1. Title

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

2. Names of instructors

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3. Abstract

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.

4. Table of contents (subject to change)

Lecture 1. Bayesian uncertainty quantification and propagation in structural dynamics simulations
1.1 Bayesian model parameter estimation / model updating
1.2 Bayesian model class selection
1.3 Updating robust predictions and robust reliability
1.4 Structural health monitoring using Bayesian model selection and updating

Lecture 2. Bayesian computational tools
2.1 Asymptotic approximations
2.2 Sampling techniques

Lecture 3. Case studies

Lecture 4. High performance computing for Bayesian UQ of complex models
4.1 Component mode synthesis
4.2 Surrogate techniques (kriging, polynomial chaos)
4.3 Parallel computing
4.4 Demonstration on high fidelity linear/nonlinear bridge models

Lecture 5. Optimal experimental design
5.1 Expected information gain
5.2 Optimal sensor placement
5.3 Optimal excitation characteristics

5. Sponsoring committee

Dynamics committee
Structural Health Monitoring and Control committee

6. Length of the course: Full-day (6 hours of instruction)