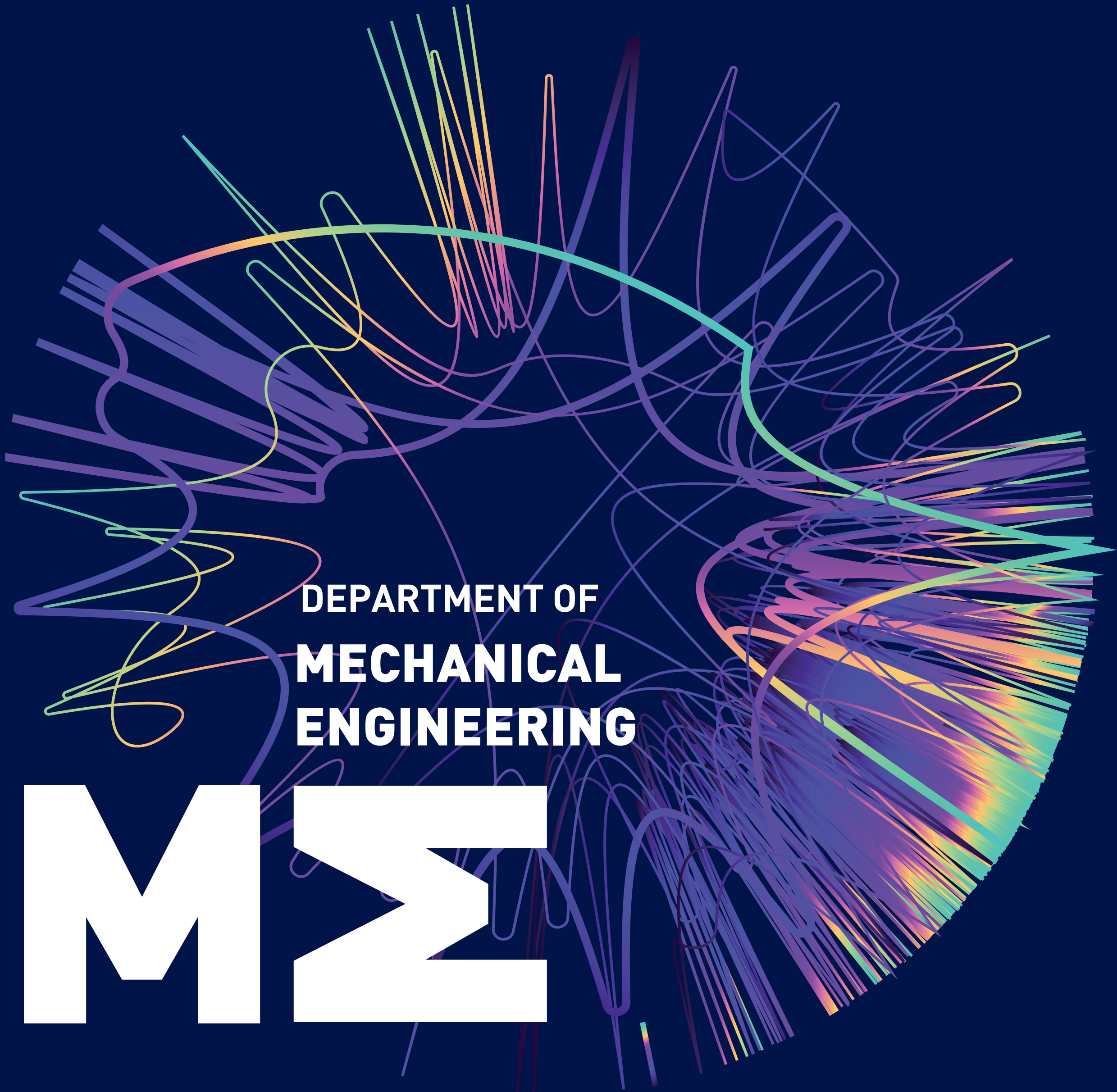


DEPARTMENT OF

MECHANICAL ENGINEERING

MΣ

INDIAN INSTITUTE OF SCIENCE

FOREWORD

Welcome to the Department of Mechanical Engineering at IISc Bangalore!

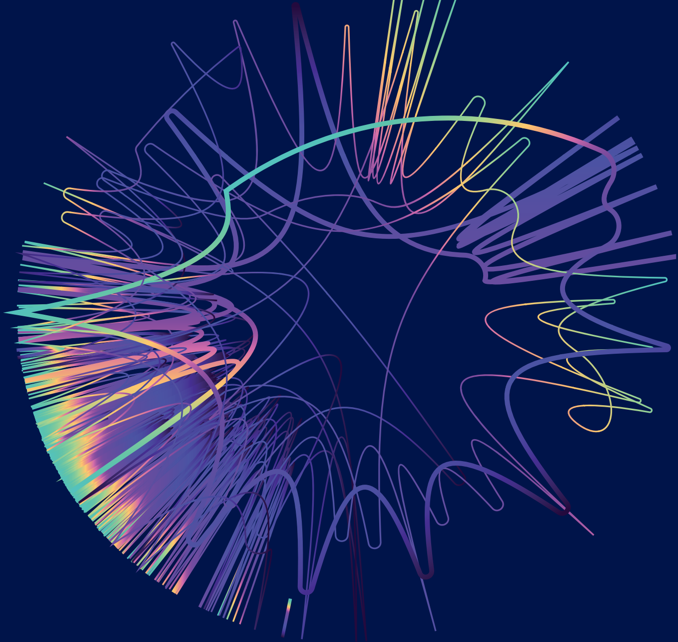
The origins of Mechanical Engineering at IISc, or ME as it is popularly known, can be traced back to the establishment of Internal Combustion Engineering in 1945 and Power Engineering in 1951. Born in an institution that was primarily focused on fundamental sciences, ME has played a pivotal role in creating technologies at the heart of engineering innovation in and beyond the walls of IISc.

Research in ME has evolved over the decades, and now spans a broad range of areas including Biomechanics, Vibrations & Acoustics, Mechanical Systems & Design, MEMS, Manufacturing & Materials processing, Energy Technologies, Solid & Fluid Mechanics, Thermal sciences, and Nano-mechanics & Tribology. These fields encompass traditional aspects of engineering that represent current technological needs, as well as emerging fields that will shape the future. The nature of research at ME has always meant that our department has been earmarked for initiating interdisciplinary programs – our faculty have pioneered the establishment of Centres for Product Design and Manufacturing, Nano-science and Engineering, BioSystems Science and Engineering, and for Energy Research at IISc.

As one of the best of its kind in the country, ME attracts not only young faculty from across the globe, but also the best students to campus. Our post graduate program strives to create the next generation of engineers, researchers and technology entrepreneurs. Our students go on to become faculty at premier institutions, scientists at R&D labs, leaders in industry and founders of start-ups.

With enthusiastic students and inspired faculty, ME will remain dedicated to excellence in research and teaching, to leading technological progress, to embracing diversity, and to taking on grand challenges in service of our society. We are ready to create the future.

Pradip Dutta
Chair
ME, IISc
January 2019



DEPARTMENT OF
MECHANICAL ENGINEERING

A BRIEF HISTORY OF THE DEPARTMENT

Mechanical Engineering activities at IISc started off in 1945 as the Department of Internal Combustion Engineering (ICE). The Mechanical Engineering section of the Power Engineering Department followed suit in 1951. A full-fledged Department of Mechanical Engineering (ME) was formed in 1956 with Prof. Arcot Ramachandran as the first chairman. His vision and leadership were instrumental in setting up the Department to address the growing technological needs of the nation. Later in 1972, ICE merged with ME under the leadership of Prof. L. S. Srinath. The Department moved its current premises on Mirinji Marg in 1994.

Thanks to the diverse and interdisciplinary nature of its research, ME has always been deeply involved in technological projects of national significance, development of indigenous expertise in new thrust areas, and has been well supported by grants from the University Grants Commission, Department of Science and Technology (DST), Ministry of Human Resources Development, the All India Council for Technical Education, and the Centre for Technology Development. For instance, ME played a key role in missions initiated by the Planning Commission of 1998 to develop technologies in the areas of Food Process Engineering and Ceramic-Metal composites. In the same year, with support from DST, the Facility for Research in Technical Acoustics was established to create a hub for research and development in Acoustics and Noise Control. The National Facility for Semisolid Forming, established in 2004 with aid from DST, DRDO and the Ministry of Mines, pioneers the development of light weight automobile components using Thixocasting processes.

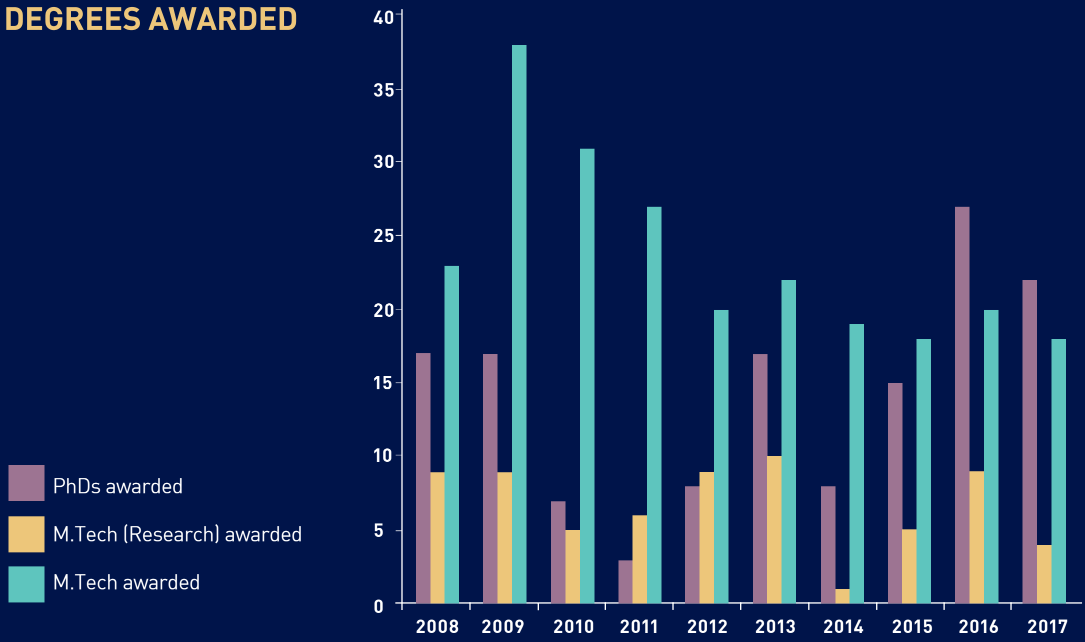
Besides national missions, ME has been actively engaged in industrial and socially relevant research in collaboration with public/private sector industries and with DRDO, ISRO and Atomic Energy laboratories. ME faculty have been proponents in facilitating technology transfer to industries and R&D labs. For example, Micro-hydel power generators developed at ME have been installed at sites all over India. As a first-of-its kind collaboration between academia and industry, the Advanced Product Design and Prototyping facility was established in 1996 as a 50:50 joint venture between IISc and Tata Consultancy Services to serve as a high-end design and prototyping centre.

ME faculty have led the formation of new centres for interdisciplinary research at IISc. ME was actively involved in setting up the Centre for Application of Science and Technology for Rural Areas in 1974, known today as the Centre for Sustainable Technologies, to develop bio-energy alternatives. The Masters in Design program initiated by the Department in 1997 ultimately helped create the Centre for Product Design and Manufacturing. The Centre for Nano Science and Engineering setup in 2010 brought together researchers engaged in diverse studies on nanoscale systems. In 2012, ME helped form the Interdisciplinary Centre for Energy Research to lead energy initiatives at IISc. Most recently, the Bio Systems Science and Engineering Centre was setup in 2015 to bring engineers and biologists under a common roof.

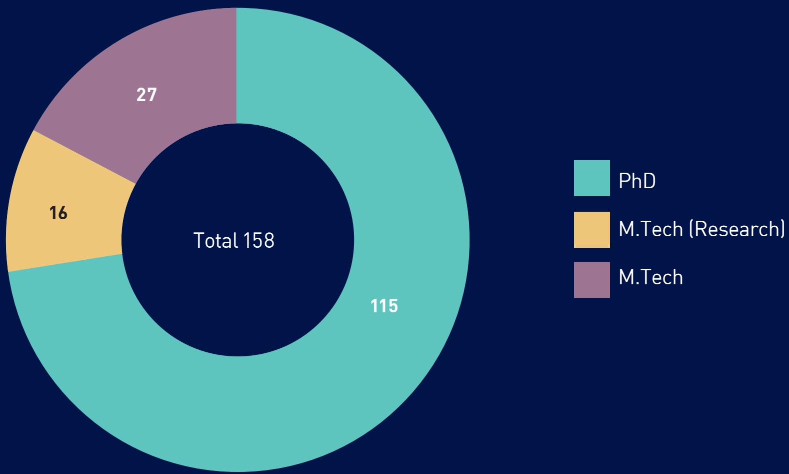
As ME marches towards its Platinum Jubilee, we reflect on the pioneering role it has played in shaping postgraduate education, research and development in Mechanical Engineering in the country to take pride, as well as to guide our future directions. Whether it be maneuvering machines or manipulating bytes, one thing is certain- ME will strive for excellence in the decades to come.

ME IN NUMBERS

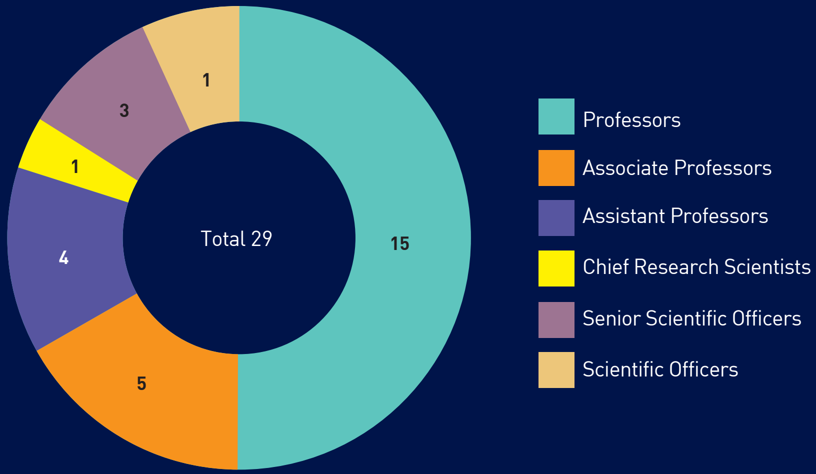
DEGREES AWARDED



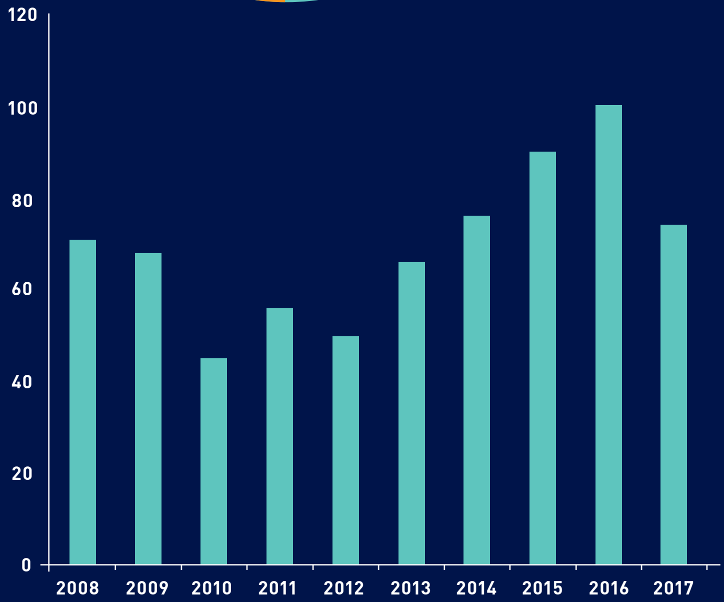
CURRENT STUDENT ON ROLL



FACULTY MAKE-UP



YEARLY PEER-REVIEWED JOURNAL PUBLICATIONS



FACULTY FELLOWSHIPS

Indian National Science Academy Fellowship (FNA) : **2**
Indian Academy of Sciences Fellowship (FASc): **3**
National Academy of Sciences (India) Fellowship (FNASc): **1**
Indian Academy of Engineering Fellowship (FNAE): **6**
ASME Fellowship: **2**
Shanti Swarup Bhatnagar Prize: **2**
JC Bose National Fellowship: **2**
Abdul Kalam National Fellowship: **1**
DST Swarna Jayanti Fellowship: **2**

RESEARCH AREAS

Acoustics and Vibrations

With applications ranging from noise control and passenger comfort in automotives to covert operation of submarines, research in acoustics and vibrations addresses fundamental questions having immediate practical applications. Recent work in the area includes:

- Understanding nonlinear sound-structure interaction by studying wave propagation in flexible waveguides.
- Modeling sound radiation and transmission in perforated panels using analytical and numerical approaches.
- Investigating asymptotic solutions methods to study sonic booms caused by supersonic jets.

Biomechanics and Biomedical devices

Recognizing the critical role of mechanics in biology, research in biomechanics and biomedical devices addresses fundamental questions at cellular scales as well as develops new devices and point-of-care diagnostic tools. Recent projects include:

- Understanding processes governing the formation of biofilms and devising ways to exploit them in engineering applications.
- Characterizing cell-substrate interactions using a combination of experimental and computational methods, which helps explore cytoskeletal remodeling associated with cancer metastasis.
- Developing tools and techniques to manipulate (e.g., grasp, roll, squeeze, peel, probe and inject) single biological cells.
- Understanding the interaction of Hepatitis-C viruses and liver cells.
- Analyzing the role of Heomodynamics in the initiation, growth and rupture of atherosclerotic plaques and aneurysms.
- Designing new sensors to measure intra-cranial pressure in brain tissues.
- Developing endoscopy simulators with haptic feedback and advanced graphical interfaces to train medical professionals.

Robotics & Design

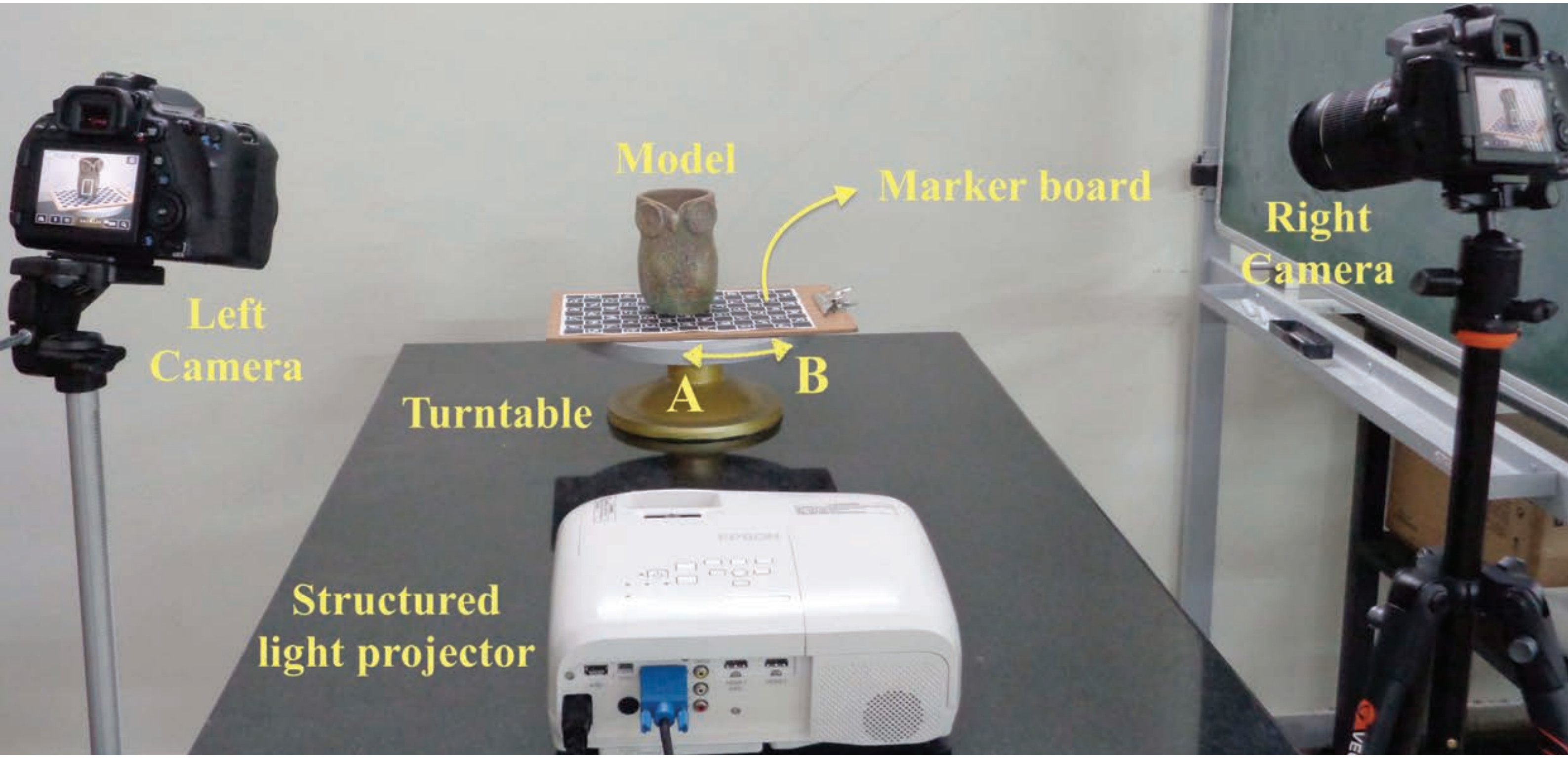
Research in robotics and design is geared to address requirements in automation and control of cyber physical systems. Recent projects include:

- Analyzing parallel manipulators and their applicaton for grasping tasks.
- Developing sun tracking manipulators to be integrated with concentrated solar power systems.
- Developing algorithms for motion planning in hyper-redundant and snake robots.
- Developing tools and actuators for minimally invasive surgical procedures.
- Understanding how the nervous systems utilizes redundancy, with application to treating ailments accompanied by loss of motor control.
- Modeling and analyzing wheeled mobile robots that are capable of negotiating uneven terrain with minimal slip.

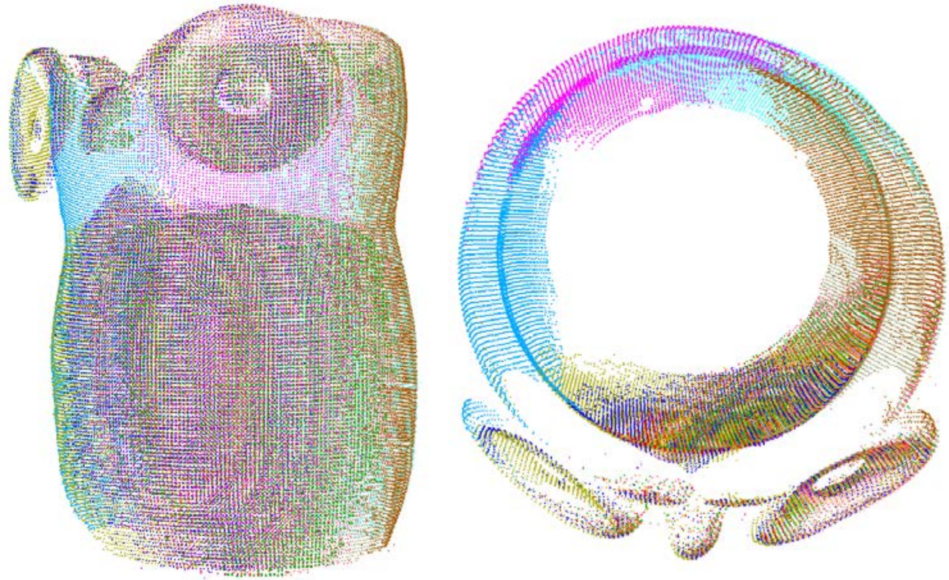
Computer Aided Design

Research on CAD and allied areas spans diverse aspects of feature-based modeling, reverse engineering, 3D geometry reconstruction, mesh generation, as well as more abstract topics related to representation of and reasoning with 3D models. Recent work includes:

- Modeling heterogenous objects by integrating material information with geometry using medial axis transforms.
- Developing representation methodologies for geometries composed of natural materials (e.g., bones, rocks, meteorites) with random and irregular distributions for use in additive manufacturing, implants and tools.
- Manipulating mesh-based models using annotations, interactive viewing, slicing, remeshing, segmentation, simplification and editing.
- Registering heterogeneous data sets including point clouds, curves and surfaces using variational algorithms for machine vision applications.



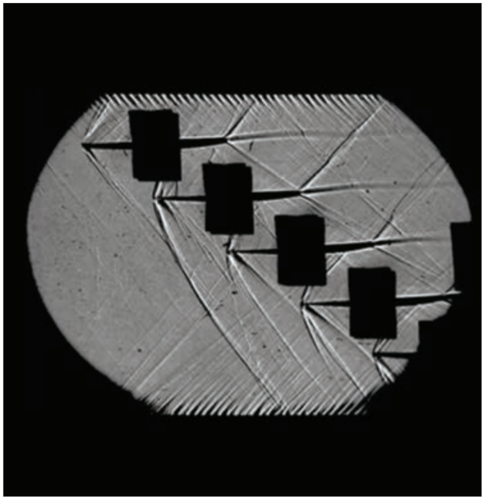
Indigenous low cost structured light scanners developed at ME use novel algorithms to construct digital avatars of prototypes/artifacts from a few photographs within a matter of seconds.



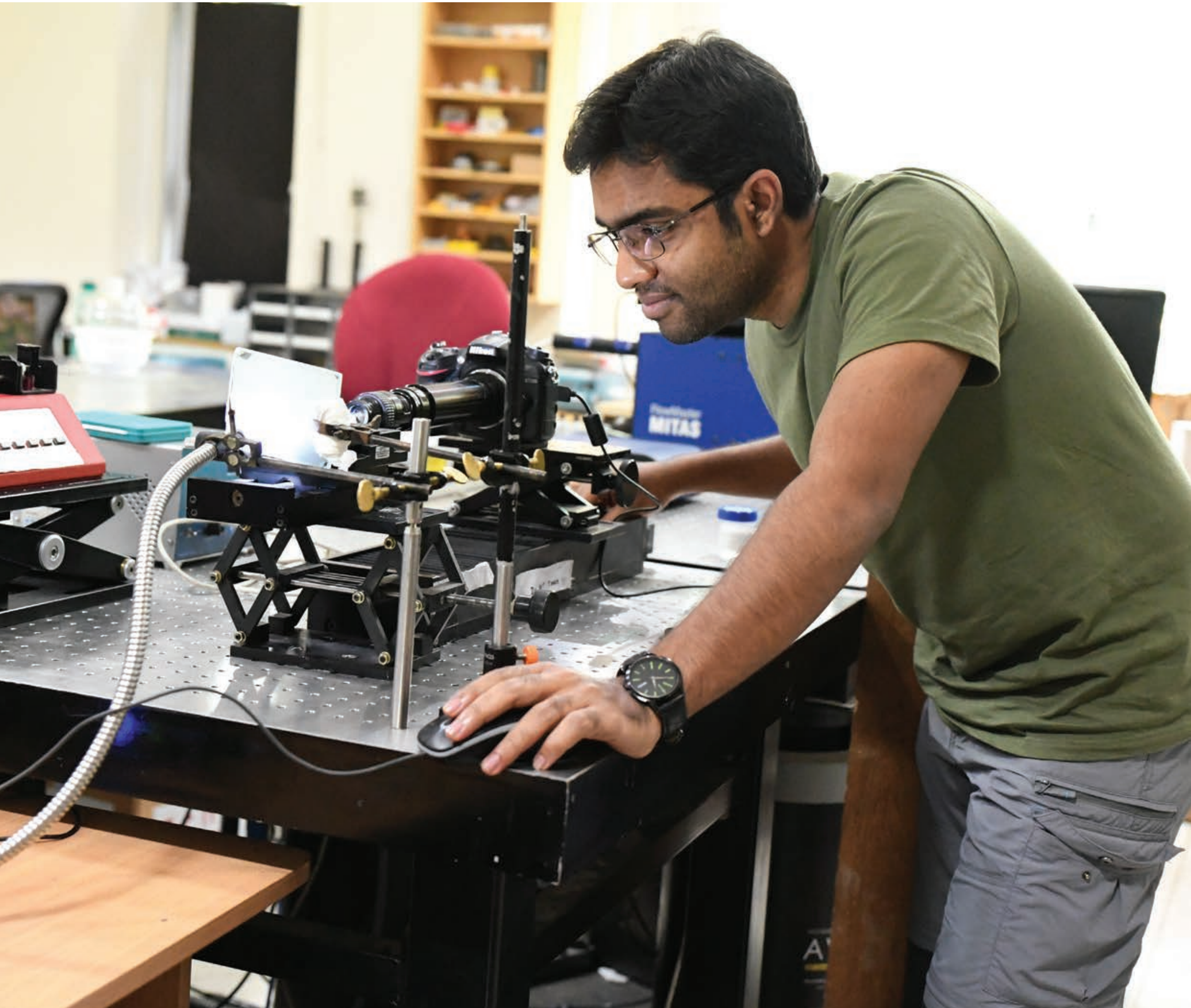
Fluid Mechanics & Flow Physics

A range of fluid mechanics phenomena spanning a multitude of length and time scales are being studied using novel experimental and computational techniques. Recent studies include:

- Developing models for turbulent flow dynamics in Rayleigh-Benard convection with application to understanding micro-physics of droplets in cloud formation and precipitation.
- Understanding optimal water/nutrient requirements and quantifying moisture losses from plants and soils for precision agriculture.
- Reducing drag by understanding complex interactions of bubbles with turbulent structures in boundary layers using experimental studies of bubble-vortex interactions.
- Studies on flutter and shock boundary layer interactions in transonic/supersonic flows occurring in aircraft engines.
- Designing bio-inspired thrust-generating systems for autonomous underwater vehicles and exploiting flexible structures to mimic aquatic locomotion.
- Developing high fidelity computational tools for high speed compressible multiphase flows and atomization of jets.
- Controlling chemical reactions and combustion rates by manipulating drops and bubbles using electric fields.



Density gradient-based flow visualization showing shocks near oscillating compressor blades to help understand flutter of aircraft engine compressor blades.


Nikon
MITAS

Manufacturing & Tribology

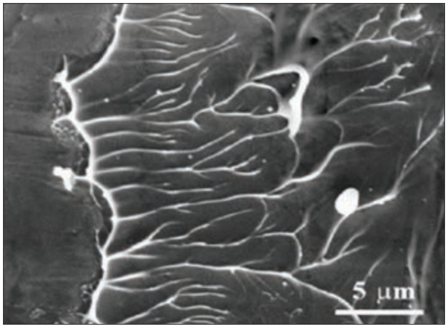
Research activities in the areas manufacturing and tribology at ME broadly focuses on understanding process-specific mechanics and material-specific mechanisms that underlie various manufacturing and finishing processes, with the goal of improving existing techniques and to guide the development of new technologies for novel materials. Recent studies include:

- Understanding deformation and flow properties in cutting and forming processes using in situ diagnostics (high-speed and Infra red imaging) and ex situ techniques (profilometry, electron microscopy).
- Processing mechanics of soft materials such as elastomers and natural polymers.
- Exploiting mechano-chemical effects to develop surface finishing processes for precision components.
- Tandem mechanical and electro-polishing of metallic components to control roughness amplitudes over a large range of frequencies.
- Developing experimental models to study complex interactions between geometry and material properties in multi-asperity contact.
- Analyzing process parameters in friction stir welding of similar and dissimilar materials (Aluminum, Copper, Titanium, Steel and Magnesium) with detailed studies of grain stability.
- Improving strength of Copper-Polymer derived ceramics without loss of ductility using friction stir processing.
- Developing new mechanical joining methods, namely, Single Material Self Pierce Riveting and Self Lock Butt Riveting, to improve joint strength.
- Understanding friction mechanisms in extrusion processes, friction drives and impact scenarios.

Mechanics of Solids and Structures

A combination of experimental methods, computational tools, numerical algorithms and expertise on material models forms the basis of research on mechanics of solids and structures. Recent work in the area include:

- Devising testing methods for extending fracture testing to thin films and coatings.
- Modeling dynamic loading on plates, shells, tubes and honeycombs to design blast and impact resistant shields for defense and space applications.
- Understanding fracture mechanisms in ductile materials to improve fracture resistance in polycrystalline alloys.
- Combining experimental observations and simulations to understand fracture in bulk metallic glasses.
- Using mechanics, structural & topology optimization to design compliant mechanisms with applications in cell mechanics, MEMS and biomedical devices.
- Analyzing and designing bistable arches in compliant mechanisms.
- Using biomechanics principles to understand arteries in healthy and diseased conditions.
- Understanding the mechanics of how instects bore into substrates to gain insights on developing engineering cutting tools.
- Modeling, simulating and measuring shapes of three-dimensional buckled elastic ribbons.
- Exploiting nonlinear geometric models to design and control flexible robots.
- Devising novel finite element methods for multi-physics problems.

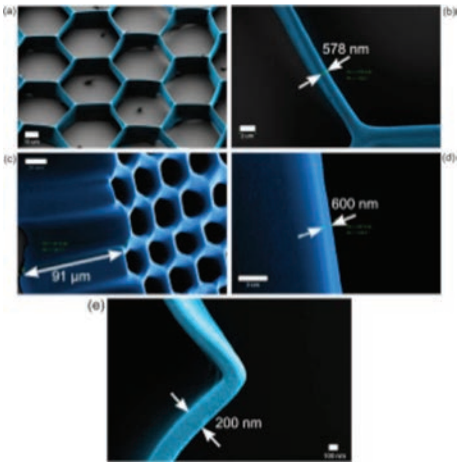


The mechanism of fracture on the surface of a Zirconium-based bulk metallic glass resembles a Taylor-Saffman instability in a fluid meniscus.

Micro and Nano Scale Processes and Devices

Research in area spans varied areas from mechanics of solids and fluids at small length scales, micro-scale transport phenomena, as well as design and fabrication of miniature sensors and actuators. Recent projects include:

- Texturing surfaces at microscales for application in thermal management systems.
- Patterning microfluiding devices using opto-electro-kinetic techniques.
- Understanding the mechanics and morphology of sessile colloidal droplets, with applications in 3D printing and DNA sequencing technologies.
- Fabricating nano-composite coatings suitable for tribological applications that require high hardness and wear resistance.
- Developing displacement and force amplifying devices using joint-less compliant mechanisms for use in grippers, cell manipulators, accelerometers, XY-stages and force sensors.
- Analyzing multi-physics sensors for MEMS devices using advanced numerical algorithms.



High-aspect ratio nano-scale structures designed to be used as scaffolds for cell culture

Thermal Sciences and Energy Systems

By exploiting principles of thermodynamics, heat & mass transfer, and detailed understanding of chemistry, research in thermal sciences and energy systems seeks to improve efficiencies of conventional systems and devise new ones. Examples of recent work in the area include:

- Designing, developing and fabricating thermal energy storage devices for solar thermal power generation.
- Generating highly efficient thermal power using super-critical Carbon Dioxide as the working medium.
- Using laser diagnostic techniques to study combustion and spray processes in internal combustion engines, gas turbines and industrial burners.
- Designing, developing and testing laboratory scale model for SCRAMJET engines.
- Developing novel atomization techniques for indigenous biofuels.
- Developing strategies for enhancing thermal and fluid transport using micro- and nano-textured surfaces with engineered wettability.
- Producing Aluminum alloys with non-dendritic structures using electromagnetic stirrers for billet casting.
- Producing net-shaped automotive components using Thixocasting.

FACULTY

ASHITAVA GHOSAL

PROFESSOR
Ph.D., Stanford University, 1986
M.S., University of Florida, 1982
B.Tech IIT Kanpur, 1980

DETAILS OF RESEARCH

The main research areas in the Robotics & Design laboratory headed by Prof Ghosal concern the analysis and design of robots and multi-body computer controlled mechanical systems, theoretical kinematics, non-linear dynamical and control systems, and product design. Prof Ghosal's group focuses on exploring associated theories, development of algorithms, software and hardware, experimental work to validate theories and algorithms, and prototyping. His group has worked extensively in the area of hyper-redundant robots and have developed new algorithms and for obstacle avoidance. Their studies on human hands reveals that exploring and exploiting redundancy present in the arm is crucial in learning to adapt quickly to external stimuli.

The group is actively involved in analyzing and designing parallel manipulators. Sun tracking parallel manipulators developed by the group are cheaper, have better pointing accuracy and are structurally robust to wind loading. Towards designing minimally invasive surgical instruments, the group has developed a laparoscopic tool that provides surgeons more flexibility, visibility and easy obstacle avoidance.

THE GROUPS WORK ON MODELING AND ANALYZING MULTI-FINGERED HANDS AS PARALLEL ROBOTS REVEALS WHY WE CAN MANIPULATE A CRICKET BALL MUCH BETTER THAN A MARBLE OR A BASKETBALL.

Simulations and experiments demonstrating motion planning and obstacle avoidance in hyper-redundant robots.

TEACHING

Dynamics and Control of Mechanical Systems
Introduction to Robotics
Computer Aided Product Design

WEB LINK: mecheng.iisc.ac.in/~asitava

ALOKE KUMAR

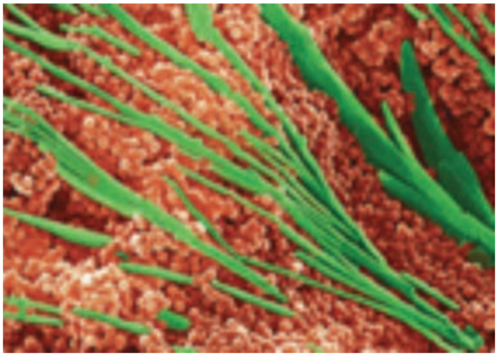
ASSISTANT PROFESSOR
Ph.D., Purdue University, 2010
M. Tech., IIT Kharagpur, 2005
B. Tech., IIT Kharagpur, 2005

DETAILS OF RESEARCH

The overarching goal of Prof Kumar's laboratory is to understand the behavior of soft materials. Qualitatively speaking soft materials differ from traditional metals and solids by displaying significant viscoelastic behavior. Biological materials are excellent examples, for instance. The group studies how bacteria and bacterial colonies respond to mechanical stresses and high strain rates. Such fundamental work has implications for a host of applications ranging from environmental and biomedical sciences. For instance, understanding the response of soft materials to impact loads will shed light on injury prevention.

Broadly, Prof Kumar's group woks at the intersection of engineering, mechanics and biology. The interdisciplinary nature of the group's research attracts students and collaborators who are mechanical, chemical, and bio-engineers, microbiologists, and even environmental scientists.

SOFT MATERIALS SHOW A RICH VARIETY OF BEHAVIOR, THAT OFTEN CHALLENGES OUR INTUITION WHICH IS BASED ON AN UNDERSTANDING OF NEWTONIAN FLUIDS.



Interaction between particles and polymers reveals a beautiful landscape that resembles a composite structure.

TEACHING

Experimental Methods on Microfluidics
Introduction to Soft Matter

WEB LINK: www.kumarlab.com

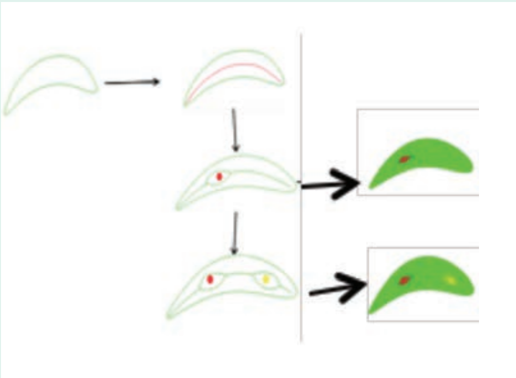
B GURUMOORTHY

PROFESSOR
Ph.D., Carnegie Mellon University, 1987
M.E., Carnegie Mellon University, 1984
B.Tech., IIT Madras, 1982

DETAILS OF RESEARCH

Research in the CAD Laboratory focuses on constructing and manipulating product information models during different phases in the product life cycle. Problems addressed include development of computer operators to construct such models and algorithms for reasoning with them to automate tasks in the product life cycle. Starting from feature based shape models, work in the laboratory has now progressed to adding information pertaining to attributes such as material and behaviour. In manufacturing, the lab focuses on studying how predictive models built with rich sensory information can be applied in machines that do not have a rich data layer. Computational Metrology addresses reasoning problems in the inspection stage, with recent research addressing issues related to inspecting deformable structures. Interoperability of the information models across the different tasks in the life cycle is another area of ongoing research.

RESEARCH AT THE CAD LABORATORY ADDRESSES PROBLEMS RELATED NOT JUST WITH REPRESENTING PRODUCT MODELS, BUT ALSO REASONING WITH THEM.



Constructing complex material distribution using non-manifold material features

TEACHING
Geometric Modelling for CAD
Elements of Solid and Fluid Mechanics
Computer-aided Design
Computer-aided Product Design

WEB LINK:
www.mecheng.iisc.ac.in/~bgm

C DHARUMAN

SENIOR SCIENTIFIC OFFICER
M.Sc. Engg., IISc, Bangalore, 2002
M.Sc., Anna University, 1984

DETAILS OF RESEARCH

Mr Dharuman's lab is broadly interested in solar energy, heat transfer and fluid mechanics. His group designs and develops new types of integrated solar water heater systems and solar energy-based desalination systems. The other major research activities in his group concerns flow visualization and measurements techniques in fluid mechanics using Particle Image Velocimetry (PIV). Using a free surface water tunnel, his group studies flow around large submerged or semi-submerged bodies at moderate speeds (<1 m/s).

MR DHARUMAN'S LAB IS CURRENTLY WORKING ON USING HEAT TRANSFER AND FLUID MECHANICS PRINCIPLES TO DESIGN AND OPTIMIZE POLYHOUSES FOR AGRICULTURAL PURPOSES.

WEB LINK:
http://www.mecheng.iisc.ac.in/users/dharuman

CHANDRASHEKHAR S JOG

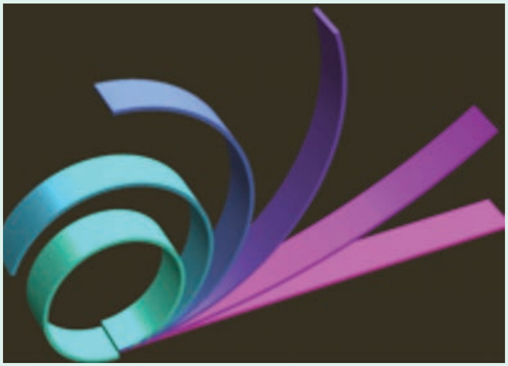
PROFESSOR
Ph.D., University of Illinois, Urbana-Champaign, 1994
B.Tech/M.Tech., Dual Degree, IIT Bombay, 1988

DETAILS OF RESEARCH

It is well known to finite element analysts that standard displacement-based elements `lock' while analyzing thin structures such as beam, plates or shells. Prof Jog's group develops hybrid-stress finite element methodologies to alleviate this issue in the general context of problems with material and geometric nonlinearities. The group develops new elements for static as well as transient analyses, that show significant improvement in accuracy compared to existing elements and facilitate straightforward application of material constitutive laws for thin structures.

The hybrid finite element strategies developed can help design more robust algorithms since the analysis using these elements is more accurate and cost effective compared to the results obtained using conventional strategies available in standard finite element software. As an example, the MEMS modules developed by the group can help in the design and development of MEMS devices.

PROF JOG'S RESEARCH GROUP IS INVOLVED IN THE DEVELOPMENT OF NEW FINITE ELEMENT STRATEGIES FOR SOLVING MULTI-PHYSICS PROBLEMS.



The problem of Euler's Elastica solved using the hybrid finite element method.

TEACHING

Continuum Mechanics
Engineering Mathematics
Finite Element Methods

WEB LINK:
www.mecheng.iisc.ac.in/users/jogc

DIBAKAR SEN

PROFESSOR
Ph.D., IISc Bangalore, 1997
M.Sc. Engg., IISc Bangalore, 1992
B.E., NIT Durgapur, 1989

DETAILS OF RESEARCH

Research in the Applied Geometry and Mechanisms laboratory headed by Prof Sen investigates motion, shape and their interaction in diverse areas ranging from theoretical and computational kinematics, mechanisms, CAD to Virtual Reality and Haptics. The group's work on understanding the kinematics of smooth forms in contact is critical for robotic grasping and fixture design. By analysing the compatibility of geometric features, the group has developed highly intuitive drag-and-drop type methods for modelling mechanical assembly. To assemble, it is important to know both the sequence and the path to be followed by each component. To this end, the group developed novel techniques to efficiently and accurately perform thousands of boolean operations of mixed dimensional tessellated objects and solved the sequencing problem for orientation preserving paths..

Human performance in menial jobs involves a diversity of capabilities, decisions and outcome variability. Prof Sen's group is interested in simulating natural human performance through autonomous whole-body posturing, grasping and functional vision modeling by modelling realistic interactions, human cognition, knowledge, skill and decision processes to emulate physical realism and performance variability which potentially causes accidents.

DIGITAL HUMAN MODELING INTEGRATES KNOWLEDGE OF KINEMATICS, GEOMETRY, ERGONOMICS, HUMAN PHYSIOLOGY AND COGNITION FOR SIMULATING SHOP-FLOOR PROCESSES TO ASSESS VULNERABILITIES IN HUMANS AND TASKS.

Simulation of a digital human model to demonstrate reach with static stability.

TEACHING

Geometric modeling for CAD
Mechanism Design
Applied Ergonomics

WEB LINK: www.mecheng.iisc.ac.in/~agml

G K ANANTHASURESH

PROFESSOR
Ph.D., University of Michigan, 1994
M.S., University of Toledo, 1991
B.Tech., IIT Madras, 1989

DETAILS OF RESEARCH

Research at the Multidisciplinary and Multiscale Design and Device (M2D2) Laboratory headed by Prof Ananthasuresh focuses on compliant mechanisms (which are joint-less elastically deformable structures), miniature mechanisms (as in Micro-Electro-Mechanical Systems), tools for mechanical characterization of biological cells, and numerous micro-sensors, actuators, devices, and systems that span multiple size-scales and applications in multiple disciplines. The common ground for all these is the novel concept of unitized elastic body optimally shaped for the desired functionality.

Posing novel synthesis and inverse problems related to compliant mechanisms and solving them for practical applications underscore the lab's work. Recent work on bistability is an example. This work is of a fundamental nature in that it gave rise to an analytical relationship that makes the design of bistable arches straightforward. Four practical applications are supported by this mechanics study: a two-terminal RF MEMS switch, a chair for the elderly and arthritics, miniature circuit-breakers, and a self-offloading diabetic footwear. Each application leads to a new facet of designing elastically deformable continuum and enriches the field of compliant mechanisms.

THE M2D2 LAB EXPLORES HOW TO DESIGN ELASTICALLY DEFORMABLE BODIES TO REALIZE DESIRED MOTIONS IN MULTI-DISCIPLINARY SITUATIONS.

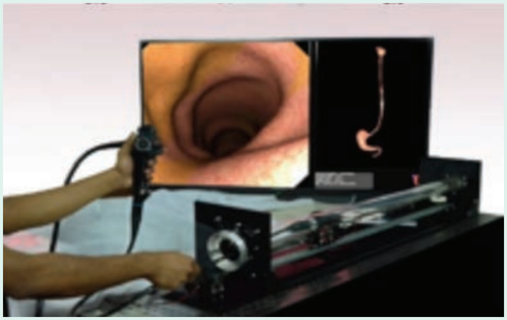


Fig: An endoscopy simulator developed at the M2D2 lab helps to train clinicians in a virtual reality environment with graphical visualization and haptics feedback.

TEACHING
Variational Methods and Structural Optimization
Topology Optimization
Introduction to Biomechanics

WEB LINK:
www.mecheng.iisc.ac.in/~suresh

G R JAYANTH

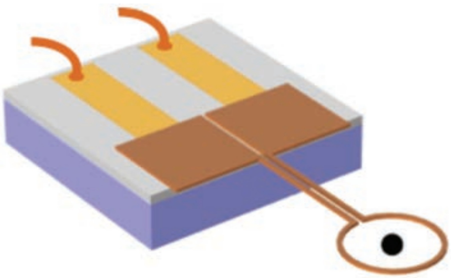
ASSOCIATE PROFESSOR
Ph.D., Ohio State University, 2008
M.S., Ohio State University, 2004
B.Tech., IIT Madras, 2002

DETAILS OF RESEARCH

Prof Jayanth's group is primarily interested in measurement and control of motion and forces at micrometer and nanometer length scales. Towards this end, the group develops new measurement techniques, probes, actuation techniques, and advanced control strategies. Such systems find immediate applications in the areas of nanometer-scale imaging, micro- and nano-manipulation, nano-robotics and three-dimensional nano-metrology. Beyond these applications, instrumentation developed by the group helps to quantify and mitigate human-wildlife conflicts.

Ongoing research projects in the group include development of modules for in-situ tip replacement in Scanning Probe Microscopes, sophisticated multi-degree-of-freedom microrobots, Atomic Force Microscope with rotatable probe-tips, Magnetic tweezers based micromanipulation, High speed atomic force microscopy, multi-axis precision motion measurement using optical sensors and Nano-positioning.

PROF JAYANTH'S GROUP IS INTERESTED IN MEASURING AND CONTROLLING MOTION AND FORCES AT MICROMETER AND NANOMETER LENGTH SCALES, FOR APPLICATIONS IN IMAGING AND MANIPULATION.



A micro-ring actuator for control of the position of magnetic micro-beads

TEACHING

Dynamics and Control of Mechanical Systems
Control System Design

WEB LINK:
https://jayanthresearchgroup.weebly.com/

GSVL NARASIMHAM

CHIEF RESEARCH SCIENTIST
Ph.D., IISc Bangalore, 1997
M.Tech., IIT Madras, 1983
B.Tech., JNTU, 1981

DETAILS OF RESEARCH

Research at the Refrigeration and Air conditioning laboratory headed by Dr. Narasimham broadly concerns forced air and hydrair precooling of food products, orifice and inertance tube refrigerators, cryogenic heat exchangers, novel heat transport systems, cryogen vapour recondensation systems, absorption refrigerators, heat pumps and heat transformers, vapour compression systems with new refrigerants, moderator thermo-hydraulics of Indian pressurized heavy water reactors, cooling of electronic equipment, fundamental heat transfer studies in coupled conduction, convection and radiation in various geometries.

THE R&AC LAB WORKS ON FLOW AND HEAT TRANSFER PROBLEMS IN LOW, MEDIUM AND HIGH TEMPERATURE SYSTEMS

TEACHING

Refrigeration Engineering
Air Conditioning Engineering
Principles of Solar Thermal Engineering

WEB LINK:
www.mecheng.iisc.ac.in/users/mecgsvln

GAURAV TOMAR

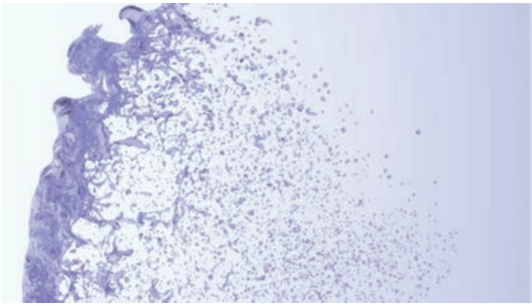
ASSOCIATE PROFESSOR
Ph.D., IIT Kanpur, 2008
B.Tech., IIT Kanpur, 2003

DETAILS OF RESEARCH

Research in the Multiphase Simulations Laboratory led by Prof Tomar focuses on simulating multiphase flows and multiscale physics. The group develops a variety of numerical tools to study multiphase phenomena.

Volume of Fluid-based methods developed by the group are used to study two phase flow phenomena such as atomization, secondary droplet breakup, bubble formation on a nozzle in the presence of electric field and viscoelastic droplet dynamics. The group's work on Smooth Particle Hydrodynamics, helps to simulate two and three dimensional free surface flows and fluid-structure interactions. The group is actively developing multiscale algorithms to understand systems that exhibit singularities in continuum modelling, which is the case in corner flows, contact line motion of droplets and drop-drop coalescence.

THE MULTIPHASE SIMULATIONS LABORATORY INVESTIGATES VARIOUS FLUID FLOW PHENOMENA INVOLVING MULTISCALE SYSTEMS.



Simulation of breakup of a liquid jet in a cross-flow, which has applications in spray systems.

TEACHING

Fluid Mechanics
Engineering Mathematics
Two-phase Flow and Boiling Heat Transfer
Computational Heat and Mass Transfer

WEB LINK: www.mecheng.iisc.ac.in/~gtom

HIMABINDU M

SENIOR SCIENTIFIC OFFICER
Ph.D., CEG Guindy, 2010
M.E., CEG Guindy, 2001
B.Tech., JNTU-Hyderabad, 1999

DETAILS OF RESEARCH

Dr Himabindu's group in the Engines & Energy Systems lab studies fundamental and applied aspects of combustion in automotive engines. The lab's mission is to generate a scientific understanding of advanced combustion and ignition concepts for engine systems. The group researches the use of lean combustion, charge dilution and biofuels to increase efficiency and reduce pollutants. The group's work in plasma ignition, glow plug assisted combustion with natural gas, methanol combustion and biogas combustion on single cylinder 4-stroke TVS and Bajaj engines are efforts in this direction.

A second aspect of the group's work concerns automotive waste heat recovery technologies. Using a thermoelectric generator test rig, the group evaluates the performance of thermoelectric materials at steady state and pseudo-transient conditions.

DR HIMABINDU'S LAB EXPLORES ADVANCED IGNITION AND COMBUSTION CONCEPTS USING ALTERNATIVE AND BIO FUELS TO EXTEND THE LIMITS OF LEAN OPERATION AND UNDERSTAND THE PERFORMANCE OF SMALL ENGINES.

WEB LINK:
http://www.mecheng.iisc.ac.in/users/himabindu

JAYWANTH ARAKERI

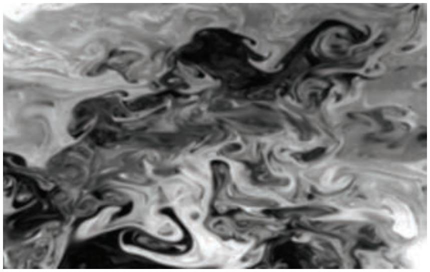
PROFESSOR
Ph.D., California Institute of Technology, 1987
M.E., Indian Institute of Science, 1981
B.Tech., IIT Madras, 1979

DETAILS OF RESEARCH

The primary focus of the Fluid Mechanics lab headed by Prof. Arakeri is towards fundamental understanding of various phenomena in fluid mechanics and heat transfer. Specifically, his group studies turbulence, transition to turbulence, unsteady flows and problems involving fluid-structure interactions. Prof Arakeri's work has identified a new type of turbulent flow- axially homogeneous tube convection. This research is currently helping to understand micro-physics of clouds, and in particular, understand the role of turbulence in condensation and droplet growth.

The Fluid Mechanics lab draws inspiration from nature- for instance from fish tails or heart valves- to discover new ways to improve efficiency and performance. The group is studying how unsteady flows, of the type found in arteries, become unstable and turbulent. Recently, the lab has been investigating using tools of fluid mechanics and heat transfer in agricultural applications, to understand heat loss and evaporation from soils and leaves, to design climate control in green houses and to control uptake of nutrients/water in aeroponics.

SIMPLE LABORATORY-SCALE EXPERIMENTS USING SALT TO CREATE DENSITY GRADIENTS RESULTS IN TURBULENT CONVECTION THAT MIMICS FLOWS IN THE EARTH'S MANTLE!



Dye visualization of a new type of turbulent convection, where flow is axially homogeneous and driven purely by a linear density gradient in a long vertical tube.

TEACHING
Fluid Mechanics
Fluid Turbulence
Elements of Solid and Fluid Mechanics

WEB LINK: www.mecheng.iisc.ac.in/users/jaywant

K R YOGENDRA SIMHA

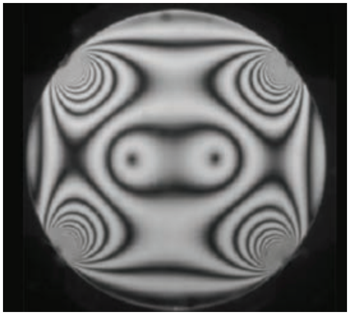
PROFESSOR
Ph.D., University of Maryland, 1985
M.E., IISc Bangalore, 1977
B.E., UVCE, Bangalore University, 1975

DETAILS OF RESEARCH

Understanding failure of solids and structures through buckling, fracture, damage and plasticity demands a creative blend of experimental, theoretical and computational strategies. The governing mechanics becomes even more challenging under impact and blast loading. Correlating microstructural aspects with macrostructural response including fracture, friction, fatigue, buckling and other instabilities through experiments and simulations is the focus of Prof Simha's Photoelasticity lab.

Blast loading on tubes and shells generates many opportunities for designing ordnance and safety equipment. For example, space debris pose a serious threat for future space missions. There is considerable amount of information on the distribution and probability of debris impact scenarios, and the group's work respresents experimental, theoretical and computational attempts at simulating complete penetration through aluminum honeycomb sandwich structures. The group is also investigating structural stability and fracture control of bipod and tripod mounts used widely for supporting telescopes, machines and munitions.

THERE IS A DIRE NEED FOR ENHANCING THE QUALITY OF TECHNICAL EDUCATION WITH A PROPER GROUNDING IN THE FUNDAMENTALS AND WITHOUT GETTING LOST IN A SEA OF MODELS AND SIMULATIONS.



Photoelastic visualization of stresses in a roller bearing under peripheral loading.

TEACHING

Structural Stability and Fracture Control
Fracture Mechanics
Applied Impact Mechanics of Solids
Structure Fracture Mechanics

WEB LINK: www.mecheng.iisc.ac.in/users/simha

KOUSHIK VISWANATHAN

ASSISTANT PROFESSOR
Ph.D., Purdue University, 2015
M.S., Purdue University, 2014
B.Tech., IIT Madras, 2010

DETAILS OF RESEARCH

Manufacturing and metalworking comprise possibly the oldest areas of research in human history, dating back to the copper and bronze ages. The advent of new materials and technically demanding applications continues to present new research challenges. The Laboratory for Advanced Manufacturing and Finishing Processes studies problems at the interface of manufacturing, mechanics and materials science. The lab's work has two distinct aspects – scientific study involving detailed experiments with complementary analytical modeling, followed by machine design/implementation for commercial applications.

The lab presently has three distinct focus areas. The first is in novel cutting and forming techniques with difficult-to-process metal systems (e.g., Ti, Ta and Ni alloys). These materials are becoming the mainstay for high performance aerospace and automotive applications. The second focus area is in understanding processing mechanics of environmentally sustainable polymer materials. The third focus area involves developing high-performance finishing processes for precision components, including several key technologies involving unusual physical phenomena such as mechanochemical effects and non-Newtonian fluid flows.

ADDRESSING TECHNOLOGICAL CHALLENGES IN MANUFACTURING: FROM BASIC SCIENCE TO ENGINEERING IMPLEMENTATION, AND FROM CONSUMER GOODS TO NEXT-GEN SPACE TRAVEL.

An innocuous combination – household inkmarkers and gluesticks – may hold the key for future cutting/finishing processes in advanced alloys.

TEACHING

Analysis of Manufacturing Processes
Engineering Mathematics

WEB LINK: www.mecheng.iisc.ac.in/~koushik

M S BOBJI

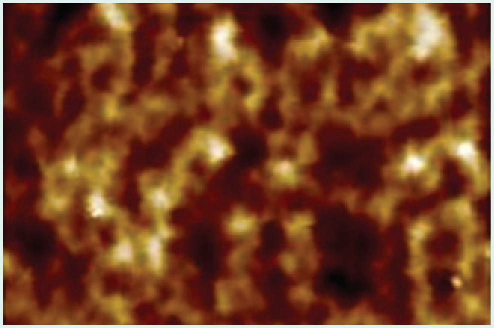
PROFESSOR
Ph.D., IISc Bangalore, 1999
M.Tech., IIT Madras, 1992
B.E., Thiagarajar College of Engineering, Madurai, 1989

DETAILS OF RESEARCH

The Force Microscopy lab headed by Prof Bobji seeks to understand the interplay between geometry and material deformation, with the aim of tuning micro-scale geometries to get customized surface mechanical properties while using novel fabrication methods. Techniques developed by the group broadly help to understand tribological characteristics of interacting surfaces at various length scales. For instance, tailoring surface roughness and creating ordered structures on the surfaces provides an ideal system to study the evolution of macroscopic phenomena across various length scales.

The group develops new tools to mechanically, electrically and thermally probe surfaces and record responses using optical, electron and atomic force microscopes, with an emphasis on coupling different imaging and precision measurement techniques. The Force Microscopy lab has developed various techniques and instruments- in-situ TEM tribometers, in-situ Micro Raman reciprocation testers, ice adhesion testers, weighing scales for biological cells, needle-tissue interaction testers and mini-Lysimeters to measure transpiration rates in plants.

THE FORCE MICROSCOPY LAB SPECIALIZES IN MEASURING SMALL FORCES, RANGING FROM MILLINEWTONS TO NANONEWTONS.



Atomic Force Microscope (AFM) image of an electropolished surface. Mechanical polishing followed by electropolishing removes surface roughness having wavelengths between 10 nanometers to 50 microns.

TEACHING
Fundamentals of Tribology
Solid and Fluid Phenomena at Small Scales

WEB LINK:
www.mecheng.iisc.ac.in/~bobji

NAMRATA GUNDIAH

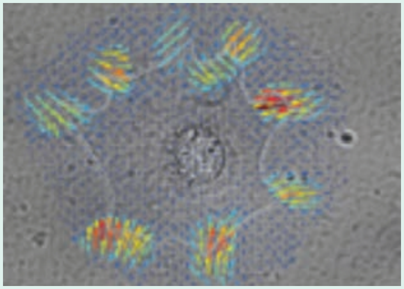
ASSOCIATE PROFESSOR
Ph.D., University of California, Berkeley, 2004
M.S., University of California, Berkeley, 2000
M.Sc, University of Pune, 1994

DETAILS OF RESEARCH

Research at the Biomechanics Laboratory, headed by Prof. Gundiah, focuses on Tissue Biomechanics, Cell Mechanobiology and Biomaterials. At the scale of tissues, Prof Gundiah's group uses methods in nonlinear mechanics, viscoelasticity, and poroelasticity to quantify the properties of naturally occurring biomaterials, such as elastin isolated from arteries and diseased arteries, and those fabricated using synthetic polymers, such as hydrogels. At the cellular level, her group quantifies interactions of focal adhesions in cells with substrates, and develops instruments to subject individual and cell collectives to shear stresses and biaxial stretching. They use advanced imaging tools and molecular biology approaches in addition to those in mechanics. The group also models these interactions using a continuum mechanical framework to explore cellular adaption and growth due to mechanical stimuli.

Laboratory interests also include characterizing materials in Nature with specific functional attributes. For example, parasitoid wasps that cut through fig substrates to lay eggs using an ovipositor, and beetle larvae that cut and eat coffee wood with their mandibles. These insects must overcome several biomechanical constraints without the tool undergoing fracture, wear or fatigue when used repeatedly. The laboratory addresses these questions and showed that zinc enrichment in insect cuticle increases material hardness in structures which are used in cutting through hard substrates.

THE BIOMECHANICS LABORATORY WORKS ON THE DEVELOPMENT AND APPLICATION OF MECHANICS TO STUDY BIOLOGICAL MATERIALS.



Nodal force map of cell adhesion on polyacrylamide substrate.

TEACHING
Materials and Structure Property Relationships
Biomechanics
Mechanics of Biomaterials

WEB LINK:
www.mecheng.iisc.ac.in/~namrata

PRADIP DUTTA

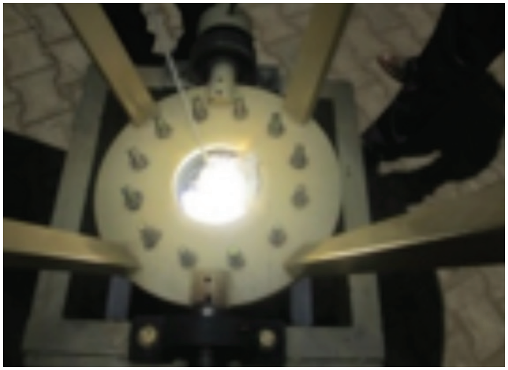
PROFESSOR
Ph.D., Columbia University, 1992
M.Tech., IIT Madras, 1987
B.Tech., IIT Kharagpur, 1983

DETAILS OF RESEARCH

The Heat Transfer Laboratory headed by Prof Dutta is interested in advanced thermal storage technologies, solar thermal receivers, compact heat exchangers, advanced cooling technologies (including adsorption cooling, loop heat pipes, phase change materials), multi-scale solidification studies and heat transfer in materials processing. Research topics range from fundamental studies to industrial and space applications, and include innovative process development, building of functional prototypes, along with development of advanced CFD models.

A major focus of the laboratory over the past two decades has been on multi-scale solidification research and its applications in materials processing, leading to the development of break-through technologies for advanced manufacturing processes. A direct outcome of this work is the indigenous development of a semisolid casting technology, which has been transferred to leading Indian automobile industries. In the area of advanced thermal technologies, the laboratory has developed a new Loop Heat Pipe System in collaboration with ISRO, which has now been space engineered and successfully flight tested for potential use in future space missions.

THE HEAT TRANSFER LAB AIMS TO SOLVE THERMAL AND COOLING CHALLENGES IN VARIOUS APPLICATIONS THROUGH FUNDAMENTAL RESEARCH AND INNOVATION.



On-sun testing of a pressurized volumetric solar receiver

TEACHING
Thermodynamics
Computational Heat transfer and Fluid Flow
Convective Heat Transfer

WEB LINK:
www.mecheng.iisc.ac.in/~pradip

PRAMOD KUMAR

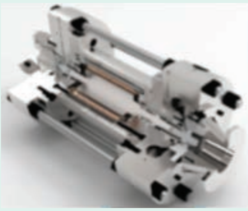
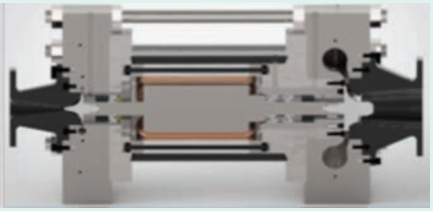
ASSOCIATE PROFESSOR
Ph.D., IISc Bangalore, 2008
M.Sc. Engg., IISc Bangalore, 2001
B.E., Govt. Engg. College, Goa, 1997

DETAILS OF RESEARCH

Supercritical carbon dioxide (s-CO_2) power cycles have the potential to attain higher cycle efficiencies than conventional Steam Rankine or Air Brayton power cycles. Besides, s-CO_2 power plants offer the possibility of compact equipment resulting from high densities of CO_2. For instance, CO_2 in the simple recuperated cycle is about 300 times denser than a corresponding steam-based Rankine cycle operating under identical turbine inlet conditions.

To realize a s-CO_2 cycle at a commercial scale, detailed experimental data such as heat transfer coefficients correlations in the supercritical regime, robust control strategies and material compatibility issues need to be established. With this intent, Prof Kumar has developed a s-CO_2 test loop facility. The primary aim of the loop is to generate experimental test data, run component endurance tests and demonstrate stable operations for extended durations at anticipated operating pressures and temperatures. In addition, the loop serves to establish the efficacy of the control system and understand dynamics of what-if scenarios by occasional offshoots beyond the designed operating regime.

THE THERMAL SYSTEMS LABORATORY SPECIALIZES IN RESEARCH AND DEVELOPMENT OF GREEN TECHNOLOGIES INVOLVING NATURAL REFRIGERANTS, HYDROCARBON MIXTURES, AND TRANS-CRITICAL CO_2 FOR COOLING APPLICATIONS ALONG WITH SUPERCRITICAL CO_2 BASED BRAYTON POWER CYCLES.

A 20kWe s-CO_2 direct drive power block coupled to a 40K rpm Switched Reluctance Generator being developed for a s-CO_2 test loop facility.

TEACHING

Thermodynamics
Convective Heat Transfer
Experimental Engineering

WEB LINK:

www.mecheng.iisc.ac.in/~pramod

RATNESH SHUKLA

ASSOCIATE PROFESSOR
Ph.D., University of California, Los Angeles, 2007
M.S., University of California, Los Angeles, 2005
B.Tech., IIT Kanpur, 2002

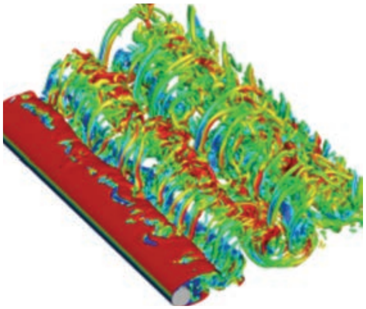
DETAILS OF RESEARCH

Prof Shukla's group focuses on the physical and fundamental understanding of the mechanics of fluid flows over a wide spectrum of spatio-temporal scales ranging from continuum to atomistic. The group performs theoretical and large-scale simulations based computational investigations in the broad areas of drag reduction and propulsion, and high-speed multiphase flows (shock-accelerated bubble dynamics).

The direct numerical simulation tools developed by the group have been extensively used to investigate bluff body flow control. These tools have helped to demonstrate that the energetic cost of controlling the flow is of utmost importance as the power expended in achieving a reduction in drag, and not the effective drag reduction itself, determines the failure or success of a flow control strategy.

The group's work on unsteady propulsion has led to the identification of a sharp transition in the peak propulsive performance of flapping foils. This of significance especially due to the recent thrust towards miniaturization of unsteady flapping foil based propulsive systems that could potentially be utilized in unmanned and micro air vehicles (UAVs and MAVs) and autonomous underwater vehicles (AUVs).

DIRECT NUMERICAL SIMULATIONS HELP TO DETERMINE OPTIMAL SURFACE ACTUATION BASED FLOW CONTROL STRATEGIES TO MINIMIZE NET POWER CONSUMPTION WHILE EFFECTIVELY REDUCING HYDRODYNAMIC LOADS.



Direct numerical simulations demonstrating bluff body flow control

TEACHING

Fluid Mechanics
Engineering Mathematics
Computational Heat Transfer and Fluid Flow
Numerical Methods for Partial Differential Equations

WEB LINK:
www.mecheng.iisc.ac.in/~ratnesh

R NARASIMHAN

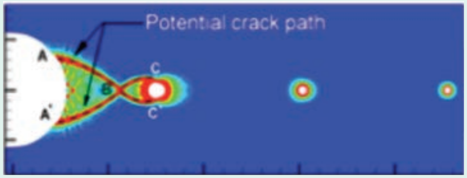
PROFESSOR
Ph.D., California Institute of Technology, 1986
M.S., California Institute of Technology, 1983
B.Tech., IIT Madras, 1982

DETAILS OF RESEARCH

Prof Narasimhan heads the Computational Solid Mechanics Lab & the INSTRON Mechanical Testing Lab. His group focuses on mechanical and fracture behavior of materials, and uses nonlinear finite element techniques along with appropriate constitutive models to simulate deformation and failure mechanisms in polycrystalline metals like aluminum and magnesium alloys, and metallic glasses.

The group also performs complementary experimental studies to validate their numerical predictions. Mapping strain fields in lab specimens using Digital Image Correlation as well as microstructural characterizations using Electron Back Scattered Diffraction, Optical and Scanning Electron Microscopy, provides insights on fundamental deformation and failure mechanisms. Recent research in the group has addressed key issues pertaining to ductility enhancement in metallic glasses and the fracture response of Mg alloys, which are highly anisotropic and deform by slip and twinning.

PROF NARASIMHAN'S WORK ON UNDERSTANDING CRACK TIP FIELDS FOR DIFFERENT LATTICE ORIENTATIONS AND FRACTURE CONFIGURATIONS CAN GUIDE THE CHOICE OF TEXTURE AND MICROSTRUCTURE IN POLYCRYSTALLINE ALLOYS FOR IMPROVING THEIR FRACTURE RESISTANCE.



Finite element simulations of plastic strains showing spontaneous cavitation ahead of a crack tip in a brittle bulk metallic glass

TEACHING
Solid Mechanics
Fracture Mechanics
Nonlinear Finite Element Methods

WEB LINK:
www.mecheng.iisc.ac.in/users/narasi

RAGHURAMAN GOVARDHAN

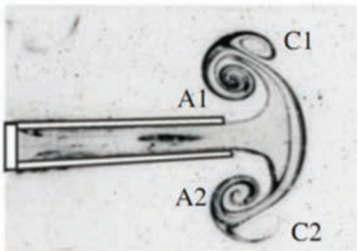
PROFESSOR
Ph.D., Cornell University, 2000
B.Tech., IIT Madras, 1994

DETAILS OF RESEARCH

Research at the Flow Physics Laboratory headed by Prof Govardhan covers a range of fluid mechanical phenomena with the focus being on fluid structure interaction problems, where there is strong coupling between the structural dynamics and the surrounding fluid mechanics. Examples of such interactions studied in the laboratory include flutter of aircraft engine compressor blades, the flexible tail of fishes, and the deformations of bubbles in turbulence. In the latter case, the interactions occur between the bubbles "elastic" surface and the flow around it. These have practical applications in aircraft engines, for building of fish-like underwater autonomous vehicles and for drag reduction in ships using bubbles.

The group's work is primarily experimental, and a number of their studies have necessitated the development of special facilities or experimental set-ups that range from a turbulent channel (water) flow for drag reduction studies using injected bubbles, to a transonic cascade facility for understanding the influence of unsteady shocks on the flutter characteristics of compressor blades. Laser based and conventional instrumentation are used to help understand the physics of these different flows.

THE FLOW PHYSICS LAB EXPLORES A RANGE OF FLUID MECHANICAL PHENOMENA WITH A FOCUS ON FLUID STRUCTURE INTERACTION PROBLEMS.



Complex vortices formed as fluid issues out of a channel with flexible ends.

TEACHING
Fluid Mechanics
Turbomachine Theory
Solid/Fluid Phenomena at small scales

WEB LINK:
www.mecheng.iisc.ac.in/~raghu

RUDRA PRATAP

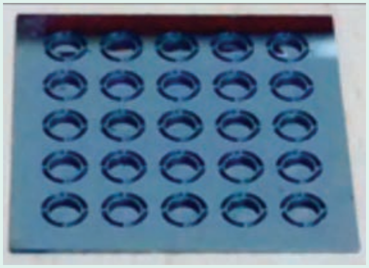
PROFESSOR
Ph.D., Cornell University, 1993
M.S., University of Arizona, 1987
B.Tech (Hons)., IIT Kharagpur, India., 1985

DETAILS OF RESEARCH

Research at the Micro-Electro-Mechanical Systems (MEMS) laboratory, headed by Prof. Rudra Pratap, is focused on design and development of novel MEMS and NEMS devices. In particular, the group focuses on vibratory devices using analytical, computational and experimental techniques to study the dynamics and mechanics of extremely small-scale structures for applications in acoustics, ultrasonics, inertial navigation and medical diagnostics. To design and fabricate devices, the group uses sound theoretical knowledge of linear and nonlinear vibrations, physics of transduction, methods of microfabrication and a host of characterization techniques.

Invariably, innovations in fabrication processes also accompanies device realization. Similarly, researching materials for micromechanical structures often leads to research on the development of device grade materials. Towards designing innovative micro and nano-scale transducers, Prof. Pratap's group collaborates with biologists and ecologists to study insects and draw inspiration from nature's design templates and transduction techniques used in a multitude of extremely small scale natural sensors and actuators.

AS THE WORLD MOVES RAPIDLY TOWARDS UBIQUITOUS INTELLIGENCE, A LARGE PART OF THIS INTELLIGENCE WILL COME FROM MEMS AND NEMS SENSORS.



An array of cricket inspired MEMS speakers fabricated on a "Silicon on Insulator" wafer.

TEACHING

MEMS Modeling Design and Implementation.
Dynamics and Control.
Modeling and stimulation of dynamic systems

WEB LINK:
www.cense.iisc.ac.in/rudra-pratap

RAMSHARAN RANGARAJAN

ASSISTANT PROFESSOR
Ph.D., Stanford University, 2012
M.S., Stanford University, 2009
B.Tech., IIT Madras, 2006

DETAILS OF RESEARCH

A guiding theme behind the work of Prof Rangarajan's group at the laboratory for Mechanics & Computation is to measure, model and control structural deformations in mechanics problems where geometry plays a decisive role. For instance, rippling of edges in tree leaves and curling of chips in metal cutting are manifestations of the influence of geometry in mechanics. Often, such effects are dominated not by specifics of the material, but by details of the geometry. A quantitative understanding is necessary to exploit such nonlinear phenomena in new technologies.

A key aspect of the group's work is to create tools necessary for studying slender structures. This includes new computer vision techniques for non-invasive three-dimensional measurements and sophisticated numerical algorithms for mechanical modeling. These tools help to venture beyond just predictive modeling and help to actively control behavior of slender structures by posing inverse problems and resolving them using optimization techniques. Such developments pave the way for designing flexible robots and building deployable structures.

Besides mechanics, geometry naturally play a dominant role in design. With the objective of replacing trial-and-error based approaches with optimization-centric methods, the group is working on numerical algorithms for problems where the unknowns are shapes and geometries.

UNDERSTANDING THE INFLUENCE OF GEOMETRY IN MECHANICS CAN HELP TRANSFORM AN INNOCUOUS ELASTIC BEAM INTO A SHAPE-MORPHING FLEXIBLE ROBOT.

Three-dimensional measurements from experiments with elastic ribbons.

TEACHING
Solid Mechanics
Mechanics of Slender Elastic Structures

WEB LINK:
www.mecheng.iisc.ac.in/~rram

R THIRUMALESWARA NAIK

SENIOR SCIENTIFIC OFFICER
Ph.D., IIT Delhi, 2007
M.E., Andhra University, 2002
B.E.,Andhra University, 1999

DETAILS OF RESEARCH

The Internal Combustion Engines Research Laboratory headed by Dr Naik focuses on studying various aspects of improving combustion in IC engines, lowering emissions, enhancing performance using alternate bio-fuels such as Hydrogen, Algae and CNG. The group also works in fuel flow spray, combustion fuel additives, renewable clean energy and vehicle transportation using various experiments and computational methods.

THE INTERNAL COMBUSTION ENGINES RESEARCH LABORATORY EXPLORES WAYS TO IMPROVE ENGINE PERFORMANCE BY ENHANCING EFFICIENT COMBUSTION UNDER DIVERSE OPERATING CONDITIONS.

TEACHING

Internal Combustion Engines
Automobile Engineering
Basic Mechanical Engineering

WEB LINK:

www.mecheng.iisc.ac.in/~rtnaik

R V RAVIKRISHNA

PROFESSOR
Ph.D., Purdue University, 1999
M.S., University of Alabama, 1994
B.Tech., IIT Madras, 1992

DETAILS OF RESEARCH

The main focus of Prof Ravikrishna's Combustion and Spray Laboratory is the fundamental study of both combustion and spray processes with relevance to their application in practical devices such as internal combustion engines, gas turbines and industrial burners, using laser-based diagnostic techniques. The activities in the laboratory span fundamental research on breakup of impinging liquid jets and combustion chemistry of next-generation fuels to applied research on trapped vortex combustors.

The experimental work is complemented by multi-dimensional computational fluid dynamic modeling of the associated thermo-fluid dynamic processes. The facilities developed at the lab include high-powered Nd:YAG lasers with second, third and fourth harmonics, Dual-pulse Nd:YAG Laser, Dye laser, Intensified CCD Camera and a High-pressure Spray Chamber with optical access. The group also utilizes various diagnostic techniques, such as Laser shadowgraphy, Interferometric Laser Imaging for Droplet Sizing Techniques, Particle Image Velocimetry, Planar Laser-induced Fluorescence and Laser-induced Incandescence.

RESEARCH AT THE COMBUSTION AND SPRAY LABORATORY DIRECTLY BENEFITS INDUSTRIAL PARTNERS SUCH AS TVS MOTORS, SIEMENS, BOSCH, TATA MOTORS, PRATT & WHITNEY, ASHOK LEYLAND AND GAS AUTHORITY OF INDIA LIMITED.

A unique high-pressure, high-temperature optically accessible chamber for the study of fuel sprays

TEACHING

Thermodynamics
Computational Heat Transfer and Fluid Flow
Applied Combustion

WEB LINK:
www.mecheng.iisc.ac.in/users/ravikris

SAPTARSHI BASU

ASSOCIATE PROFESSOR
Ph.D., University of Connecticut, 2007
M.S., University of Connecticut, 2004
B.E., Jadavpur University, 2000

DETAILS OF RESEARCH

The work of Prof Basu's group offers insights into transport mechanisms, instabilities, vaporization dynamics and mixing in functional droplets (colloidal, fuel, precursor) as encountered in applications ranging from surface engineering, combustion to biological applications. In this context, his group looks into particle transport in droplets under natural conditions as well as with external stimuli. The group researches complex flow patterns, assembly of particles, interfacial processes and buckling.

Prof Basu's group has also delved into the area of droplet combustion, including self-excited instabilities, bubble induced ebullition and different coupling mechanisms between flame-acoustics-droplet. In the area of sprays, they investigate vaporization and breakup characteristics of droplets in swirling flows related to gas turbine combustors.

PROF BASU'S LAB EXPLORES TRANSPORT PROCESSES IN MULTIPHASE SYSTEMS AT DIFFERENT SPATIO-TEMPORAL SCALES, WITH APPLICATIONS RANGING FROM GAS TURBINE COMBUSTION TO SURFACE PATTERNING.

A visualization of impinging droplets.

WEB LINK:
www.mecheng.iisc.ac.in/~sbasu

SUSMITA DASH

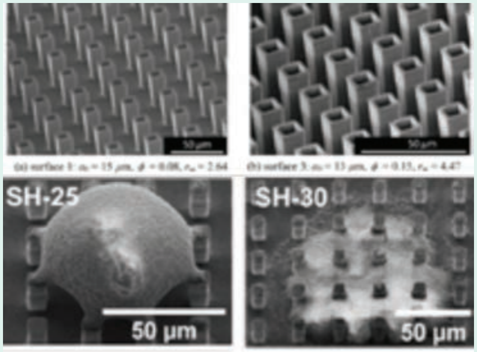
ASSISTANT PROFESSOR
Ph.D., Purdue University, 2014
B.Tech., NIT Rourkela, 2008

DETAILS OF RESEARCH

The Microscale Transport Laboratory, directed by Dr. Susmita Dash, utilizes fundamental understanding of thermal fluid transport phenomena in conjunction with micro and nano scale surface texturing to address challenges related to thermal management, fouling, anti-icing, and microfluidics. The performance of most practical systems including heat exchangers, microfluidics, thermal management systems and desalination units are limited by the interactions and losses near the solid-liquid-vapor contact lines. Manipulating contact line dynamics can reduce excessive energy losses via hysteresis, thermal and fluid transport resistance, and nucleation energy barriers. The group focuses on studying interactions at the triple contact lines to develop strategies using engineered surface wettability and morphology that can significantly enhance the thermal and fluid transport performance.

Current research efforts in the group include developing scale mitigation strategies in the presence of dissolved salts. Another focus area of the group is enhancing thermal performance during quenching by facilitating faster film to transition boiling regime.

THE MICROSCALE TRANSPORT LABORATORY FOCUSES ON DEVELOPING STRATEGIES TO ENHANCE THERMAL AND FLUID TRANSPORT PERFORMANCE USING MICRO- AND NANO-TEXTURED SURFACES WITH SPECIFIC WETTABILITY.



Hybrid silicon microtextures and control of colloidal particles in an evaporating droplet via surface texturing.

TEACHING

Thermodynamics
Two-phase Flows & Boiling Heat Transfer

WEB LINK:

https://www.dashresearchlab.com/

SATISH V KAILAS

PROFESSOR
Ph.D., IISc Bangalore, 1994
M.E., IISc Bangalore, 1989
B.Tech., Govt. Engg. College Thrissur, 1987

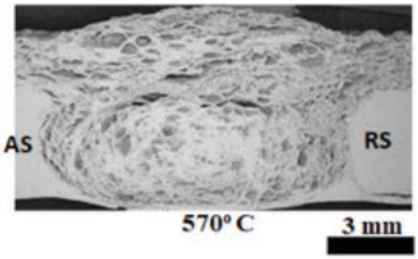
DETAILS OF RESEARCH

The Surface Interation and Manufacturing (SIAM) lab led by Prof. Kailas broadly studies friction, wear and lubrication in the context of tribology, and solid state friction welding processes in the context of manufacturing. The group researches fundamental mechanisms at work during sliding in friction drives, particularly at high speeds and the mechanism of friction stir welding. The group distinguishes itself in designing experimental systems aimed at replicating tribo-systems of practical interest.

SIAM is possibly the first lab in India that ventured into the emerging area of friction stir welding. The group specializes in understanding friction stir welding of various aluminum alloys, copper alloys, T-joints, as well as welding aluminum to dissimilar metals such as copper, titanium and steel. The group actively engages local industries to build friction stir welding machines based on its research discoveries. The lab is also researching friction stir processing to develop new materials such as area-specific metallic foams. Polymer derived ceramic metal-matrix composites developed this way have high strength and high ductility.

Prof Kailas's group is also engaged in designing novel mechanical joining techniques and have developed two new processes 'same metal self-pierce riveting' and 'self-pierce butt riveting.' With an eye on driving sustainable tribological products, the SIAM lab has developed an eco-friendly cutting oil emulsion.

LIFE WITHOUT FRICTION IS IMPOSSIBLE, AND TERMINATES DUE TO WEAR!



Area specific foams developed in aluminum by friction stir processing have excellent damping characteristics.

TEACHING
Materials and Structure Property Correlations
Materials, Manufacturing and Design

WEB LINK:
www.mecheng.iisc.ac.in/users/satvk

V R SONTI

PROFESSOR
Ph.D., Purdue University, 1994
M.S., Southern Illinois University, 1988
B.Tech., IIT Kharagpur, 1986

DETAILS OF RESEARCH

Prof Sonti and his group at the Vibro-Acoustics lab develop analytical/semi-analytical solutions to sound-structure interaction problems. Using asymptotic methods to study wave propagation in nonlinear structural-acoustic waveguides, the group has confirmed important aspects of self-mode interations, namely, amplitude modulation governed by the nonlinear Schrodinger Equation, and the occurrence of bright and dark solitons. They believe that exciting results on cross mode interactions and resonances are within reach.

Prof Sonti's group is also interested in developing fully coupled models for sound radiation and transmission through perforated panels set in rigid baffles using semi-analytical methods. Their findings on radiation efficiency and transmission loss have important consequences for noise control in industrial applications. Their recent results provide closed form formulas for the modal coupling coefficients using tools from complex analysis.

Towards understanding sonic booms associated with supersonic aircrafts, the group is developing a combination of analytical, numerical and asymptotic methods for solving the nonlinear Tricomi equation underlying such phenomena.

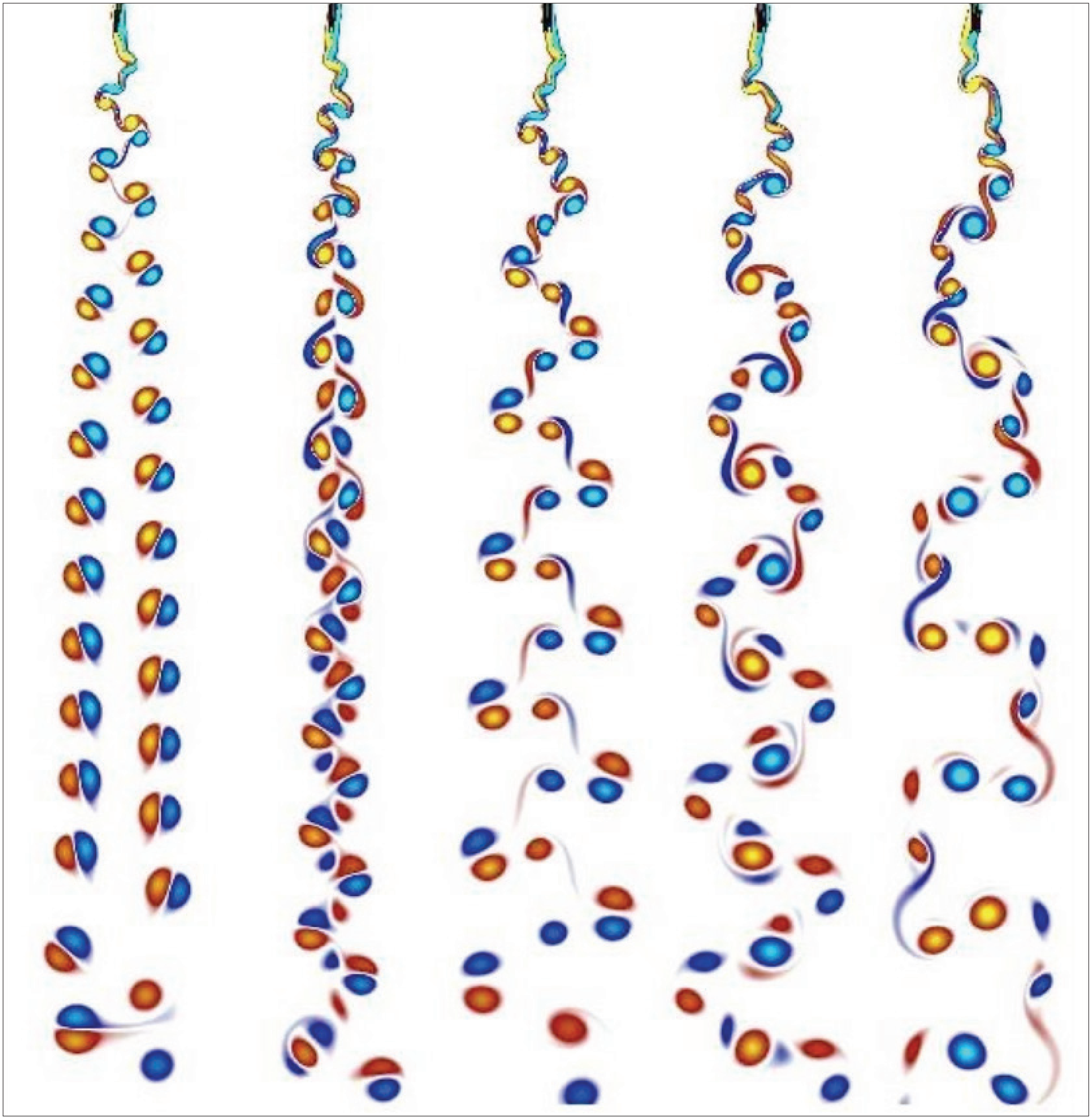
THE STRUCTURAL ACOUSTICS GROUP DEVELOPS CLOSED FORM SOLUTIONS TO WELL-POSED PROBLEMS IN THE AREA OF SOUND-STRUCTURE INTERACTION.

Visualization of a standing wave pattern in a *Chladni* plate

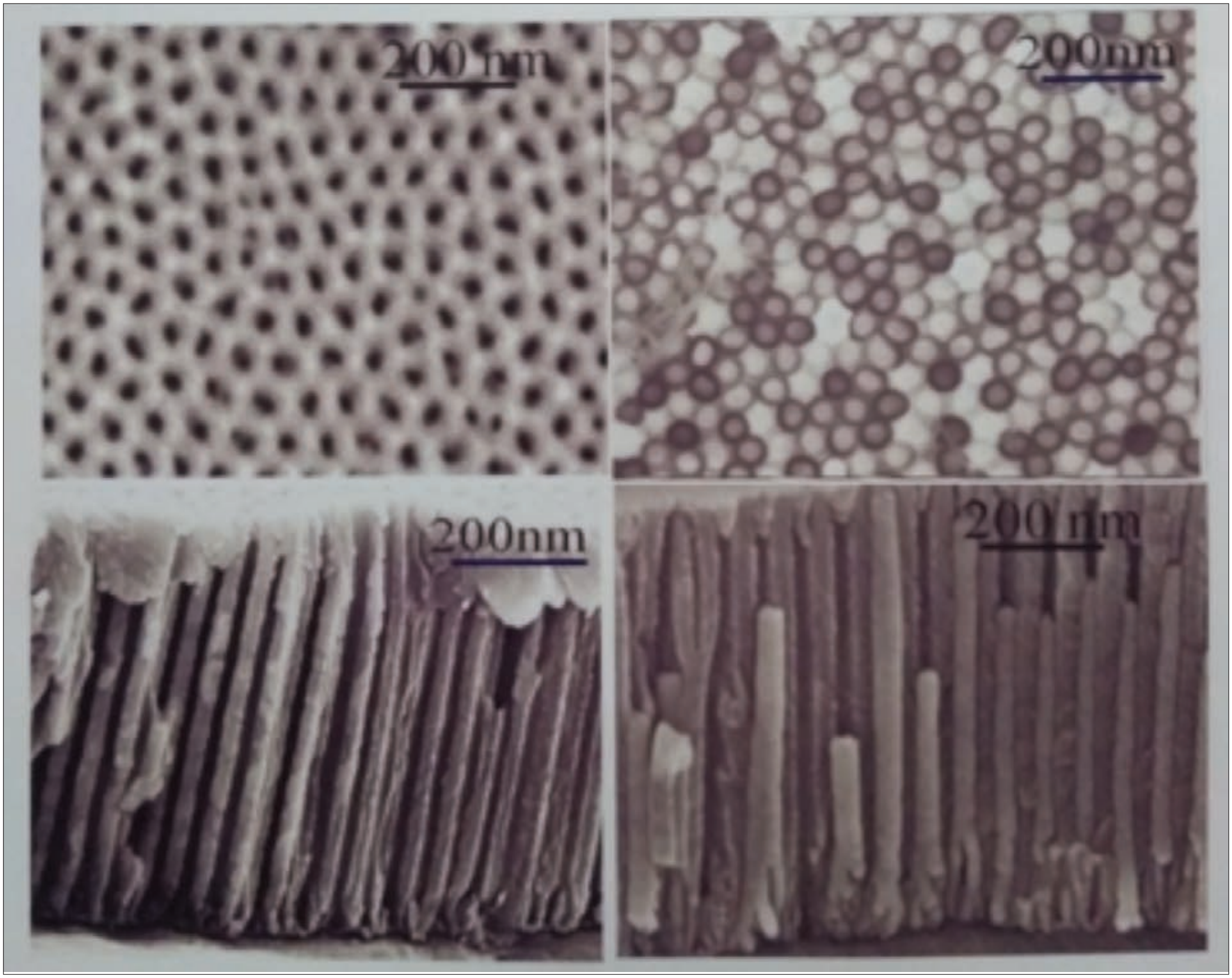
TEACHING

Fundamentals of Acoustics
Vibrations of Plates and Shells
Structural Acoustics
Complex Variables

WEB LINK:
www.mecheng.iisc.ac.in/~sonti



Vortex shedding patterns associated with slow and fast bio-inspired oscillatory locomotion. Coloured vorticity contours indicate wake vortices that result from variations in translational speed (low to high speeds from left to right) in fish-like oscillatory self-propulsion.

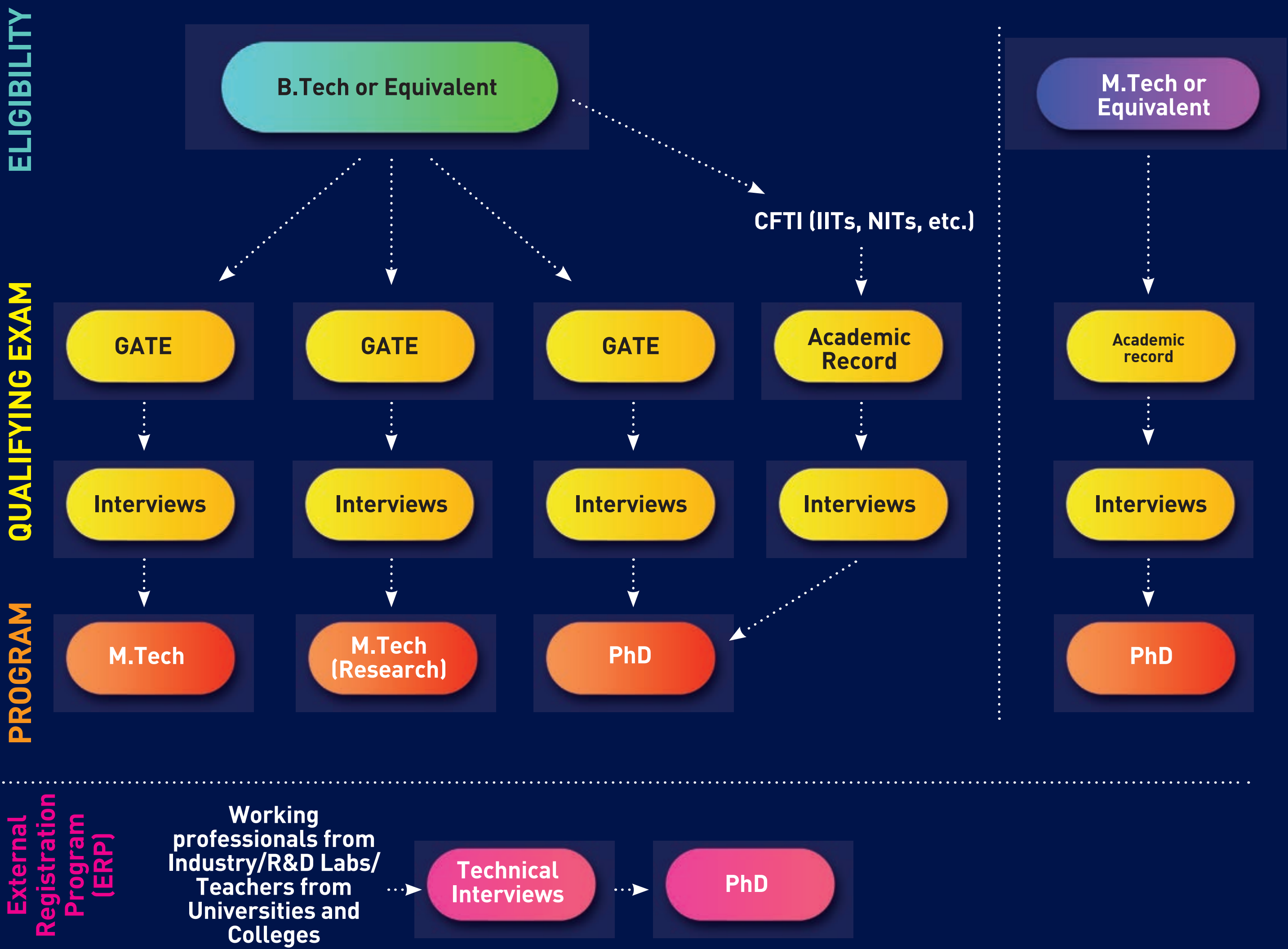


Top and cross-sectional scanning electron microscope image of nickel-based nano-porous Alumina composite.

ACADEMIC PROGRAM

Graduate admissions

The ME student community is a microcosm of India's diversity. Students come from all over the country, and bring with them diverse social, economic, cultural and educational backgrounds to share with the department. A brief summary of selection criteria for admission to ME is provided below. For more detailed information, please visit https://www.iisc.ac.in/admissions.



Graduate level Academic programs

ME offers three graduate level programs: Doctor of Philosophy (PhD), Masters by research (M Tech-Res) and Masters by coursework (M Tech). About 65% of our roughly 180 students on roll pursue research degrees {PhD & M.Tech (Research)}.

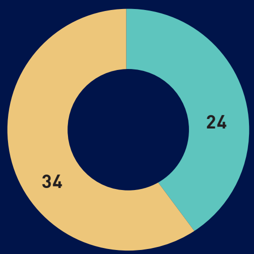
Doctor of Philosophy: The PhD program is primarily intended for students who desire a career in research, advanced development or teaching. The program is designed to give students sound fundamentals in mechanical engineering sciences, along with intensive study and research experience in a specialized area over a 4-5 year period.

Masters by Research: The 2-year M.Tech (Research) program is designed for students seeking advanced training in areas of mechanical engineering through a balanced curriculum, along with research experience through a thesis.

Masters by Coursework: The 2-year M.Tech program is intended for students with undergraduate degrees in mechanical engineering. The program is based on rigorous and well-rounded training in mechanical engineering subjects through a set of core courses and electives, along with a year-long project to give the students experience of research and in-depth study on a specialized topic.

Where do our students go?

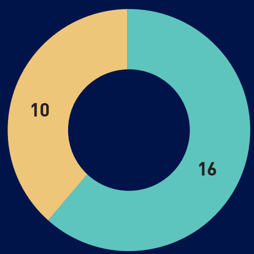
M.TECH SURVEYED: 58



Pursuing PhDs

In Industry (incl. GE, TATA Motors, Rolls Royce, ISRO, DRDO, Services)

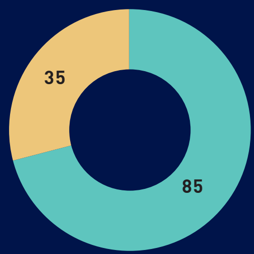
M.TECH (RESEARCH) SURVEYED: 26



Pursuing PhDs

In Industry

PhDs SURVEYED: 120



In Academia (post-docs and faculty)

In Industry (R&D Orgs/Labs, Private Companies, Services)

FROM RESEARCH TO TECHNOLOGY

BluSnap helps you keep a cool head on the road

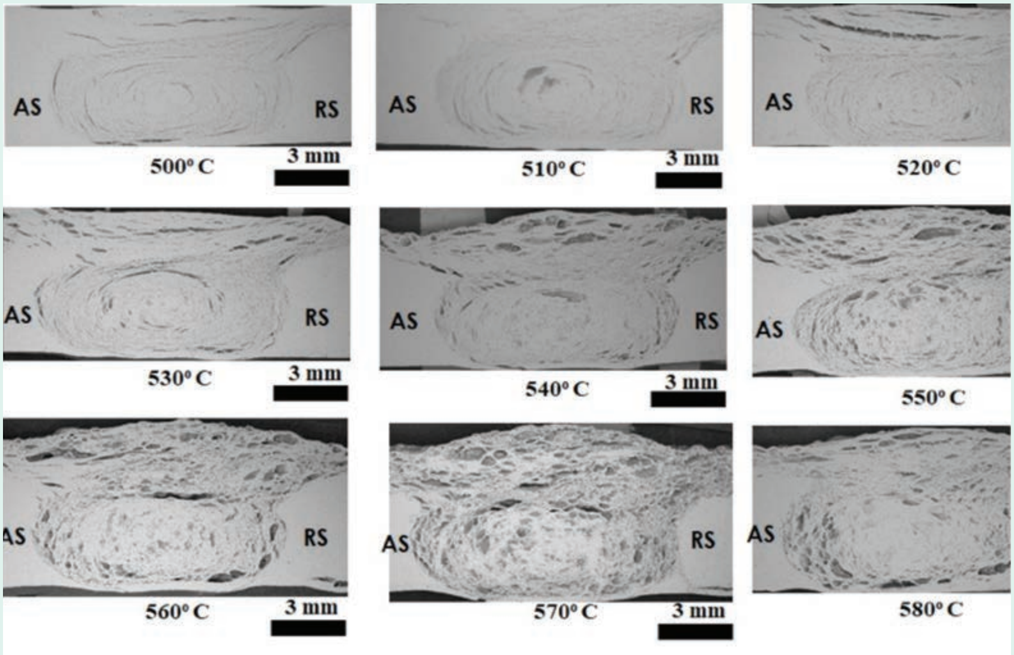
Together with Aptener Mechatronics Pvt. Ltd. Prof. Govardhan and Prof Arakeri have developed portable cooling devices that can be snapped on to motorbike helmets. To provide cool and dust free air for the rider, the team designed the device using their expertise in air flow and thermal control, and has undergone extensive laboratory testing.

Endomimyk

EndoMimyk is the first product of Mimyk, a start-up from IISc. It is a training platform for endoscopy procedures. It combines haptics and graphics to provide an immersive simulation. It is a result of collaborative effort between Mechanical Engineering and Computer Science and Automation departments and was supported by the Robert Boch Foundation for Cyber Physical Systems in IISc.

In-Situ Polymer Derived Metal Matrix Composites by Friction Stir Processing

A break-through technology developed by Prof Kailas's group creates novel metal-matrix composites that have high strength and high ductility. The key to designing these materials lies in dispersing small polymer particles in metals such as Aluminum or Copper, using friction strip processing. Subsequent heating converts the dispersed polymer into a ceramic.



CONNECTING WITH COMMUNITY

Open Day

The Open Day is much more than a day long carnival at IISc. It is a cherished tradition. Each year on this day, ME throws open its doors and invites the public to Explore, Experience and Enjoy the wonders of scientific and technological research and innovation in the Department. Everyone- toddlers, seniors, students and parents- enjoy the games, demonstrations and trivia conjured up for the event. The atmosphere is festive and the amazement is palpable. Visit www.iisc.ac.in for information about the next open day at IISc.

Egg chutes

Science demos

Demonstration of mechanisms

Water rockets

STAFF AND ADMINISTRATION

Administrative staff

Devaki

F.S Banu

Mangala. R

Sampath. P

Chinnamma

Technical staff

Abdul
Kareem

G.Babu

Chandran. N

Haridasan K.G

Raja. K

Srinivasa Raghavan


MECHANICAL
ENGINEERING


Tissue
PLANAR BI-AXIAL TEST SYSTEM

Design: TheFool.in

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