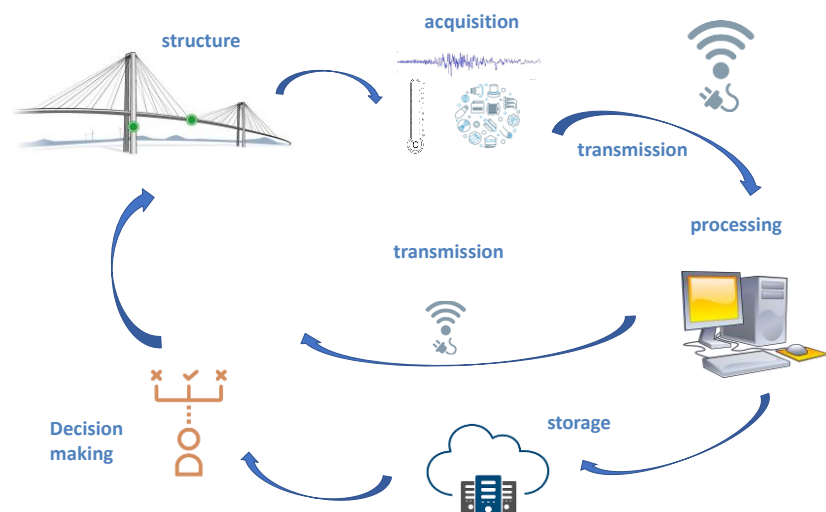
Structural Health Monitoring for integrity management of civil structures and infrastructures

Maria Pina Limongelli

Keith Worden

Guido de Roeck

Carlo Rainieri







Mission of the course The aim of this course is to introduce students to the basic aspects of Structural Health Monitoring with an emphasis on Vibration-based methods for damage identification as a decision support tool for integrity management of civil structures and infrastructures. The learning objects of the course are:

- 1) Understand the basic concepts of SHM and its applications
- 2) Acquire a basic knowledge of data management procedures (acquisition, signal processing, treatment of uncertainties)
- 3) Acquire knowledge on data driven and model-based methods for damage identification
- 4) Understand the concepts of value of information analysis with specific reference to monitoring information

Main topics The course is structured into 4 modules: fundamental of SHM, model-based methods for damage identification, machine learning methods for condition assessment, SHM for decision support. The topics covered in the four modules include an introduction signal processing in time and frequency domain, indicators to characterize the structural performance; damage identification using data-driven and model-based methods; value of information from SHM for integrity management. Case studies will be presented to illustrate the theoretical lessons and critically discuss advantages and drawbacks of different approaches to SHM. Lectures, will be given by an international staff of researchers active in the field of SHM..

Learning evaluation Students will be evaluated based on a [report](#) they will prepare and present at the oral examination. The subject of the report will be agreed upon with prof. Limongelli at the end of the course.

Prerequisites Basic notions of structural dynamics and modal analysis, finite element analysis.

	<p>Maria Pina Limongelli, was awarded her PhD in seismic engineering from Politecnico di Milano in 1996. She is Associate Professor of Structural and Seismic Engineering at Politecnico di Milano since 2006. Author of more than 100 scientific papers on damage identification for structures and infrastructures. Participates with leading roles to several National and European projects on Structural health Monitoring and Bridge Condition Assessment. Member of the editorial board of several Scientific Journals and International Conferences on SHM. Active members of ISHMII, IABSE, fib and JCSS</p>		<p>Keith Worden, has been Professor of Mechanical Engineering at the University of Sheffield, UK, since 2002. He heads the Dynamics Research Group (drg.ac.uk) in Sheffield and his main interests are in SHM and nonlinear structural dynamics. He is co-author (with Charles Farrar of Los Alamos National Laboratories) of the book <i>Structural Health Monitoring: a Machine Learning Perspective</i>. He is a director of the <i>Laboratory for Verification and Validation</i> (lvv.ac.uk), in Sheffield, which is a unique facility, designed to support SHM testing across scales and environments.</p>
	<p>Guido de Roeck is professor emeritus at the Department of Civil Engineering of KU Leuven, past head of the Structural Mechanics Section and author of more than 500 scientific journal and conference papers. His research focusses on structural mechanics, structural dynamics, vibration based structural monitoring, operational modal analysis, model updating, human induced vibrations, damage assessment. He has been involved with leading roles in many European research projects and networks: coordinator of EC Brite Euram SIMCES, participant to the projects FADLESS, LCC and DETAILS.</p>		<p>Carlo Rainieri got his PhD in engineering of materials and structures from the University of Naples "Federico II" in 2009. He is researcher at the Construction Technologies Institute of the National Research Council of Italy since 2019. He is author of more than 150 scientific papers Structural Health Monitoring and co-author of the book <i>Operational Modal Analysis of civil engineering structures: An introduction and guide for applications</i>. In 2019 he received the IOMAC Award for his contributions to the development of operational modal analysis. He joined several National projects on civil Structural health Monitoring and he is active member of ISHMII and IOMAC</p>

Course outline

Date (2023)	Room	time	Lecturer	Topic
May 22	tbc	9:00-11:00	M.P. Limongelli	Introduction to SHM of civil structures. Motivations and challenges
May 22	tbc	11:00-13:00	M.P. Limongelli	Basics of signal processing in time and frequency domain
May 22	tbc	14:30-18:30	C. Rainieri	Introduction to operational modal analysis: theory
May 23	tbc	9:00-13:00	C. Rainieri	Introduction to operational modal analysis: applications
May 23	tbc	14:30-17:30	G. de Roeck	Progress in SHM by application of new sensing techniques
May 24	tbc	9:00-13:00	G. de Roeck	Model-based damage identification using modal characteristics
May 24	tbc	14:30-17:30	K. Worden	Basic principles of machine learning
May 25	tbc	9:00-13:00	K. Worden	Machine learning for SHM
May 26	tbc	9:00-13:00	M.P. Limongelli	Vibration-based features for damage identification
May 26	tbc	14:30-16:30	M.P. Limongelli	Value of information from SHM

Location: **Politecnico di Milano. Campus Leonardo**



ENROLMENT PROCEDURE FOR SINGLE PhD COURSES

The applicant, a new user of the Politecnico's online services, must register at the link www.polimi.it/onlineservices using the REGISTER function.

Otherwise, use the credentials you already have.

Using these credentials (person code and password) log in to the online services www.polimi.it/onlineservices and access "*Application for doctoral single courses*"

To apply the applicant must:

- Upload the Curriculum Vitae
- Choose the courses (max two courses/max 10 ECTS credits)
- Upload a cover letter for each course
- Save the application
- Send the application and wait for it to be assessed

The applicant will then receive an e-mail notification that the request has been assessed and can view the details using the application.

The assessment of each application will be carried out by the PhD programme Coordinator who provides the course, and the result may be:

- application not accepted
- application accepted, with "paid" attendance: in this case the payment of € 500 including the tuition fee of € 25,59 is required.
- application accepted, with "free" attendance, in this case € 25,59 will be charged as tuition fees.

If the application is accepted, the enrolment procedure will be complete when the applicant accepts the assessment and makes the payment of the above-mentioned amount via PagoPA, using the link that will be displayed in the application (or alternatively the applicant may refuse the assessment, in which case the application will be cancelled).

To appear in the list of those enrolled in the programme and record the score, the applicant must go to the departmental secretary or the PhD School offices to verify their identity, if they have not already done so ("*user recognition*").

After completing the enrolment procedure, the applicant may download a certificate or self-certification through the application "*Certificate and self certification request*" available on the online services www.polimi.it/onlineservices

Issuing of certificates requires the payment of a €16 stamp, plus an additional €16 stamp for each certificate issued. The score obtained will be visible on the certificates only after the professor has completed the recording procedure.

After payment it will be possible to view and download:

- the electronic receipt of the IUUV (Unique Payment Identifier, which is the identification element of the operations passing through PagoPA)
- the payment receipt

To access these documents, it is necessary to connect to the online services www.polimi.it/onlineservices and select the application "*University fees and economic benefits*" -> "*payment history*"

If the applicant needs an invoice, they should send the payment receipt to michele.disabato@polimi.it