# AIChE Webinar Series

*Computing & Systems Technology Division (CAST) Welcomes*


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## *Arbitrary Polynomial Chaos for Uncertainty Quantification of Correlated Random Variables in Nonlinear Systems*


Traditional sample-based uncertainty propagation methods are generally computationally intractable for online optimization-based estimation and control applications. Generalized polynomial chaos (gPC) has emerged as an efficient uncertainty propagation method for nonlinear estimation and optimal control problems under probabilistic model uncertainty. However, gPC requires the random variables be independent and have known probability distributions. In this talk, we discuss arbitrary polynomial chaos (aPC) for quantification of correlated multivariate random variables in nonlinear systems. We demonstrate how quadrature rules can be extended to arbitrary weight functions in multiple dimensions using moment-matching optimization techniques. Furthermore, we discuss that the polynomial basis construction and multivariate quadrature (or cubature) rules only rely on moments of the distribution. Thus, aPC does not require knowledge (or even the existence) of the underlying probability distributions of random variables, which makes aPC more robust to errors in uncertainty modeling. We demonstrate the application of aPC for uncertainty quantification in open- and closed-loop nonlinear systems with arbitrary multivariate probabilistic uncertainties.


**Biography:**

Ali Mesbah is Assistant Professor of Chemical and Biomolecular Engineering at the University of California at Berkeley. Before joining UC Berkeley, he was a senior postdoctoral associate at MIT. He holds a Ph.D. degree in systems and control and an M.Sc. degree in chemical engineering, both from Delft University of Technology. He is a senior member of the IEEE Control Systems Society and AIChE. He is the recipient of the AIChE's 35 Under 35 Award in 2017, the IEEE Control Systems Outstanding Paper Award in 2017, and the AIChE CAST W. David Smith, Jr. Graduation Publication Award in 2015. His research interests are in the areas of optimization-based systems analysis, fault diagnosis, and predictive control of uncertain systems.

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