



SEMINAR

APPLIED MATHEMATICS AND MECHANICS

FS982

2 December 2022

A DCAMM seminar No. 763 will be presented by

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Department of Mechanical Science and Engineering (MechSE)
University of Illinois at Urbana-Champaign

The title of the lecture is

**Inverse design and physical realization of mechanical and magnetic metastructures
with programmable nonlinear responses**

Abstract:

The rational design and realization of programmable materials and structures play important roles in enabling functional devices, such as actuators, sensors, and robotics. Yet, the use of heuristically developed structural patterns could lead to restricted design space and potential failure to achieve specific target behaviors.

This talk will first introduce a topology optimization approach to inverse design soft mechanical metastructures, which are precisely programmed with a variety of extreme yet function-oriented responses under large deformations. The synthesized metastructures exhibit organic geometries and motions with irregular distribution of different material phases. Within the structure, different hyperelastic materials play distinct roles yet seamlessly collaborate through sophisticated deformation mechanisms. In addition, the properties of metamaterials and metastructures typically remain fixed after being designed. To enable reprogrammable behaviors, we introduce a magneto-mechanical topology optimization approach to generate magnetic metamaterials with responses that can be altered by external magnetic fields. The obtained magnetic metastructures exhibit one response under purely mechanical loading, and switch to a distinct response under simultaneous mechanical and applied magnetic fields.

With proposed optimization frameworks and hybrid fabrication, we design and fabricate a library of mechanical and magnetic metastructures that realize a wide range of precisely programmed nonlinear responses, including multi-plateau, switchable deformation, and adaptable snap buckling. These switchable yet programmable mechanical responses are enabled by the interactions among unique geometry, large deformations, and magnetic actuation (when applicable). The proposed optimization-driven computational design strategies can be utilized to design and realize multi-functional devices in various applications.

DATE:	Tuesday, 13 December 2022
TIME:	14:00 – 14:45
PLACE:	Building 414, Room 061B DTU, Technical University of Denmark

Danish pastry, coffee and tea will be served 15 minutes before the seminar starts.

All interested persons are invited.

Niels Leergaard Pedersen

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