ME Seminar

Instabilities in magneto-elastic soft materials

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ABSTRACT

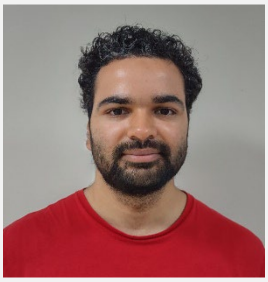
Structural transformations are key to the design and development of adaptive and functional metamaterials. Among the various mechanisms that drive these transformations, elastic instabilities are particularly advantageous due to their sudden and reversible nature, where the characteristics of the instability dictate the material design space. This talk focuses on instability development in magneto-elastic soft materials and demonstrates how the coupling of magnetic and mechanical fields offers a powerful strategy for controlling structural transformations.

In the first part, I will present a class of transformable soft materials that can be magnetically programmed to morph into various encoded patterns by harnessing the interplay between magnetic interactions and instabilities. This system consists of a soft matrix embedded with regularly spaced magnetic inclusions. These inclusions act like programmable defects, guiding the material to transform into specific shapes when triggered. By adjusting the spacing of the inclusions and the strength of the magnetic field, we can control whether the transformation is dominated by mechanical forces or magnetic interactions. Finally, by employing this framework, we design a magneto-mechanical metamaterial in which we program the deformation field to achieve local material densification and demonstrate its use as a strain-tunable vibration absorber.

In the second part of the talk, I will present a composite material made of a magnetoactive layer embedded within a soft, non-magnetic elastomer. The composite is subjected to compressive strains in the presence of magnetic field. Our modeling and experimental study show that the critical buckling strain is highly tunable by the applied magnetic field. In particular, the composite buckles significantly earlier when the field is applied, leading to well-developed controllable wavy patterns in the post-buckling regime.

ABOUT THE SPEAKER

Nitesh is a Postdoctoral Fellow at the Georgia Institute of Technology. He earned his Ph.D. in Mechanical Engineering from the University of Wisconsin-Madison and his bachelor's degree from IIT Roorkee. His work has been recognized with several awards, including the Thomas J. R. Hughes Fellowship, the Distinguished Student Award from APS, and the NSF Presenter Fellowship. Beyond his research, Nitesh actively engages in science outreach and served as an Outreach Fellow for the U.S. National Committee for Theoretical and Applied Mechanics.



10th September 2025, 4:00 PM, Online (MS Teams)