

CIVIL AND ENVIRONMENTAL ENGINEERING DEPARTMENT SEMINAR



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Date: Thursday, May 21st, 2026

Time: 3:00pm – 4pm EST

Location: In person, Bingham Building, Vose #138 Zoom Link: [here](#)

*Integrated Finite Element–Machine Learning Frameworks for
Geoenergy and Smart Infrastructure*

Abstract: Understanding the behavior of materials and structures is central to geoenergy systems and civil infrastructure, where predictive simulations support design, optimization, and risk mitigation. Despite major advances in computational mechanics, balancing model fidelity with computational efficiency remains a persistent challenge, especially for nonlinear and multiphysics problems. This talk presents two complementary research directions that integrate machine learning with advanced computational mechanics frameworks to address these limitations. The first part of the talk introduces I-FENN, a general hybrid framework that integrates machine learning directly into the finite element method (FEM). The framework is particularly motivated by subsurface energy applications, including carbon sequestration and geothermal systems, where nonlinear multiphysics simulations remain computationally demanding. In I-FENN, neural networks are trained to approximate selected coupled physical processes and are then embedded within the FEM solution procedure to accelerate the evaluation of state variables. The framework enables efficient and accurate simulations of problems involving nonlocal damage, phase-field fracture, thermoelasticity, and poroelasticity. By combining the robustness of FEM with the efficiency of machine learning surrogates, I-FENN provides a scalable strategy for modeling coupled fracture, fluid flow, and thermal processes relevant to geoenergy systems, while remaining broadly applicable to computational mechanics problems. The second part of the talk focuses on structural digital twins, where real-time sensing and predictive simulations are combined to create continuously evolving computational representations of physical infrastructure. On the digital-to-physical side, a deep operator neural network grounded in structural mechanics enables rapid and accurate prediction of structural response while rigorously satisfying equilibrium and energy consistency through stiffness-based constraints. On the physical-to-digital side, damage identification is achieved through a multistage framework combining signal processing, system identification, and machine learning to detect, localize, and quantify deterioration. The methodology is demonstrated on the KW51 bridge in Leuven, Belgium, and ongoing work is extending the framework to infrastructure systems in Abu Dhabi, UAE.

Bio: Dr. Mobasher is an Assistant Professor of Civil and Urban Engineering at New York University Abu Dhabi (NYUAD). Dr. Mobasher holds Associated Appointment with New York University, Tandon School of Engineering. Dr. Mobasher is also a Co-PI and the leader of the Energy Research Theme for Sand Hazards and Opportunities for Resilience, Energy, and Sustainability (SHORES) at NYUAD. Dr. Mobasher received his PhD and MPhil Degrees from Columbia University in Engineering Mechanics. Prior to joining NYUAD, Dr. Mobasher was an Associate at the Applied Science Practice of the multidisciplinary consultancy firm Thornton Tomasetti. Dr. Mobasher's research is focused on modeling fracture and multi-physical response of manmade and natural materials across spatial and temporal scales. The research contributes to the development of a wide-range of numerical models to address the needs for non-linear modeling of materials subjected to mechanical and multi-physical loading scenarios. His research scope was expanded to explore the integration between the Machine Learning (ML) and Artificial Intelligence (AI) approaches along with well-established computational methods such as Finite Element Method (FEM).