INTEGRATED EXPERIMENTAL AND COMPUTATIONAL APPROACHES TO THE DIAGNOSTICS OF STRUCTURES AND COMPONENTS

PhD Program in Mechanical Engineering

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Course contents

Several types of sensors can be used to gather information on the system or the damage state of a structure under test. The measuring strategy, the design and implementation of the experimental activity is analysed first in the course, considering both traditional measuring approaches and innovative vision-based techniques with RGB and hyperspectral cameras. The use of unmanned aerial vehicles for 3D shape, strain field and vibration measurement is discussed, in particular for applications in dangerous, harsh or hardly reaching environments. Damage or abnormal behaviour identification involves the definition of proper 'damage indicators' that can be estimated starting from the data recorded by a network of sensors. The variation in time of the damage indicators represents an index of possible anomalies linked to damage. A direct analysis of the recorded data can give a first real-time indication of the system condition and on its possible evolution, while reliable simulations of the system response can support the estimation of damage severity and location. In a context that involves periodical inspections and evaluations, time-consuming numerical (finite element) analyses may be replaced by fast analytical surrogate models, also introduced in the course. Case studies allow exploring the practical application of the different structural damage identification approaches.

Teaching staff

Emanuele Zappa was awarded his PhD in Applied Mechanics from Politecnico di Milano in 2002. He is currently Full Professor in Mechanical and Thermal Measurements, since 2020. He is Associate Editor in Chief of the IEEE Transactions on Instrumentation and Measurement. He has authored more than 130 scientific papers in the field of measurements, with a focus on vision-based techniques: digital image correlation, 3-D structured light scanning, and stereoscopy. His original contribution covers the development, the improvement, and the uncertainty analysis of the aforementioned techniques, as well as their application in complex and harsh environments.

Gabriella Bolzon graduated in Civil Engineering from Padova University in 1986, received her PhD in Structural Mechanics from Bologna University in 1991. At present, she is Associate Professor of Structural Engineering and Computational Mechanics at the Politecnico di Milano. She has been working and teaching in an International context (in Australia, France, Germany, India, Japan, Spain) and involved in several National and International Research Projects. She is author or co-author of more than 100 scientific contributions. Her present research interests focus on diagnostic analysis and parameter identification by deterministic and stochastic techniques.

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 and Visiting Professor at IFSTTAR, (France) since 2014 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 and organizer of successful Special sessions on SHM for several International Conferences.

Attendees

The course is open to **all PhD students from UASR** having a basic structural background in any engineering field (aerospace, biomedical, civil, mechanical, …) upon registration. Lectures will be given both in presence and in remote mode.

Attendance certificate will be provided.

Registration

Online attendance is free of charge for everyone. Attendance in presence is free for Politecnico di Milano students, while the charge for others is € 32.20 as insurance fee.

To subscribe the course and for organization details: phd-dmec@polimi.it

Calendar

Date	Time (Italian time zone GMT+2)	Lecturer	Topic
9/2/2022	10:00am-12:00pm	E. Zappa	Introduction to the course and discussion of the evaluation techniques. Sensors for vibration monitoring: state of the art approaches
9/2/2022	1:00-3:00 pm	E. Zappa	Sensors for vibration monitoring: innovative approaches
10/2/2022	10:00am-12:00pm	E. Zappa	Vision-based measuring approaches for vibration monitoring
10/2/2022	1:00-3:00 pm	E. Zappa	Vision-based techniques for full 3D shape reconstruction in static and dynamic conditions
11/2/2022	10:00am-12:00pm	E. Zappa	Unmanned aerial vehicles for 3D shape, strain and vibration measurement in harsh environments. Hyperspectral and infrared imaging for non-destructive evaluation of damage and degradation
11/2/2022	1:00-3:00 pm	E. Zappa	Application to a case study
14/2/2022	10:00am-12:00pm	G. Bolzon	Introduction to model-based inverse analysis approaches; measurements and sensitivities
14/2/2022	1:00-3:00 pm	G. Bolzon	Problem formulation into a deterministic context; minimization tools
15/2/2022	10:00am-12:00pm	G. Bolzon	Problem formulation into a stochastic context; filters
15/2/2022	1:00-3:00 pm	G. Bolzon	Simulation techniques
16/2/2022	10:00am-12:00pm	G. Bolzon	Model reduction tools
16/2/2022	1:00-3:00 pm	G. Bolzon	Application to a case study
17/2/2022	10:00am-1:00pm	M.P. Limongelli	Damage phenomena and indicators at the material level
18/2/2022	10:00am-1:00pm	M.P. Limongelli	Damage phenomena and indicators at the structural level

Course location: Politecnico di Milano. Campus Bovisa. Building B23.

For further information on teaching matters, please contact: **emanuele.zappa@polimi.it**