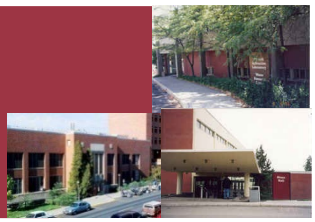
# Civil & Environmental Engineering

Washington State University



## Uncertainty-Informed Analysis and Optimal Design: from Model Validation to Topology Optimization

In recent years, evaluating the predictive capability of computational models has become an indispensable part of simulation frameworks. A report by a National Science Foundation blue ribbon panel on simulation-based engineering science identifies Uncertainty Quantification as a key player in the future of predictive analysis because some degree of uncertainty is inevitable in both "the ability of a model to reflect reality and in the data the model uses". Whether attributed to the discrepancy between the mathematical model and the physical reality or the variability in the parameters that define the model or the inputs, this uncertainty must be taken into account to achieve reliable predictions of the response or to arrive at designs that are robust. A set of structural mechanics problems in which the incorporation of uncertainty is at the heart of the modeling process will be discussed. These include, among others, developing probabilistic frameworks that look at the mechanics of thin-walled structures through an uncertainty-informed lens and strategies for robust topology optimization where robustness in design is achieved through systematic embedding of uncertainty in the built geometry and material properties into the objective and sensitivity calculations. A consistent data-driven framework that draws upon advances in data mining, information theory, and statistical inference and estimation techniques to build realistic stochastic models from experimental measurements will be presented. Recent advancements in uncertainty quantification based on spectral representation and propagation of uncertainty and multi-fidelity information fusion that lie at the core of developed methodologies will also be discussed.

## About Dr. Mazdak Tootkaboni

**Dr. Tootkaboni** is an Associate Professor of Civil and Environmental Engineering and a member of Center for Scientific Computing and Data Science Research at UMassD. Dr. Tootkaboni's research is cross-disciplinary and focuses on integrating advances in optimal design, stochastic modeling, applied statistics and data analytics with methods of applied and computational mechanics to develop techniques that help engineering mechanics community move towards more reliable, resource-efficient, and resilient solutions. These techniques are highly relevant in devising risk- and uncertainty-conscious design and analysis frameworks and have a wide range of applications, from the analysis of instability and collapse behavior in stability-critical structures to design optimization under uncertainty. Dr. Tootkaboni's research has been funded by NSF, ONR, MASS DEP and UMASS president's office. He is a recipient of the NSF early CAREER award, University of Massachusetts System President's Science and Technology award, and the University of Massachusetts Dartmouth Chancellor's Sponsored Research Recognition. Dr. Tootkaboni is an associate member of ASCE, a member of Engineering Mechanics Institute (EMI) and an active member of EMI's Probabilistic Mechanics Committee. He also serves as associate editor on the editorial board of Journal of Engineering Mechanics.

**Date: April 11, 2022**
**Place: PACCAR Auditorium, Zoom**
**Time: 11:00 a.m. - 12:00 p.m.**