MECHANICAL & AEROSPACE ENGINEERING GRAD STUDENT SEMINAR

Variational Regularization and Adaptive Finite Element Methods: Rigorous Convergence Analysis in Complex Fracture Mechanics

Friday, November 6
11:00 AM
AME Room 106



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ABSTRACT: Understanding and predicting fracture propagation in complex materials remains a central challenge in solid mechanics and applied mathematics. This talk explores rigorous mathematical modeling and adaptive computational frameworks for both quasi-static and dynamic brittle fracture. In the first part, we examine regularized variational models of quasi-static fracture in "strain-limiting" elastic solids, presenting novel adaptive mesh refinement algorithms equipped with robust local error indicators and provable convergence guarantees. In the second part, we transition to dynamic fracture, introducing a convergent adaptive finite element method for phase-field models that couple elastodynamics with Ambrosio-Tortorelli regularization. We discuss how staggered time-stepping and variational inequalities strictly enforce damage irreversibility, enabling the autonomous resolution of complex phenomena such as crack branching and tortuosity. Through these frameworks, we demonstrate how combining analytical convergence theory with intelligent mesh adaptivity yields high mathematical reliability and significant computational efficiency over uniform refinement.

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