Course #103 : **Uncertainty Quantification: An Info-Gap Approach to Design and Decision**

Sunday, January 30, 2011, 8:00 am - 6:00 pm

Course Description

Engineers use measurements and science-based models to design systems, evaluate reliability, and make plans and policies. However, models may be simpler than reality, causal factors may be unknown, measurements may err or be incomplete, and systems may change over time in unknown ways. Probability is useful for modeling and managing some of these uncertainties. However some uncertainties are *info-gaps:* disparities between what *is known* and what *needs to be known* in order to make good decisions. For instance, we may not know the correct probability distribution or all of the relevant physical mechanisms such as non-linearities or time dependencies and we certainly do not know future surprises. This course studies info-gap theory for modeling and managing uncertainties in structural analysis, design, and decisions based on structural models.

This course has three components. *Lectures* present new material and *exercises* help participants master this material. The emphasis is on understanding new concepts through simple examples. Finally *mini-projects* are formulated by the participants, individually or in small groups. The instructor assists the groups in developing their mini-projects.

Instructor

Yakov Ben-Haim is a professor in the Faculty of Mechanical Engineering and holds the Yitzhak Moda'i Chair in Technology and Economics at the Technion – Israel Institute of Technology (yakov@technion.ac.il). Yakov initiated and developed info-gap decision theory, which is a quantitative methodology for modeling and managing severe uncertainty that is applied in engineering analysis and design, reliability analysis, project management, economics, homeland security, biological conservation and medicine. See http://info-gap.com

Who Should Attend

Graduate students and researchers involved in structural model updating, system analysis and design, and reliability assessment, will learn how to model and manage uncertainties in data and models.

Program

- **Lecture:** *Limitations of probability.* Probability is a powerful tool, but not applicable in all situations. We illustrate this and discuss several paradoxes of probability.
- **Lecture:** *Vibration suppression with uncertain load.* We consider the choice between stiffness and damping in designing a vibrating cantilever subject to uncertain impact loads.
- **Exercises:** Basic: *Trigger mechanism.* Challenge: *Static deflection of a cantilever.*
- **Lecture:** *Probabilistic reliability with info-gap uncertainty.* What to do when the tails of the probability distribution are uncertain? We combine info-gap robustness with probabilistic reliability.
- **Lunch**
- **Exercise:** *Probabilistic reliability with info-gap uncertainty.*
- **Lecture:** *Tychonov Updating of a Linear System with Model Uncertainty.* Data is used to update a linear model. However, the assumed model structure may be wrong. We seek an update with adequate fidelity to data and high robustness against model misspecification.
- **Exercise:** *Estimate spring stiffness with model uncertainty.*
- **Lecture:** *Decision-making with validated models.* We have validated models of two alternative systems, and now we must choose between them. The future performance of each system is random and the probability distributions are uncertain. We choose between the systems so that the expected performance is good and the robustness to uncertainty is large.
- **Demo:** *GapZapper*, a free matlab-based computer shell for info-gap applications. Bring your PC.
- **Mini-projects.** Brainstorm on decision problems. Break into working groups. Verbally formulate decision, uncertainty models, system models, and performance requirements. Begin mathematical formulation.

Course Fee

The regular course fee is $350, and the student course fee is $175. Course fee includes box lunch, course handout material, and refreshment breaks. Lodging and additional food or materials are not included.