

Course 104: Bayesian Model Updating and Uncertainty Quantification: Theory, Computational Tools, and Applications

Sunday, January 29, 2017 | 8:00 a.m.–5:00 p.m.

Course Description

In simulations of complex physical systems, uncertainties arise from imperfections in the mathematical models introduced to represent the systems and their interactions with the environment. Such uncertainties lead to significant uncertainties in the predictions using simulations. Since such predictions form the basis for making decisions, the knowledge of these uncertainties is very important. The course will present the Bayesian model updating framework, the associated computational tools, and selected applications, along with the main challenges for quantifying and propagating uncertainties in complex structural dynamic simulations.

Course Outline

Bayesian uncertainty quantification and propagation in structural dynamics simulations

- Bayesian model parameter estimation/model updating
- Bayesian model class selection
- Updating robust predictions and robust reliability
- Bayesian Hierarchical modeling
- Structural health monitoring using Bayesian model selection and updating

Bayesian computational tools

- Asymptotic approximations
- Sampling techniques

High performance computing for Bayesian UQ of complex models

- Component mode synthesis
- Surrogate techniques (kriging, polynomial chaos)
- Parallel computing
- Demonstration on high fidelity linear/nonlinear bridge models

Optimal experimental design

- Expected Kullback-Leibler divergence and information entropy
- Asymptotic and sampling techniques
- Optimal sensor placement
- Optimal excitation characteristics

Case studies

- Dowling Hall Footbridge
- 10-story RC building
- Metsovo Bridge
- Small-scale laboratory vehicle model

Who should attend

Engineers, researchers and graduate students who deal with finite element model validation as well as uncertainty quantification and propagation in structural dynamics simulations using vibration measurements.

Course Fee

The regular fee is \$500 and the student fee is \$250. Course fee includes course handout material and refreshment breaks. Lodging, additional food and other materials are not included.

Cancellation Liability

If the course is cancelled for any reason, the Society for Experimental Mechanics' liability is limited to the return of the course fees.

Instructor(s):

Costas Papadimitriou—*University of Thessaly, Greece*
Papadimitriou (PhD CalTech) is Professor of Structural Dynamics at the University of Thessaly (Greece). He holds the position of the Executive Vice-President of the European Association of Structural Dynamics (EASD). He has over 25 years of experience in the areas of Bayesian uncertainty quantification and propagation, computational structural dynamics, finite element model validation, structural health monitoring and structural reliability. He has co-authored over 250 papers in journals and conference proceedings and co-edited two special journal issues on the subject and the section on Structural Health Monitoring in the Encyclopedia of Earthquake Engineering. He has organized more than thirty minisymposia on the subject and has given invited/keynote lectures in international conferences. He chaired the "Dynamics" committee of ASCE-EMI and chairs the "Identification, Model Updating and Inverse Problems" committee of EASD.

Babak Moaveni

—*Tufts University*

Dr. Moaveni is currently an Associate Professor at the Department of Civil and Environmental Engineering at Tufts University. Dr. Moaveni's main research interests include vibration-based system and damage identification of civil structures; finite element model updating; and uncertainty quantification in structural dynamics. He has co-authored 21 journal papers and 38 conference papers on related topics. He is currently serving as the chair of the ASCE-SEI technical committee "Methods of Monitoring Structural Performance" and as the vice-chair of the ASCE-EMI "Structural Health Monitoring and Control" committee.



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