DEPARTMENT OF MECHANICAL ENGINEERING
WILLIAM MAXWELL REED SEMINAR SERIES

" Nonlinear behavior of lightweight structures: Influence of the geometric and material properties"

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Abstract: Lightweight structures (e.g., arch, lattice dome, shell, and stiffened shell structures) have been extensively explored and utilized in various industries, especially in aerospace applications. In this talk, I will present my recent works on the nonlinear behavior of lightweight structures resulting from highly geometric nonlinearity and advanced material properties, respectively.

In the first part of the presentation, I will focus on the nonlinear transient behavior and multi-stability of several lightweight structures depending on their geometric conditions. The work aims at developing relations between the analytical models utilized in nonlinear dynamics and continuous lightweight structures in practice. Unlike the traditional linearization-based stability analysis, we work on the stabilities *in-the-large* and the nonlinear transitions, including multiple snap-through behavior for these structures. Numerical simulations based on Finite Element Method (FEM), geometrically exact theory, and branch-switching method will be presented, as well as experimental validations on 3D-printed structures. The study reveals the significant influences of the index-1 saddle equilibria on nonlinear transitions of these lightweight structures and their high sensitivity to geometric conditions.

In the second part of my talk, I will go over my recent work on the nonlinear behavior in lightweight structures caused by complex material properties (e.g., flexoelectricity). Flexoelectricity refers to a phenomenon which involves a coupling of the mechanical strain gradient and electric polarization. This study aims at developing an advanced computational approach in analyzing the crack development in flexoelectric materials at multiple length scales. A meshless Fragile Points Method (FPM) based on local, simple, polynomial and discontinuous trial and test functions is presented, as well as an algorithm for simulating crack initiation and propagation in the FPM with a Bonding-Energy-Rate(BER)-based criterion. The proposed method is efficient, free of mesh distortion and can bypass the tedious numerical integrations in most previous meshfree methods. This work reveals that flexoelectricity, coupled with piezoelectric effect, can help, hinder, or deflect the crack propagation paths and should not be neglected in nano-scale crack analysis.

Bio: Dr. Yue Guan is a currently postdoctoral research associate in the Department of Mechanical Engineering at Texas Tech University (TTU). She received her B.S. and M.S. degrees in civil engineering at Tsinghua University, and Ph.D. degree in mechanical engineering at Duke University. She joined the Center for Advanced Research in the Engineering Sciences at TTU in 2019. Her research focuses on the stability and nonlinear behavior of lightweight structures and developing advanced computational methods at multiple length scales in solid mechanics.

Date: Wednesday April 21st
Place: https://uky.zoom.us/j/92940732923
Time: 2:00PM EDT
Contact: Dr. Alexandre Martin 257-4462

Attendance open to all interested persons

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