

Environmental Engineering Seminar

The Astani Department of Civil & Environmental Engineering presents



Ioannis A. Kougioumtzoglou
Associate Professor, Columbia University

Date: Thursday, October 28, 2021

Time: 11:00am-12:00pm

Place: MCB 101

Zoom Meeting:

<https://usc.zoom.us/j/99680049945>

Meeting ID: 996 8004 9945

Passcode: 905716

Path Integrals in Stochastic Engineering Dynamics

Abstract:

Ever-increasing computational capabilities, development of potent signal processing tools, as well as advanced experimental setups have contributed to a highly sophisticated modeling of engineering systems and related excitations. As a result, the form of the governing equations has become highly complex from a mathematics perspective. Examples include high dimensionality, complex nonlinearities, joint time-frequency representations, as well as generalized/fractional calculus modeling. In many cases even the deterministic solution of such equations is an open issue and an active research topic. Clearly, solving the stochastic counterparts of these equations becomes orders of magnitude more challenging. To address this issue, the speaker and co-workers have developed recently a solution framework, based on the concept of Wiener path integral, for stochastic response analysis and reliability assessment of diverse dynamical systems of engineering interest. Significant novelties and advantages that will be highlighted in this talk include:

- i) The methodology can readily account for complex nonlinear/hysteretic behaviors, for fractional calculus modeling, as well as for non-white and non-Gaussian stochastic process representations.
- ii) High-dimensional systems can be readily addressed by relying on a variational formulation with mixed fixed/free boundary conditions, which renders the computational cost independent of the total number of degrees-of-freedom (DOFs) or stochastic dimensions; and thus, the 'curse of dimensionality' in stochastic dynamics is circumvented.
- iii) The computational cost can be further drastically reduced by employing sparse representations for the system response probability density function (PDF) in conjunction with compressive sampling schemes and group sparsity concepts. Moreover, the methodology is capable of uncertainty quantification associated with the system response PDF estimate by relying on a Bayesian formulation.

Various examples are presented and discussed pertaining to a wide range of engineering systems including, indicatively, a class of nonlinear electromechanical energy harvesters and a 100-DOF stochastically excited nonlinear dynamical system modeling the behavior of large arrays of coupled nano-mechanical oscillators.

Bio: Prof. Ioannis A. Kougioumtzoglou received his five-year Diploma in Civil Engineering from the National Technical University of Athens (NTUA) in Greece (2007), and his M.Sc. (2009) and Ph.D. (2011) degrees in Civil Engineering from Rice University, TX, USA. He joined Columbia University in 2014, where he is currently an Associate Professor in the Department of Civil Engineering & Engineering Mechanics. He is the author of approximately 150 publications, including more than 75 technical papers in archival International Journals. Prof. Kougioumtzoglou was chosen in 2018 by the National Science Foundation (NSF) to receive the CAREER Award, which recognizes early stage scholars with high levels of promise and excellence. He is also the 2014 European Association of Structural Dynamics (EASD) Junior Research Prize recipient "for his innovative influence on the field of nonlinear stochastic dynamics". Prof. Kougioumtzoglou is an Associate Editor for the ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems and an Editorial Board Member of the following Journals: Mechanical Systems and Signal Processing, Probabilistic Engineering Mechanics, and International Journal of Non-Linear Mechanics. He is also a co-Editor of the Encyclopedia of Earthquake Engineering (Springer), and has served as a Guest Editor for several Special Issues in International Journals. Prof. Kougioumtzoglou has co-chaired the ASCE Engineering Mechanics Institute Conference 2021 and Probabilistic Mechanics & Reliability Conference 2021 (EMI 2021 / PMC 2021), and has served in the scientific and/or organizing committees of many international technical conferences. Prof. Kougioumtzoglou is a member both of the American Society of Civil Engineers (M.ASCE) and the American Society of Mechanical Engineers (M.ASME), while he currently serves as a member of the ASCE EMI committees on Dynamics and on Probabilistic Methods. He is a Licensed Professional Civil Engineer in Greece, and a Fellow of the Higher Education Academy (FHEA) in the UK.



USC University of
Southern California

