Ackert Hall, Room 120
Wednesday, November 20, 2024
4:00 P.M.

Coffee and Cookies
Chalmers Hall, Room 168
3:45 P.M.

Biochemistry & Molecular Biophysics Seminar

Physics-Informed Machine Learning for Characterization, Predictive Modeling, and Optimization of Agrifood and Biomedical Systems

Davood B. Pourkargar

Chemical Engineering
Kansas State University

This seminar will explore the transformative potential of physics-informed machine learning (PIML) frameworks for predictive modeling and optimization across agrifood and biomedical domains. This interdisciplinary approach addresses critical drug development and sustainable food production challenges by integrating mechanistic principles with advanced data-driven modeling techniques. In biomedical applications, the focus is replacing conventional animal models with computational models that emulate human tissue and organ dynamics. These models, informed by organ-on-a-chip (OoC) experiments and multiscale physiochemical frameworks, improve understanding of disease progression and drug interactions. By combining first-principles modeling with machine learning, the hybrid framework enables accurate predictions with fewer experimental data points, optimizing OoC experiments. This integration streamlines the preclinical process, enabling the development of more effective drugs with optimal dosages and minimized side effects. In agrifood applications, the seminar will highlight advancements in plant-based meat production using a PIML framework. Pilot-scale extrusion processes are modeled to predict and control critical parameters like flow, pressure, and temperature based on heat and mass transfer principles. This enables the optimization of extrusion conditions, improving the quality and texturization of plant-based proteins, such as peas, wheat, and soy. A novel computer vision tool also automates microstructure analysis, linking raw material properties and process conditions to product quality attributes like fibrousness and texture. Results demonstrate the capability of PIML to predict extrusion system performance, guiding real-time process control and advancing the sustainable production of plant-based meat alternatives. By exploring applications in both biomedical and agrifood sectors, this talk demonstrates how innovations in computational modeling drive efficiency, enhance product quality, and address societal demands for ethical, sustainable, and practical solutions in healthcare and food systems.