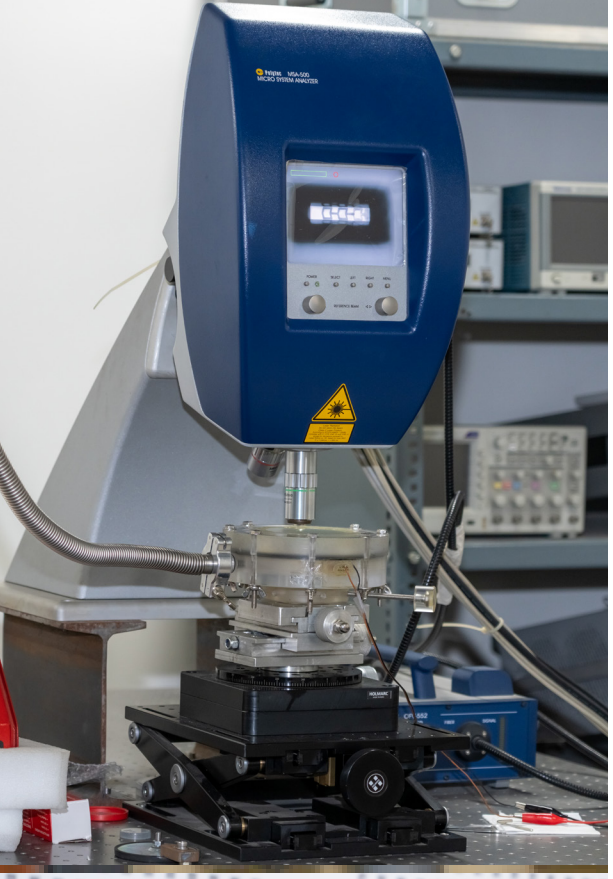

Integrated Design and Manufacturing
Additive manufacturing
Forming
Laser material processing, welding
Sustainable & Circular manufacturing
Multi-scale manufacturing
Digital fabrication, smart manufacturing
Automation & control,
Virtual Reality -Industry 4.0
Mechanics and Design
Acoustics
Fracture and fatigue
Experimental mechanics (Macro)
High strain rate
Vehicle dynamics
Vibrations
Nonlinear dynamics
Computational mechanics
Small-scale experiments
Mechanical & Aerospace Engineering
Thermofluid Engineering
Fluid mechanics
Soft and active matter
CFD (compressible and incompressible)
Multiphase flow
Nano Heat transfer
Combustion
Underwater oil jets
Blast wave mitigation
Aerospace Engineering
Structures; Non-Destructive Evalution
Aerodynamics
Propulsion
Control and guidance
Helicopter dynamics
Aero-manufacturing
Flight mechanics
Satellite
Drone



Mechanics and Design

The Mechanics and Design field integrates principles of mechanics, structural analysis, kinematics, dynamics, machine design, vibration, optimization, and experimentation to create innovative and efficient mechanical systems. MAD stream is one of the dynamic and innovative streams within the Department. It is dedicated to the department's mission and vision. It fosters a culture of collaboration, creativity, and continuous improvement.Our highly skilled and diverse faculty consistently deliver high-quality results across various fields, positively impacting the Department and its broader goals through research papers, patents, and more.

Our continuous learning initiatives empower faculty and students to leverage cutting-edge tools and methodologies, expanding our capabilities for innovative problem-solving by actively cultivating partnerships with internal and external stakeholders, such as industry, research institutions, and the govt, we foster a collaborative environment that promotes innovation and facilitates meaningful impact within our institute and beyond. Students are encouraged to pursue their interests through diverse electives and projects, fostering their development as versatile professionals prepared to confront challenges, while industry experts contribute to their knowledge through meaningful engagement.

Experimental Solid Mechanics:

Experimental solid mechanics plays a vital role in developing and validating theoretical models and numerical simulations. Experimental data obtained from these tests help improve the material designs, structural analyses, and the understanding of failure mechanisms, ultimately contributing to advancing engineering and manufacturing processes. Besides performing fundamental research, the associated faculty members engage actively in industry-based problems and the development of methods for experimental stress analysis pertaining to digital photoelasticity and digital image correlation for accurate whole-field non-contact optics-based stress/strain measurement.

Facilities

UTM-10KN, 100KN, 250 KN

3D-Printer

Air-coupled ultrasonic testing machine.

DIC (2D and 3D)

Impact testing machine

Hardness testing machine

Digital photoelasticity experimental setup machine.

Optical Microscope

Experts

Prabhat Kumar,Ramji Manoharan, Safvan Palathingal, Syed Nizamuddin Khaderi, Viswanath Chinthapenta,

Labs

Micro-Mechanics Lab
CAE Lab
Dynamics Lab
Micro-Electro-Mechanical Systems Lab
Engineering Optics Lab
Solid Mechanics Lab
Material Characterization Lab
Impact Mechanics Lab
MEMS Lab

Computational Solid Mechanics:

Computational solid mechanics has revolutionized the field of engineering, allowing for advanced analysis (e.g., computational fracture mechanics focusing on aerospace grade alloys and components), design, failure mechanisms, to predict failure mechanisms and optimization of structures and materials. It complements experimental approaches and has become an indispensable tool in various industries. It has applications in various fields, including structural analysis, geomechanics, biomechanics, materials science, and manufacturing processes. The stream consists of highly motivated and skilled faculty members in this field.

Facilities

High-end workstations
SHPB (Compression, Tension and Triaxial), Drop weight tower, High-speed camera (Phantom V-12.1)
3D-Printers

Experts

Chandrika Prakash Vyasarayani, Nizamuddin Khaderi Syed, Prabhat Kumar, Prakhar Gupta, Ramji Manoharan, Safvan Palathingal, Sai Sidhardh, Viswanath Chinthapenta,

Labs

K Lab
Sidhardh's research group
Searching Unique Class of Small-scale High-performance Materials Lab (SUCSHM)
Topology Optimization Computational Design Lab
Computational Solid Mechanics Lab
Impact Mechanics Lab

Dynamics, Vibration, and Acoustic:

Dynamics, vibration, and acoustics are three related areas of study related to the behavior and performance of all-terrain vehicles, robotics, and industrial machinery, focusing on their dynamic response, vibration characteristics, and acoustic properties. They involve a combination of experimental studies, computational modeling, and simulation techniques to design and engineer mechanical systems that meet desired performance and customer expectations. Faculty members perform comprehensive analyses of mechanical system behavior, multi-body dynamics, including effects of structural dynamics, vibration transmission, engineering noise control, Nature inspired acoustic applications and psycho acoustic.

Facilities

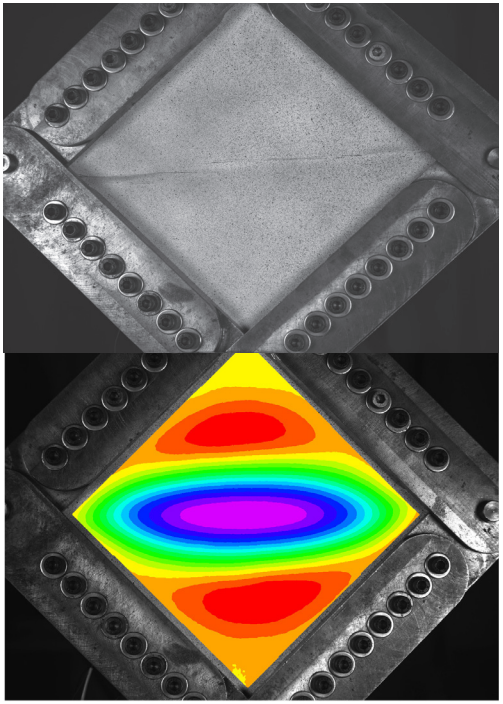
Acoustic Camera
Advanced Sound Level Meter
Binaural Dummy headset
Experimental Modal analysis
Scanning Vibrometer(Polytec make)
Micro Analyzer (Polytec)
Data Acquisition system (m+p)
Tire Scan System (Tekscan)
Maker bot (3Dprinter)
Impedance Tube

Experts

Ashok Kumar Pandey, Chandrika Prakash Vyasarayani, Prasanth Kumar R, Venkatesham B,

Labs

Acoustics Lab
Vibration Lab
Dynamics Lab
SenAct Lab
Vehicle Dynamics Lab



Composite structures:

Composites find applications in various industries, including aerospace, automotive, marine, sports equipment, construction, and consumer goods. A greater emphasis on their mechanical behavior under various loading conditions must be understood. Many faculties focus on composite manufacturing, characterization, fracture properties estimate, damage modeling, structural level testing, and finite element analysis mechanical characterization under quasi-static loading (room temperature and high strain-rate phenomenon). A few of us also work in NDE & T applied to composite damage assessment using ultrasonics and acoustic emission.

Facilities

Autoclave composite fabrication machine
Water-coupled ultrasonic testing machine
Vacuum-bagging technique
Phased-array NDT techniques.
Fiber stitching machine

Experts

Ramji Manoharan, Sai Sidhardh, Syed Nizamuddin Khaderi, Viswanath Chinthapenta

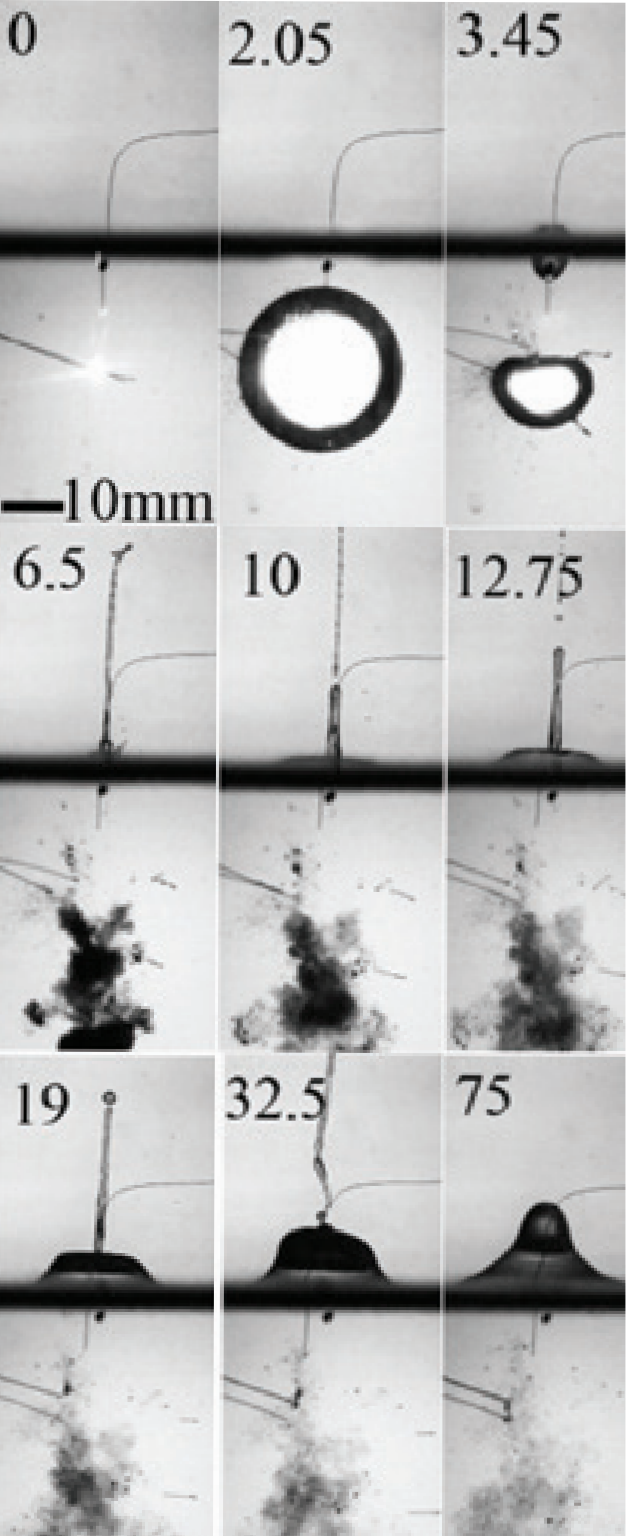
Labs

NDT&E Lab Robotics & Intelligent Systems Lab
Composites Fabrication Lab

Key features.

The research and development at MAD stream can be summarized as:

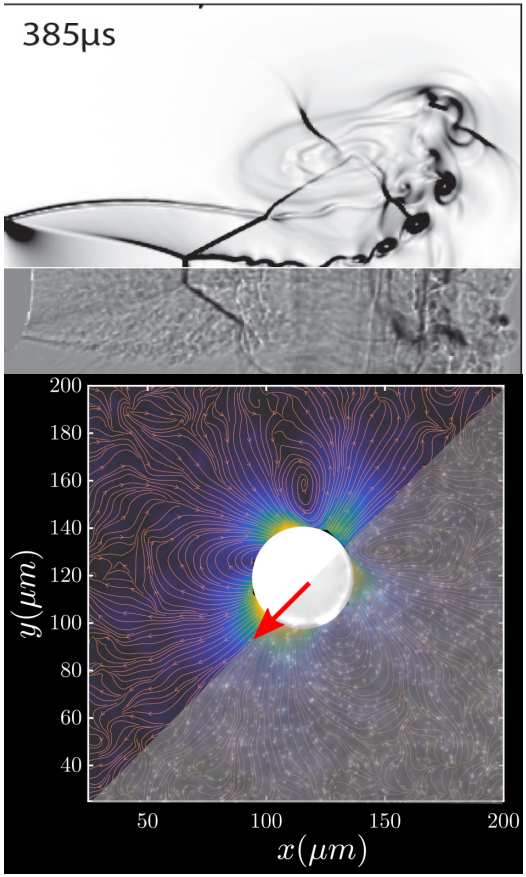
- ***Expertise:*** Experimental Solid Mechanics, Fracture Mechanics, Finite Element Analysis, Vibration, MEMS, Vehicle Dynamics, Computational Solid Mechanics, Solid-fluid Interaction, Topology Optimization, Compliant Mechanisms, Soft Robotics, Multiscale and Smart/Multi-physics Modelling, Biomechanics, Inverse problems, Control Theory, Mechatronics, Slender Structures, Fractional Calculus, Composite Mechanics, Engineering acoustics, Sound Quality, Nature inspired acoustic applications, Nano and Micro-mechanics, Computational Contact Mechanics, Structural Health Monitoring, etc.
- ***Equipment and Tools:*** The MAD stream has modern and relevant equipment related to experimental solid mechanics, dynamics, vibration and acoustic, composite material development, and impact test.
- ***Strength:*** The research strength of the stream is broadly categorized into experimental solid mechanics, computational solid mechanics, Dynamics, vibration, acoustic, and composite structures.
- ***Software:*** The stream has access to different paid software, e.g., Abaqus, Ansys, COMSOL, MATLAB, Actran, Romax, Simcentre etc. for performing research.
- ***Current and Future directions:*** The MAD stream strives to achieve excellence in current cutting-edge research directions, to collaborate with national and internal research labs and faculty members, and to support the industry and



Thermofluid Engineering

Fluid flow and energy transfer play crucial roles in many processes in nature and industry. The Department of Mechanical and Aerospace Engineering (MAE) at IITH thus places a special focus on the field of Thermo-Fluid Engineering. With Hyderabad's reputation as a hub for research institutions/ labs and industries, IITH provides an excellent environment for collaboration between academia and industries. This collaboration is strengthened by the Thermo-Fluid Engineering stream within MAE, which offers M.Tech and Ph.D. programs specifically tailored to contribute to the growth and development of Thermo-Fluid Engineering.

Our curriculum is designed to acknowledge the diverse nature of the Thermo-Fluids stream it aims to prepare the upcoming generation of researchers and engineers to tackle fundamental problems and address the ever-evolving challenges faced by industries. In this regard, we offer fundamental courses in Mathematics, Fluid Mechanics, Heat Transfer, and Computational Fluid dynamics followed by more advanced courses like Interfacial phenomena, microhydrodynamics, Advanced CFD, Turbulence and Turbulence Modelling, Compressible Flow and its Computation, IC Engine Combustion and Pollution, Chemical kinetics and Modelling in Reactor Flows., etc. As a part of the laboratory coursework, the students get hands-on experience in various state of theo-ar experimental facilities related to thermofluid engineering.



Experimental and Theoretical Fluid Dynamics:

The Experimental and Theoretical Fluid Dynamics group conducts fundamental research as well as engages in industrially-relevant research. The group is capable of high-speed imaging, macro-micro scale flow visualization experiments, and building customized experimental set-ups to study different fluid flow problems. The expertise available within the group includes droplet dynamics, sprays, cavitation, bubble dynamics, contact line dynamics, thin films, high-speed flows, aerosols, blast and shockwaves, low Reynolds number fluid mechanics, capillarity and wetting phenomena, microfluidics, active soft matter, etc.

Experts

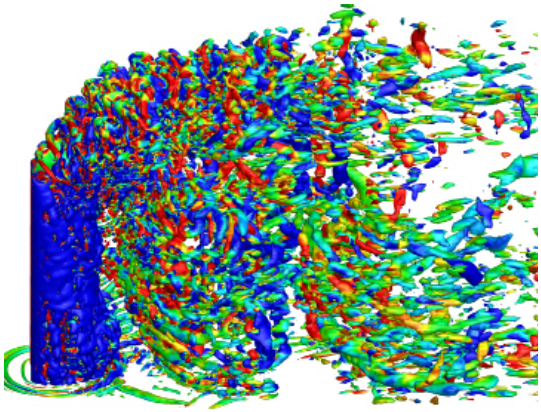
Badarinath Karri ,Harish N Dixit, Lakshmana D Chandrala, Raja Banerjee, Ranabir Dey

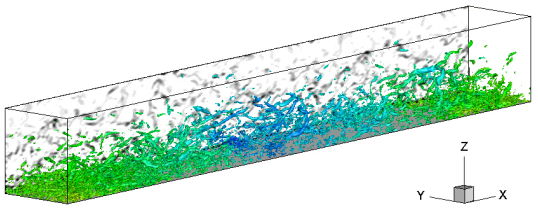
Labs

Flow Physics Lab
Liquid Spray Lab
Soft Matter and Micro-swimmers Lab
Cavitation and Bubble dynamics Lab
Wind Tunnel Lab

Facilities

Phase Doppler Particle Analyzer
Low-speed Particle Image Velocimetry
Rheolab QC rheometer
KRUSS DSA25S Goinometer
Nikon Eclipse Inverted Flourescence microscope
Wind Tunnel





Computational Fluid Dynamics (CFD):

Computational Fluid Dynamics (CFD) utilizes finite computational grids to computationally solve fundamental equations that describe fluid flows, heat transfer, mass transfer, and other physical phenomena. Our CFD group boasts expertise in diverse areas, such as multiphase flows, turbulent flow modeling, hypersonic and supersonic flows, battery thermal management, and reacting and non-reacting flows. We develop high-fidelity in-house codes on structured and unstructured grids to simulate complex fluid flow problems. Additionally, our proficiency extends to open-source platforms like OpenFOAM and commercial packages such as ANSYS, COMSOL, and STAR-CCM+. The major computational facilities available with the group are GPU systems, High-end Workstations, and Param Seva (HPC facility).

Experts

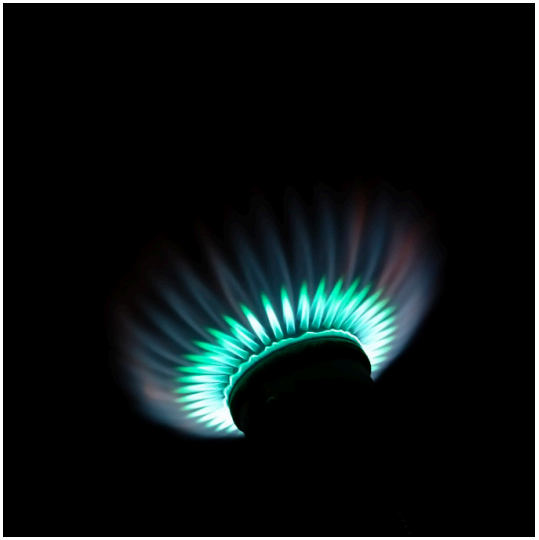
Harish N Dixit, Nishanth Dongari,
Niranjan S Ghaisas, Raja Banerjee, Sachidananda Behera ,
Sayak Banerjee, V. Eswaran, Venkatasubbaiah K

Labs

Computer Aided Engineering Lab

Facilities

Param Seva (HPC facility)
ANSYS
COMSOL



Combustion, Emission and Energy:

The Combustion, Emission, and Energy group carries out both experimental and numerical studies in the field of combustion in related to IC Engines, Gas turbines, and rockets/jet propulsion. The group also extensively works in the field of renewable energy. The expertise available in the group includes alternative zero-carbon fuels, biofuels, chemical kinetics applied to combustion, combustion diagnostics, turbulent combustion, in-flame emissions measurement, IC engine and Gas Turbine testing performance, development of fuel-flexible burner, batteries for electric vehicles, wind energy, etc.

Facilities

Flex fuel combustors
Chemiluminescence imaging
Rainbow Schlieren deflectometry
High-speed imaging
Stereo particle imaging velocimetry
Structured laser-induced planar imaging
Laser-induced incandescence
Planar laser-induced fluorescence imaging
Compressed Air facility with storage
Optical Access IC Engine
CRDI research engine
GDI research engine
Constant volume spray chamber
Gas chromatography and vacuum ultraviolet spectroscopy

Experts

Nishanth Dongari,Niranjan S Ghaisas, Pankaj Kolhe, Raja Banerjee, Saravanan Balusamy, Sayak Banerjee,

Labs

Combustion Diagnostics Lab
Advanced IC Engine Lab

Key features

The research at Thermo-Fluids Engineering has been geared toward both fundamental studies and industrial applications through experimental, numerical, and analytical studies. This can be elaborated into the following aspects:

- ***Expertise***: Research expertise in the stream is broadly categorized into three groups, Experimental and Theoretical Fluid Dynamics, Computational Fluid Dynamics, and Combustion, Emission and Energy.
- ***Facilities:*** Wind Tunnel, Phase Doppler Particle Analyzer, Particle Image Velocimetry, microscopy Rainbow Schlieren deflectometry, Stereo particle imaging velocimetry, Compressed Air facility with storage, Optical Access IC Engine, and Gas chromatography and vacuum ultraviolet spectroscopy are a few related facilities available.
- ***Collaborations:*** The faculty members in the Thermo-Fluids stream foster collaborations with esteemed academic institutions and industry partners. These collaborations span a diverse range of sectors, including aerospace, defense, and automobile industries, among others. Some faculty members are also part of the vibrant infra-IITH soft and active matter group.
- ***Strengths:*** The Thermo-Fluids group possesses a vast and diverse range of research expertise, engaging in both fundamental and industrial research endeavors. This breadth of knowledge allows us to explore the fundamentals of Thermo-Fluids Engineering while also addressing practical challenges faced by industries.

Integrated Design and Manufacturing

Globally, manufacturing's role in economic development is crucial. India aims to lead in this sector, hinging on quality engineers. Traditional production engineering falls short for modern needs; a practical-analytical mix is vital. The 2013-launched Integrated Design & Manufacturing (IDM) MTech program bridges theory and real-world application. IDM immerses students in shop floor manufacturing, design, and software tools, meeting dynamic demands. It shifts from 'T' learning to dual-depth understanding. With courses like Additive Manufacturing and Fluid Mechanics, IDM equips well-rounded professionals. Successfully running for a decade, details are on the website.

In this approach, the program moves from the conventional 'T' based learning to based learning with two deeper understanding of two interrelated aspects. While courses like Additive Manufacturing, Material Removal Processes, Metal Forming, Design for Manufacturability & Assembly, Industry 4.0 and Advanced Material Joining Processes focus on deeper understanding of Manufacturing, courses like Finite Element Methods, Fluid Mechanics and Heat Transfer, Computational Fluid Dynamics and Scaling Laws & Multi-scale Manufacturing strengthen the fundamental understanding of the student.

The program is successfully running for more than ten years, additional details of the same can be obtained from the website.

Digital fabrication and Hybrid manufacturing

Digital fabrication in today's manufacturing context refers to computer aided design and production methodologies where the digital data provides the key input which defines the part geometry, properties, and process parameters for the successful realization of the final product: in short it emphasizes flexibility. The group works in various aspects of digital fabrication which not only encompasses all major forms of manufacturing including additive, subtractive and deformation based techniques but often goes beyond to include a combination of one or more of these techniques also known as 'hybrid manufacturing' and allows to realize complex parts with improved properties leading to newer and resource efficient processes. The current expertise in the group includes additive manufacturing (including large scale and small scale), flexible metal forming processes, metal cutting and finishing process as well as the integration of metal additive-formative systems and metal additive-subtractive systems. Custom designed machine tools and setups are also being developed.

Facilities

Wire arc additive manufacturing system
Twin wire arc additive manufacturing system
Large area additive manufacturing system (L-DED)
Powder Bed Fusion machine
8 axis CNC machine for forming and machining.
Custom designed material testing for electro plasticity
Pulse generator
Custom designed roll forming machine (electric pulse aided)
Vertical Milling Machine
Burnishing set-up

Experts

Anirban, Anurup, Gopinath, Suryakumar, Venkata Reddy.

Labs

Hybrid Manufacturing Processes Lab
Additive & Subtractive Lab
Laser processing lab

Insert image caption here

Process mechanics and control

Deep understanding of the process mechanics and control is another vital aspect of research activity. In this aspect, our group works in deposition, deformation, transformation, and subtractive processes at multi scales including laser material processing and surface engineering.

Facilities

1kW continuous wave laser (Fiber)

Nanosecond pulsed lasers (Q-switched and Fiber)

IR Thermal camera and pyrometers

Friction stir processing

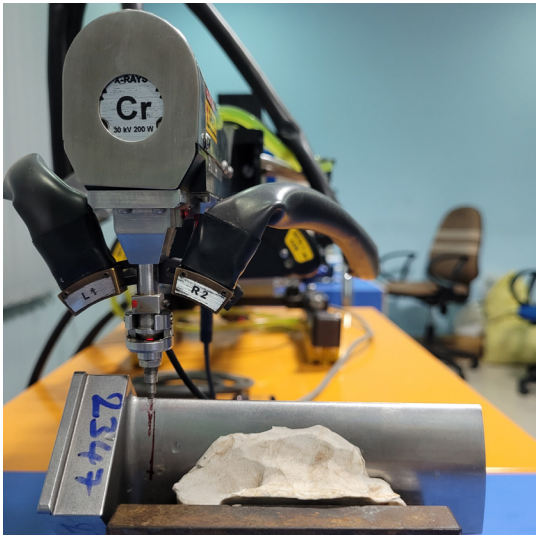
Simulation software (Materialise, Simufact)

Experts

Anirban, Anurup, Gopinath, Suryakumar, Venkata Reddy.

Labs

Laser processing lab
Hybrid Manufacturing Processes Lab
Additive & Subtractive Lab



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Material properties and characterization

The characterization of the material properties as well the finished parts' properties are very important to quantify and optimize any manufacturing process. Our metrology and characterization lab hosts a range of equipment for in-depth study of various functional and mechanical properties.

Facilities

CMM: Coordinate Measuring Machine

3D laser scanner

Form Measuring Station

Microhardness tester

Wear tester

Measuring Microscope

Residual Stress Measurement System (XRD)

Profile Projector

Scanning Electron Microscope (SEM)

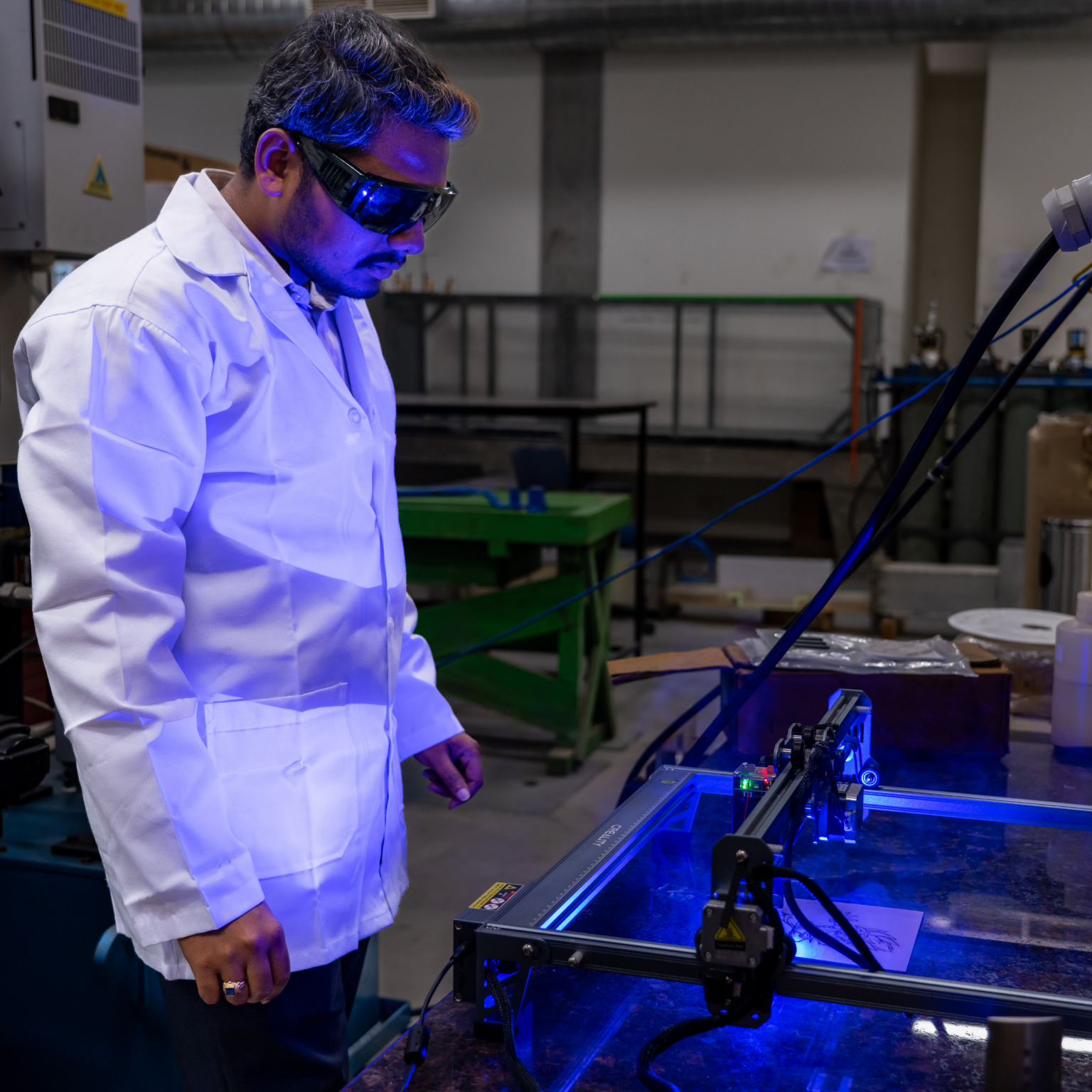
Experts
Anirban, Anurup, Gopinath, Suryakumar, Venkata Reddy.

Labs
Metrology and Characterization Lab

Key feature

The research at IDM has been geared towards "New Process, Product and Machine Development at Multi-scales". This can be elaborated into the following aspects:

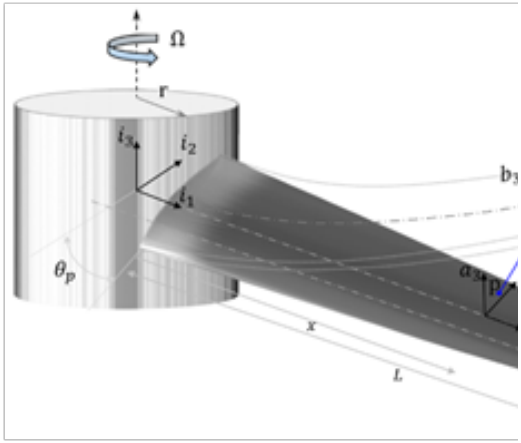
- ***Processes:*** Research expertise includes additive manufacturing, laser processing, machining, metal forming, welding and allied processes needed to achieve the basic product outline.
- ***Equipment:*** Metal 3D printer (both wire and powder based), laser sources and processing heads, 3-axis CNC machine, incremental sheet metal forming machine, GMAW and Twin-wire welding setup are a few related equipment available.
- ***Tools:*** In addition to the above processes, multiple analysis, and characterization tools like FE analysis, thermal simulation, SEM, microhardness measurement etc. are available.
- ***Applications:*** While many applications are possible, current, and potential engagement includes collaboration with the aerospace, defense, tooling, and electronics manufacturing industry.
- ***Strengths:*** There is a good strength and focus on developing new processes, including design and development of the machines involved and helping in indigenization of some of these technologies.
- ***Future Directions:*** Keeping in view the future contours of the technologies, we also have ongoing work on the themes of Industry 4.0, Circular Manufacturing etc. with the aim of increasing the overall energy efficiency of the systems and utilizing the IoT tools for achieving it.

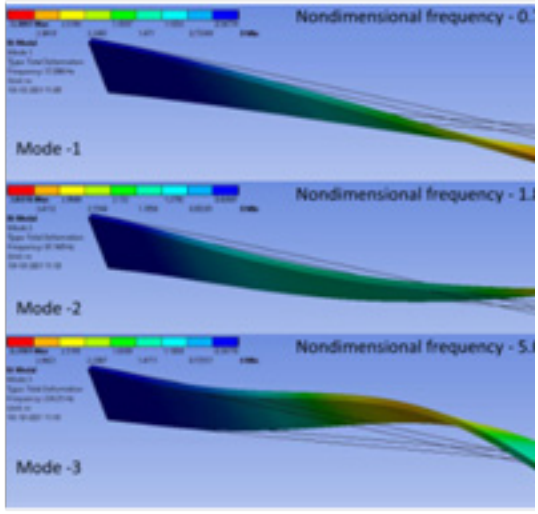


Aerospace Engineering

The Department of Mechanical and Aerospace Engineering (MAE) at IITH places particular emphasis on research problems within the field of aerospace engineering. With Hyderabad's status as a hub for aerospace research institutions and industries, IITH offers an ideal setting for fostering collaboration between the academic community and the aerospace sector. This partnership is further reinforced by the Aero stream of MAE, which provides MTech., Ph.D., and minor programs in Aerospace Engineering specifically designed to contribute to capacity building within the aerospace sector.

Our curriculum is designed acknowledging the dynamic nature of the aerospace sector and aims to prepare the upcoming generation of engineers and researchers to effectively navigate and address the evolving challenges and opportunities within the industry. One of the primary goals of the Aero stream is to incorporate courses that educate and train students in aerospace system design. In line with this objective, the department's advanced laboratories provide students essential practical exposure to experimental and computational techniques encompassing areas such as aerodynamics, propulsion, aero-structural mechanics, and flight mechanics.





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Aerodynamics:

Aerodynamics group focuses on complex problems such as aeroelasticity, vibroacoustics, aeroacoustics, that affects aerospace systems both computationally and experimentally. The group also explores fragmentation behavior and extreme mechanics associated with shock/blast wave loading of aero-structures.

Experts

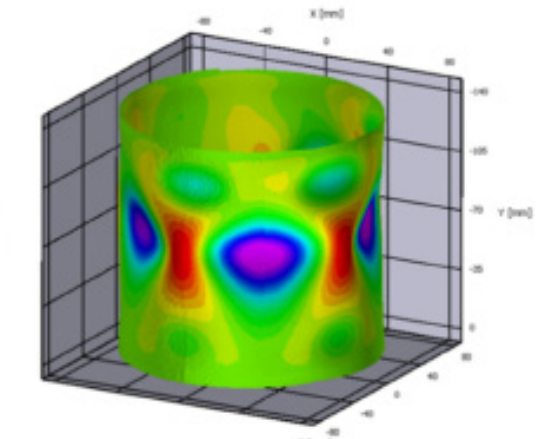
Mahesh M. Sucheendran

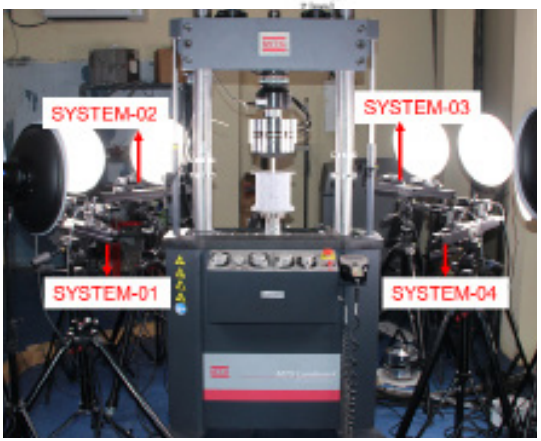
Labs

Mahesh M. Sucheendran's Research Group

Facilities

Submerged Jet Tunnel
Propeller Testing Facility
High Speed Computational Facility





Aerospace Structural Mechanics:

The aerospace structural mechanics group is engaged in developing multifunctional high-performance materials and structures required for next generation aerospace vehicles. The composite structure's lab has facilities for analysis, design, fabrication, mechanical testing and characterisation of aerospace structures. Non destructive testing and evaluation lab hosts state of the art facilities for the assessment of structural integrity of aerospace components. At IMPACTS laboratory, the researchers develop novel experimental techniques for multiscale and Multiphysics characterization of composites and alloys for aerospace

Experts

Chandra Prakash, Gangadharan R.

Labs

IMPACTS Lab
Composite Structure's Lab
NDT&E Lab

Facilities

Autoclave for fabrication of composite structures
Tailored Fiber Placement -Advanced composite manufacturing
Phased array ultrasonics, Air coupled Ultrasonics, Thermography
Raman Spectroscopy

Aerospace Propulsion

The Aerospace propulsion laboratory in the MAE department at IITH focuses on investigating the combustion behavior, dynamics and control aspects of different solid fuels (metal particles, composite and pyroelectric propellants) and gaseous fuels. Novel combustion systems are developed and their operational efficiency and combustion dynamics are studied. Dynamics of propulsion systems for drones in conjunction with their flight dynamics are also studied.

Facilities

Metal fuel combustor
Windowed Strand burner
Pyroelectric solid propellant thruster system
Thermoacoustic test rig
Test facility for drone flight and swarming
High Speed imaging facility
Particle Image Velocimetry (PIV)
Planar laser-induced fluorescence (PLIF)

Experts

K. Gnanaprakash ,Vishnu R Unni

Labs

Energetics and Combustion Lab
Dynamics and Control Lab (DysCo)

Key features

Aerospace stream aims to make significant contributions towards the development and advancement of aerospace technologies through addressing research problems that are pertinent to the current aerospace technology landscape and by emphasizing a holistic approach to education that encompasses system-level knowledge.

- ***Capacity building:*** Aero stream offers a minor program and a master's program in Aerospace Engineering. Our courses are tailored towards futuristic technologies and foster system level thinking and practical implementations.
- ***Strengths:*** Our research expertise encompasses composite structures for satellite and aircraft applications, extreme mechanics associated with aero systems, aeroelasticity, shock/blast wave loading of aero-structures, combustion dynamics and advanced propulsion systems.
- ***Future Directions:*** The future focus of the stream will be on development and study of advanced UAVs and micro-UAVs, swarm dynamics, deployable structures for satellite and aircraft applications, novel propulsion systems and hypersonics.