CCEE Structures & Mechanics (SEM) Seminar – Mon. June 28th (1:45 - 3:00 pm)

Zoom link: https://ncsu.zoom.us/j/98200034791?pwd=OTJYQmk1anhTdGRPWHV3eWpjRDJEUT09

Passcode: 11235

Material Design Using Topology Optimization

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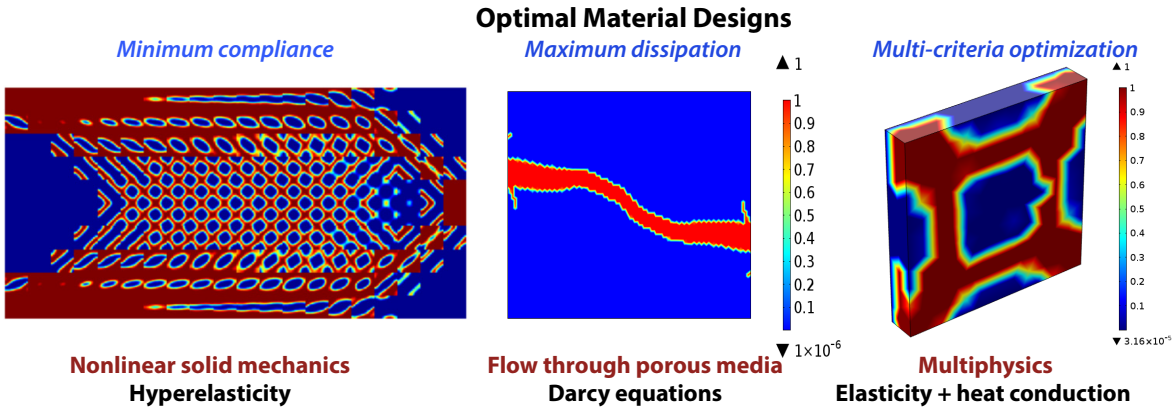
Abstract: Topology optimization (TopOpt) is a leading design procedure for obtaining optimal material layouts. Since TopOpt is a mathematically driven approach, the entire design procedure is automated with minimal or no human intervention. An attractive feature of TopOpt is its ability to introduce new boundaries (holes) into the design space; thus, TopOpt can produce final material layouts that differ entirely from initial guesses. This presentation details a design framework to obtain optimal material designs for various engineering applications. The talk will highlight my group's efforts to fill in several aspects of the knowledge gap: (i) analytical solutions for canonical problems that give a more profound understanding of optimal designs. (ii) A viable approach for incorporating manufacturing constraints into the design space, thereby improving the synergy between design and fabrication. (iii) A framework for multi-criteria optimization to handle a class of multi-physics design problems. *First*, I will present a two-scale topology optimization framework—design variables at the microscale and desired goal at structure (macro) scale—for nonlinear elasticity; this framework is suitable for applications such as armor design and metamaterials. *Second*, by utilizing the dissipation rate, I will outline a robust design framework for flow through porous media applications; for these problems, the usual objective functions such as compliance and minimum power principle are not applicable. *Third*, I will illustrate optimal material designs for heat management in structural systems—a multi-criteria optimization problem. The talk will conclude with an outline of an ongoing effort of designing periodic wave barriers and foundations using TopOpt for mitigating damage to infrastructure due to earthquakes.



Bio: Professor Kalyana Nakshatrala is an associate professor in the Department of Civil and Environmental Engineering with a courtesy appointment in Mechanical Engineering at the University of Houston (UH). In 2019, he was a faculty associate at the California Institute of Technology. Before becoming a faculty member, he was a postdoctoral research associate at the University of Illinois at Urbana-Champaign (UIUC) in collaboration with Los Alamos and Pacific Northwest National Laboratories. Nakshatrala received his Ph.D. in Civil Engineering with a certificate in Computational Science and Engineering along with two M.S. degrees, one in structural engineering and the other in applied mathematics, from UIUC. He obtained his bachelor's degree in Civil Engineering from the Indian Institute of Technology-Madras. Professor Nakshatrala is devoted to student mentorship and recently had a PhD advisee win first prize at the 2018 Engineering Mechanics Institute Conference and another doctoral student win the 2016 Robert J. Melosh Medal, an international award given to the best student paper in Computational Mechanics. He has also been recognized for his dedication to teaching, including the 2019 Kittinger Teaching Excellence Award—the highest teaching honor conferred by the Cullen College of Engineering at UH. He remains active in the academic community as an associate editor for the ASCE *Journal of Engineering Mechanics* and serves on the early career research board for IOPScience's *Multifunctional Materials.*