# Mechanical Engineering Graduate Student Seminar Series

**Sunday, July 26 2026 at 12:30, Lady Davis Building, Auditorium 250**

## GPU-Accelerated High-Resolution Numerical Simulations of Compressible, Reacting Flows for Scramjet Engines

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**Adviser: Prof. Steven Frankel**

Scramjet engines are a key enabling technology for sustained airbreathing hypersonic flight, yet their development has proven exceptionally difficult. Ground test campaigns are costly and long-running, and they yield only sparse measurements of the internal flowfield, whereas accurate simulation can resolve the full three-dimensional state throughout the flowpath. However, simulating this environment is itself formidable; within the combustor, shock trains, shock–boundary-layer interaction, turbulent mixing, and finite-rate chemistry interact across length and time scales spanning several orders of magnitude. Ignition and flame stabilization hinge on residence times on the order of milliseconds. Conventional simulation tools, based on CPU computing, can struggle to capture these complex physical phenomena, especially in reasonable turn-around times. This work presents the development and application of high-resolution numerical methods for compressible reacting flows in a fully GPU-resident framework. I will describe the algorithmic choices and implementation strategies required to sustain high-order shock capturing and detailed thermochemistry entirely on the GPU, and the challenges encountered along the way. The methodology is first exercised on a reacting shock-bubble interaction, demonstrating accurate shock capturing, mixing, and unsteady combustion dynamics. Quantitative validation follows against DNS data for a turbulent, reacting hydrogen shear layer and a reacting hydrogen boundary layer flow. Building on these cases, I will present ongoing simulations of a scramjet combustor and the path toward flight-representative configurations.

Note: the seminar will be given in English