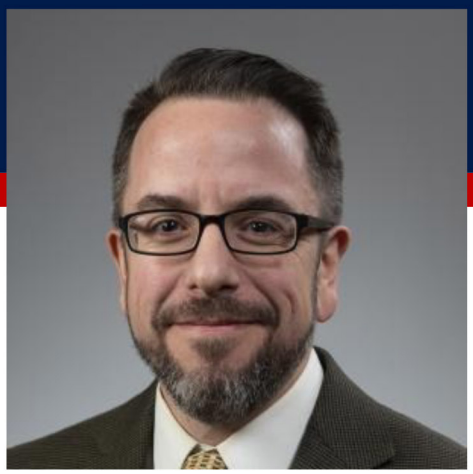
# Polymer Seminar

February 28, 2025

11:15 am Science 1 - Room 1002

*Host: Anson Ma*



## Jonathan Rothstein

Mechanical and Industrial Engineering

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## Non-Newtonian Fluid Structure Interactions: How Viscoelasticity can both Enhance and Suppress Flow-Induced Vibrations in Solid Structures

**Abstract:** When a flexible object is placed in a flow of a Newtonian fluid, it is well known that the shedding of separated vortices at high Reynolds number can drive the motion of the structure. This phenomenon is known as vortex induced vibrations (VIV). The response of the same structures in a non-Newtonian fluid is, however, still not well understood. Unlike Newtonian fluids like water that are characterized by a constant viscosity, the viscosity of Non-Newtonian fluid can vary with shear rate by either thickening or thinning. Additionally, through the addition of high molecular weight polymers or wormlike micelles to a Newtonian fluid, non-Newtonian fluid can exhibit fluid elasticity making the fluids viscoelastic. In this talk, we will show that the addition of viscoelasticity to the fluid can have profound effects on the Fluid-Structure Interactions (FSI). At large Reynolds numbers, where inertia of the fluid is important, we will show that elasticity changes the vortex-shedding patterns creating an elastic boundary layer that pushes vortex formation further downstream of the structure, reducing the interaction with the structure and suppressing the VIV observed for Newtonian fluids. Additionally, unlike Newtonian fluids, the flow of viscoelastic fluids can become unstable at infinitesimal Reynolds numbers due to a purely elastic flow instability. We will show that at these high Weissenberg numbers and zero Reynolds number, the resulting time varying viscoelastic fluid forces can grow large enough to cause a structural motion in much the same way that vortex shedding induces motion for Newtonian fluids. In this talk, we will present our investigations of non-Newtonian FSI through a series of both experimental and computational investigations of the flow fully-characterized viscoelastic fluids past flexible and flexibly mounted cylinders and thin elastic sheets.

**Bio:** Jonathan P. Rothstein is a Distinguished Professor of Mechanical Engineering at the University of Massachusetts – Amherst. He joined the Mechanical and Industrial Engineering Department at the University of Massachusetts in 2001 and has been a visiting faculty at KU Leuven in the Department of Chemical Engineering in 2007 and again in 2015. He has the distinction of having won both an NSF CAREER Award in 2006 and an ONR YIP Award. He has been recognized within the College of Engineering at UMASS with the Outstanding Teaching Award in 2015, the Goldstein Outstanding Junior Faculty Award in 2007 and the Outstanding Senior Faculty Award in 2020. He was the first recipient of Metzner Early Career Award in 2007 from the Society of Rheology along with the SoR Outstanding Service Award. He has won a number of other prestigious awards including the Frenkiel Award from American Physical Society's Division of Fluid Dynamics (APS/DFD) in 2002 and the 3M Non-tenured Faculty Award in 2003.

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