



# Semi-sesquicentennial of mecheng@IISc Distinguished Seminar Series



## Predictive Digital Twins and the Data-driven Future of Computational Science

**Prof. Karen E. Willcox**

Director of the Oden Institute for Computational Engineering and Sciences,  
Associate Vice President for Research, and  
Professor of Aerospace Engineering and Engineering Mechanics, University of Texas, Austin  
<https://www.ae.utexas.edu/people/faculty/faculty-directory/willcox>

**April 7, 2021 at 6:30 PM IST**

**Meeting link: <http://bit.ly/3cTKCAI> (MS Teams)**

### ABSTRACT

A digital twin is an evolving virtual model that mirrors an individual physical asset throughout its lifecycle. Key to the digital twin concept is the ability to sense, collect, analyze, and learn from the asset's data. This talk will discuss the ways in which digital twins have the potential to transform design, manufacture, and operation of engineering systems. To make digital twins a reality, many elements of the interdisciplinary field of computational science, including physics-based modeling and simulation, inverse problems, uncertainty quantification, and scientific machine learning, have an important role to play. In this work, we develop a probabilistic graphical model as a formal mathematical representation of a digital twin and its associated physical asset. We create an abstraction of the asset-twin system as a set of coupled dynamical systems, evolving over time through their respective state-spaces and interacting via observed data and control inputs. The abstraction is realized computationally as a dynamic decision network. Predictive capabilities are enabled by physics-based reduced-order models. We demonstrate how the approach is instantiated to create, update and deploy a structural digital twin of an unmanned aerial vehicle.

### ABOUT THE SPEAKER

Karen E. Willcox is Director of the Oden Institute for Computational Engineering and Sciences, Associate Vice President for Research, and Professor of Aerospace Engineering and Engineering Mechanics at the University of Texas at Austin. She is also External Professor at the Santa Fe Institute. Before joining the Oden Institute in 2018, she spent 17 years as a professor at the Massachusetts Institute of Technology, where she served as the founding Co-Director of the MIT Center for Computational Engineering and the Associate Head of the MIT Department of Aeronautics and Astronautics. Prior to joining the MIT faculty, she worked at Boeing Phantom Works with the Blended-Wing-Body aircraft design group. She is a Fellow of the Society for Industrial and Applied Mathematics (SIAM) and Fellow of the American Institute of Aeronautics and Astronautics (AIAA).



Session chair: Dr. Kota Harinarayana, General Aeronautics, Bengaluru