



Mechanical Engineering Seminar

Monday, April 28, 2025, at 14:30, D. Dan and Betty Kahn Building, Room 217

<https://technion.zoom.us/j/95804168695>

Advanced Geometric Representations in Engineering Simulations

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Hosted by: Prof. Alon Wolf

Engineering simulations of physical phenomena have driven major advancements in the mechanical, civil, aerospace, and biomedical fields, typically through numerical analysis. Modern challenges in these fields often involve geometrically complex designs, where geometry can evolve in shape and topology such as in topology optimization or multiphase flow. A key challenge in such cases is accurately replicating the geometry within analysis models where PDEs are solved. Traditional approaches often use separate representations for geometry and analysis, introducing discrepancies that compound numerical errors with additional geometric inaccuracies. This in turn leads to errors in evaluating physical responses near material boundaries, for example, surface tension in multiphase flow or stress concentrations in elasticity.

This talk presents recent advancements in integrating precise geometry with analysis using Isogeometric Analysis (IGA), which employs spline-based models to enhance accuracy and smoothness in solving geometrically complex physical problems. A novel, fully unified geometry–analysis model for single- and multiphase engineering problems with moving boundaries, developed by the speaker, will be introduced, demonstrating clear advantages over traditional approaches in topology optimization, two-phase flow, and stress concentration analysis. Additionally, a new method combining IGA with the Finite Volume Method (IGFVM) will be presented, where control volumes precisely replicate curved geometries, enabling the application of conservation laws on the exact geometry. Applications of IGFVM in heat transfer and elasticity will be presented. Further applications of advanced geometric representations in 3D printing will also be discussed.

Emad Shakur is an Associate Researcher at the Technion Research & Development Foundation, specializing in Computational Mechanics with a focus on topology optimization and advanced simulation techniques, aiming to bridge geometry and mechanical simulations. He completed his B.Sc., M.Sc., and Ph.D. at the Technion and received the Jacobs Award for Distinguished Academic Achievements. Shakur also worked as a research scientist at RICAM the Johann Radon Institute for Computational and Applied Mathematics, Austrian Academy of Sciences, where he focused on integrating CAD and computational geometry with mechanical simulations.

