Uncertainty Quantification in Physical Systems

Professor Americo Cunha Jr.
NUMERICO – Nucleus of Modeling and Experimentation with Computers
Rio de Janeiro State University (UERJ)
Brazil

Abstract: Computational models have been extensively used for design and analysis of complex physical systems and/or engineered devices. However, any computational model is uncertain with respect to the system of interest, due to variabilities on its parameters (data uncertainties) and, mainly, because of the assumption made on its conception that may not be in agreement with reality (model uncertainties). Data uncertainty is inherent to measurements limitations, imperfections in manufacturing process, material and geometric variabilities, etc. Meanwhile, model uncertainty is essentially due to lack of knowledge about the underlying physics. Model these uncertainties and quantify their impact on the system response is often a challenging task, that is essential for: (i) specify a reliability region around numerical simulation; (ii) certify risk decisions; (iii) design components with low sensitivity to parameter variation (robust design); (iv) validate physical models; etc. This presentation aims to expose the types of uncertainties that are inherent to physical systems, how to consistently construct a stochastic model of uncertainties through a probabilistic approach, and to present some examples of applications.

Biographical Sketch: Dr. Americo Cunha is an Assistant Professor of Applied Mathematics at Rio de Janeiro State University (UERJ) in Brazil, co-founder and coordinator of the laboratory NUMERICO – Nucleus of Modeling and Experimentation with Computers. His research interests include nonlinear dynamics, computational science and engineering, uncertainty quantification, inverse problems and model order reduction. Dr. Cunha has B. Eng., M.Sc. and D.Sc. degrees in Mechanical Engineering from Pontifical Catholic University of Rio de Janeiro (PUC-Rio) in Brazil, where he also obtained a B.Sc. degree in Applied Mathematics. During his D.Sc. course he spent 18 months at Paris, working in a laboratory of Multi-scale modeling and simulation of Universite’ Paris-Est. Currently he maintains academic cooperation with researchers from Brazil, Argentina, and France.