Course 103:
Nonlinear System Identification In Structural Dynamics

Sunday, January 29, 2017 | 9:00 a.m.–6:00 p.m.

Course Description

Because nonlinearity is a frequent occurrence in real-life applications, there is a need for efficient and rigorous analysis methods for accounting for nonlinear phenomena. This course focuses on nonlinear system identification techniques, which amounts to extract useful information directly from experimental measurements. Specifically, the identification process is a progression through three steps: nonlinearity detection, nonlinearity characterisation and model parameter estimation. The course will present these three steps in great detail and illustrate them using both academic and industrial examples.

Who should attend

Graduate students and researchers who need to learn how to extend system identification to nonlinear vibrating structures. Practicing engineers who need to account for nonlinear behavior in their applications instead of overlooking it, as is the common practice.

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.

Instructors

Gaëtan Kerschen—*University of Liège*
Keith Worden—*University of Sheffield*

The instructors have extensive experience in nonlinear structural dynamics, from analytical and numerical modeling to the interpretation and exploitation of experimental measurements.

Gaëtan Kerschen

Keith Worden

Course Outline

This short course is organized into seven lectures.

Lecture 1: From linear dynamics to nonlinear dynamics

- Symptoms of nonlinearity
- Common types of nonlinearity

Lecture 2: Introduction to nonlinear system identification

- State-of-the-art of linear system identification
- Challenges of nonlinear system identification

Lecture 3: Nonlinearity detection

- Breakdown of linear properties (superposition principle, FRF invariance, etc.)
- Hilbert transform

Lecture 4: Nonlinear characterization

- Hilbert transform, time-frequency analysis, higher-order FRFs and Volterra series
- Restoring force surface method
- Case study: the F-16 aircraft

Lecture 5: Nonlinear parameter estimation

- NARMAX models.
- Subspace identification for nonlinear systems.
- Nonlinear finite element model updating.
- Case study: the Airbus Defence and Space SmallSat spacecraft

Lecture 6: Nonlinearity and uncertainty

- Bayesian methods of nonlinear system identification

Lecture 7: Closure and group discussion

- Brief summary of the short course and concluding remarks
- Feedback from attendees, questions and final survey