MHRD Scheme on Global Initiative on Academic Network (GIAN)

Blast and Shock Resistant Bio-Inspired Functional Materials Design Methodologies

Overview

Conventional materials, such as metallic alloys, ceramics, cementitious materials, graphite/glass fiber reinforced woven and unidirectional composites are heavy and fail to provide adequate protection under extreme loading conditions, (e.g. high-energy blast or ballistic protection). The design of ultralight weight structures with enhanced blast and ballistic resistant properties and characteristics for hazard mitigation would require complex heterogeneous, functionally graded, layered composites. A variety of biological systems exhibit unique microstructural constructions that are tailored to provide exceptional functional response to dynamic loading conditions. For instance, fish scales are known to exhibit enormous resistant to penetration loading. A fish scale contains two to three distinct layers with saw tooth type anchoring structural features in addition to the gradation of hydroxyapatites and collagens. The rostrum of a paddle fish and beak of a woodpecker are functional materials with microstructures to absorb energy and momentum in a most efficient manner. The geometrical and material architectures are highly nonlinear with a wide variety of biomolecules providing resistance to defect nucleation and growth that are essential to absorb energy. The nonlinear geometries and materials generate ideal pathways to disperse and attenuate stress wave propagation to efficiently manage intense loadings. To design ultralight weight structures with high strength and toughness, biological systems provide unique design concepts such as the mechanisms involved in mitigating damage progression due to the gradation of protein like collagen fibers along the layers. The ability to design new material system would require characterization and modeling of biomaterials at all length scales and under high strain rate and shock loading conditions. With the advent of 3-D printers, it is now possible to print thin layers with wide range of properties. Bio-inspired systems provide certain design methodology to organize and arrange the various layers of dissimilar materials, from crystalline ceramics to heterogeneous biodegradable wood products. The fundamental elastic properties can be determined using representative volume element based finite element analyses using high resolution models. Dynamic experimental methods such as the split Hopkinson bar and shock tubes provide testbeds to characterize and validate the manufactured functionally layered material panels.

The primary objectives of the course are

i) Exposing the participants to the multi-physics fundamentals of bio-inspired material systems;

ii) Providing Details of Nano / Micro / Meso level characterizations of a few Bio-Inspired Material Systems

iii) Providing fundamentals of Quasi-Static, High Strain Rate and Shock Wave Experiments

iv) Providing constitutive modeling methodology and computational simulation techniques related to the design analyses of advanced functionally layered composite panels

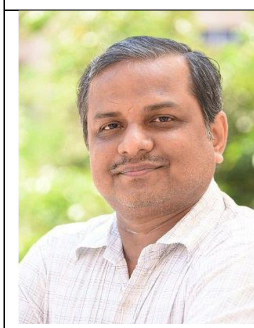
v) Providing case studies related to a few selected biomaterial systems

This course is intended for graduate as well as advanced undergraduate students, post-doctoral research associates, government researchers, academic professionals, and practicing engineers. Course participants will learn these topics through lectures and assignments.

Modules	Duration: **January 10- January 21, 2022** Time: **5:30 PM to 9:30 PM (IST)** Lectures will be delivered in **virtual mode** **Who should attend?-** Students, faculty members and other professionals working in the area of mechanical engineering, civil engineering and materials science and engineering
Fees	The participation fees for taking the course is as follows: **Participant from abroad (other than SAARC countries) : USD 100** **Participant from Industry/ Research Organizations : INR 3000** **Participant from Academic Institutions (Faculty) : INR 1500** **Students : INR 200** **SAARC country participants:** Fees are the same with the fees for the Indian participants.

The Faculty

Prof. A. M. Rajendran is the Chair and University Distinguished professor of the Mechanical Engineering Department at the University of Mississippi, Oxford, MS, USA. He is an elected Fellow of the American Society of Mechanical Engineers, Fellow of the Society of Engineering Sciences, Distinguished Fellow of ICCES, and Emeritus Fellow of U.S. Army Research Laboratory. He has published book chapters and several journal articles on bioinspired material systems. He received his PhD from the University of Washington, Seattle, WA, USA in 1981.



Prof. Niranjan Sahoo is affiliated to Mechanical Engineering Department at Indian Institute of Technology Guwahati. He received PhD degree from Indian Institute of Science Bangalore, in the year 2004. He is the recipient of BOYSCAST research fellow from DST – New Delhi and DAAD research fellow from DAAD–Germany. His research interest is mainly, in the area of shock wave experiments, impact assessment and deformation behavior on materials, measurement diagnostics and instrumentation for short duration experiments. He has more than 100 research publications in peer reviewed journals and conferences.

Dr. Prasenjit Khanikar is an Assistant Professor of Mechanical Engineering Department at the Indian Institute of Technology Guwahati. He received his PhD from North Carolina State University, and thereafter, he worked as a Postdoctoral Research Scientist at Columbia University in the City of New York. His research interests are 3D-printed mechanical metamaterials, high entropy alloy and high strain rate material behavior.

Course Coordinators

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