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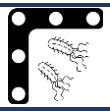
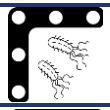
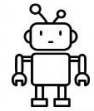
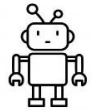
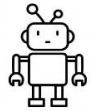
LIST OF PROPOSALS

IDPHD2026001	Study of DropletzDynamics Using Experimental, Computational, and Machine Learning Methods		
IDPHD2026002	Data-Driven Simulation of Non-Newtonian Fluid Flows Using Experimental Data and Computational Fluid Dynamics		
IDPHD2026003	Shear-induced dispersion in granular flows		
IDPHD2026004	Collective Dynamics of Active Liquid-Crystal Droplets in Newtonian and Viscoelastic Fluids		
IDPHD2026005	From Electrified Jets to Nanofibers: Investigating the Fluid Mechanics of Polymer Electrospinning		
IDPHD2026006	AI enabled thermoplasmonic microfluidic platform for programmable manipulation of liquid flow and optical fields on a chip		
IDPHD2026007	Machine Learning–Based Assessment of Structural Behaviour of Metal Cladding Systems under Wind Loading.		
IDPHD2026008	Design and Fabrication of MEMS-TMR Magnetometer for Robotics Applications		
IDPHD2026009	Coherent Beam Combining–Based Adaptive Laser Beam Shaping for Advanced Photonics Applications		
IDPHD2026010	Development of organic semiconductor materials and devices for healthcare applications		
IDPHD2026011	The Intrinsic Electronic Stability Limit of Solid-State Battery Electrolytes from DFT and Machine Learning Simulations		
IDPHD2026012	DFT-Guided Design of Organic-Inorganic Hybrid Electrodes for High-Performance Supercapacitors		

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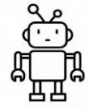
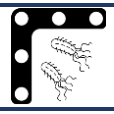
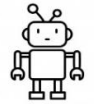
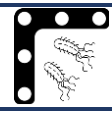
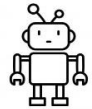
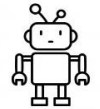
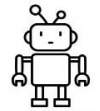
IDPHD2026022	Computational Designing of Novel Transition Metal Based Spin-Crossover Material for Spintronics and Thermoelectric Applications		
IDPHD2026023	Multi-phase CFD and Coupled CFD-DEM models for flow of complex suspensions with an application for 3D Concrete Printing		
IDPHD2026024	On multiscale topology optimization with design-dependent pressure loading		
IDPHD2026025	SPARSH: Soft Physical systems for Adaptive Robotics and Sensing in Healthcare		

IDPHD2026026	Understanding of intercalation mechanisms of multivalent metal-ions across MXene Galleries		
IDPHD2026027	Developing Improved Aeration Systems for Biological Wastewater Treatment Processes		
IDPHD2026028	Waste-to-value: Recycling plastic waste into fuels using biomass-waste-derived advanced functional catalysts		
IDPHD2026029	Tabletop Hybrid Laser Accelerators		
IDPHD2026030	Integrated Electrochemical CO_2 Capture and Conversion		
IDPHD2026031	Next-Generation Engineered Isoporous Membrane: Polymer Formulations for Sustainable Water Purification and Resource Recovery		
IDPHD2026032	Co-Designing Serious Games to Build Climate Resilience in Vulnerable Last Mile Communities		
IDPHD2026033	Designing of Transition Metal grafted on Porous Matrix as Efficient Catalysts for Electro- and Photocatalytic Conversion of CO_2 to Chemicals		
IDPHD2026034	Design and Fabrication of Electrospun Ferroelectric/2D Materials Composites for Architectures Upgraded TENG Devices		
IDPHD2026035	Ti, Mo, V-based MXenes and Metal Oxides/Sulfides as Advanced Electrode Materials for Aqueous Zn-ion Batteries		
IDPHD2026036	Micro–Macro Investigation of Failure of Mine Overburden Dumps and Associated Runout Hazards		
IDPHD2026037	HARVEST: Harnessing Agrivoltaics, Robotics, Virtual Systems and AI through Integrated Engineering and Design		
IDPHD2026038	Sustainable Asphalt Mixtures: Evaluating Lignin as a Renewable Binder Extender		

IDPHD2026039	Dirt to Design: Engineering High-Tech Materials from Chromite Mining Waste by Sustainable Hydrometallurgical Route		
IDPHD2026040	Versatile Wide Bandgap Perovskites for Tandem Solar Cells (VIP-TSCs)		
IDPHD2026041	3D-printable photonic porous ceramics for passive cooling applications		
IDPHD2026042	Discovery Through Play: Bringing Experimental Science to Schools via Interactive 3D Models		
IDPHD2026043	Spatiotemporally Optimized Active Control of Thermoacoustic Instability using Nanosecond Repetitively Pulsed Plasma Discharge		
IDPHD2026044	Understanding sheared turbulent flows: from boundary-layers and wind-turbines to tokamaks		
IDPHD2026045	Development of a Laser-Based Wireless Power Transfer System for UAV		
IDPHD2026046	Extraction of rare earth elements from secondary sources (coal ash, overburden, red mud etc)		
IDPHD2026047	Smart Sensors for Lung and Breast Cancer Therapy		
IDPHD2026048	Fluorescence-based Detection and Analysis of DNA Methylation		
IDPHD2026049	Human Heat Strain and Survivability under Extremely Hot Conditions: Integrated Thermoregulation and Climate Modelling		
IDPHD2026050	A robust, control-theoretic framework for optimal enzyme allocation in genome-scale metabolic networks		
IDPHD2026051	Hybrid Nanotheranostic Platforms for Precision Targeting and Image-Guided Therapy of Metastatic Abdominal Tumors		

IDPHD2026052	Development of AI-based prognostic risk models and biomarker discovery for neurodegenerative disorders using radiomics, neurophysiological and multi-omics data		
IDPHD2026053	Uptake, translocation and bioaccumulation of microplastics in biological systems: In vitro and in vivo studies		
IDPHD2026054	Integrating Machine Learning and Multiscale Modeling to Advance Drug Targeting of Opioid Receptors		
IDPHD2026055	Designing bioinspired flavin-based module for specific cellular colocalization, sensing and bioimaging applications		
IDPHD2026056	Quantitative Magnetic Resonance Imaging and Artificial-Intelligence-enabled radiotherapy planning		
IDPHD2026057	Development of a Comprehensive Machine Learning Based Platform for Optimization, Reduction and Integration of Chemical Kinetic Mechanisms into LES and RANS based Turbulent CFD Codes		
IDPHD2026058	Physics-Informed Neural Networks for solving Inhomogeneous wave equations		
IDPHD2026059	Unrolled deep learning based sparse solvers: Analysis and application to inverse problems in Tomography		
IDPHD2026060	Developing Neurosymbolic Framework for Interatomic Potentials: Bridging Machine Learning and Materials Physics for Interpretable Atomistic Models		
IDPHD2026061	Artificial Intelligence Assisted Smart Systems for Next-Generation Photonic Technologies		
IDPHD2026062	Decentralized Federated Learning for Health Care Management		

VERTICAL: SOFT AND ACTIVE MATTER & MECHANICS OF MATERIALS

IDPHD2026001 Study of Droplet Dynamics Using Experimental, Computational, and Machine Learning Methods

Supervisor 1: **Prof. Sachidananda Behera**
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Supervisor 2: **Prof. Kirti Chandra Sahu**
Department: Chemical Engineering
Email: ksahu@che.iith.ac.in

Abstract

The project aims to study droplet dynamics using an integrated approach combining experiments, computational fluid dynamics (CFD), and machine learning methods. Controlled experiments will be carried out to examine droplet motion, deformation, breakup, and interactions under varying flow and environmental conditions, using high-speed imaging techniques already established within the group. CFD simulations will complement the experiments and provide detailed insight into the underlying fluid dynamic mechanisms. Machine learning techniques will then be employed to analyse the generated data obtained from the experiments and numerical simulations. This combined approach will lead to a clearer understanding of droplet dynamics and offer a robust framework for modeling complex droplet-driven processes relevant to both natural phenomena and engineering applications, including microfluidic devices.

Keywords

Fluid Dynamics, Droplet, Experiments, CFD, ML

Funding

MoE (Regular)

Background & Motivation

Droplet dynamics plays a crucial role in many natural phenomena and engineering applications, including rainfall, sprays, and microfluidic systems. Understanding droplet motion, deformation, breakup, and interactions under complex flow conditions remains challenging. Consequently, advanced experimental techniques, CFD, and machine learning approaches are increasingly important for addressing these challenges in modern scientific and industrial applications.

Essential Qualifications

BE/B-Tech, ME/MTech in Mechanical, Chemical, and Aerospace Engineering; MSc in Physics with fluids background

Desirable Qualifications

Knowledge of Fluid Mechanics and Heat Transfer

Key Publications (Last 3 Years)

1. N. V. Anirudh, S. Behera and K. C. Sahu, Unveiling crown-finger instability of a non-spherical drop impacting a liquid surface, Journal of Fluid Mechanics, 2026, 1030, A9.
2. N. V. Anirudh, S. Behera and K. C. Sahu, Coalescence of non-spherical drops with a liquid surface, International Journal of Multiphase Flow, 2024, 175, 104800.
3. S. S. Ade, L. D. Chandrala and K. C. Sahu, Size distribution of a drop undergoing breakup at moderate Weber numbers, Journal of Fluid Mechanics, 2023, 959, A38.
4. S. S. Ade, P. K. Kirar, L. D. Chandrala and K. C. Sahu, Droplet size distribution in a swirl airstream using in-line holography technique, Journal of Fluid Mechanics, 2023, 954, A39.
1. S. S. Ade, D. Gupta, L. D. Chandrala and K. C. Sahu, Application of deep learning and inline holography to estimate the droplet size distribution, International Journal of Multiphase Flow, 2024, 177, 104853.

Broad Proposal Objectives

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VERTICAL: SOFT AND ACTIVE MATTER & MECHANICS OF MATERIALS

IDPHD2026002 **Data-Driven Simulation of Non-Newtonian Fluid Flows Using Experimental Data and Computational Fluid Dynamics**

Supervisor 1: **Neetu Tiwari**
Department: Mechanical & Aerospace Engineering
Email: neetu.tiwari@mae.iith.ac.in

Supervisor 2: **Anand Mohan**
Department: Chemical Engineering
Email: anandm@che.iith.ac.in

Abstract
This project aims to develop a hybrid simulation method that integrates sparse experimental measurements with CFD to accurately predict pipe flows of non-Newtonian fluids using data driven method. It involves improving simulations by assimilating real-time velocity and pressure data from Ultrasonic Velocity Profiler using nudging: this will be validated for shear-thinning and shear-thickening models.

Keywords
Non-Newtonain fluid, CFD, data driven method, Ultrasonic velocity profiler

Funding
MoE (Regular)

Background & Motivation

Many studies improved experimental flow diagnostics such as Ultrasonic Velocity Profiler, Particle Image Velocimetry, and Particle Tracking Velocimetry using data assimilation to enhance spatial and temporal resolution and reduce noise. However, they rarely correct CFD solutions. Hybrid approaches like PTV–DNS and nudging-based CFD assimilation exist but are mostly limited to Newtonian turbulence, leaving non-Newtonian flow simulations largely unexplored.

Essential Qualifications
Mechanical Engineering, Chemical Engineering, BSC+MSC Physics

Desirable Qualifications
CFD

Key Publications (Last 3 Years)

1. Tiwari N (2023) Ultrasonic velocity profiler placement for flow over cylinder based on determinant greedy line selection method. Exp Fluids 64:119. https://doi.org/10.1007/s00348-023-03661-4
2. Tiwari N (2024) Time resolution improvement of ultrasonic velocity profiler for flow over cylinder using EPOD method with optimally placed time-resolved sensors. Exp Fluids 65:. https://doi.org/10.1007/s00348-024-03903-z
3. Tiwari N., Murai Y. (2021), Ultrasonic velocity profiler applied to explore viscosity- pressure fields and their coupling in shear-thinning vortex streets, Experiments in Fluids 62, 185 . (Springer, IF=2.5) https://doi.org/10.1007/s00348-021-03257-w
4. Mohan Anand, Banothu Gnaneshwarii (2026),A variant of Stokes' second problem for a new shear thinning model for paint,Applications in Engineering Science,Volume 25,2026,100288, ISSN 2666-4968, https://doi.org/10.1016/j.apples.2025.100288.
5. Sai Manikiran Garimella, Mohammed Ameenuddin, Mohan Anand (2022),Computational fluid dynamics study of kaolin–water flow in a T-junction using a novel shear-thinning fluid model, The Canadian Journal of Chemical Engineering 101 (6), 3624-3633, 2023

Broad Proposal Objectives View Broad Proposal Objectives (PDF)

VERTICAL: SOFT AND ACTIVE MATTER & MECHANICS OF MATERIALS

IDPHD2026003 Shear-induced dispersion in granular flows

Supervisor 1: **Dr. Jyotirmoy Rana**
Department: Mathematics
Email: jrana@math.iith.ac.in

Supervisor 2: **Dr. Ramkarn Patne**
Department: Chemical Engineering
Email: ramkarn@che.iith.ac.in

Abstract

Shear-induced dispersion plays a crucial role in the transport of particulate and granular materials in industrial and geophysical flows. This project investigates solute dispersion in granular flows, using Gill's methodology to estimate effective dispersivity. The influence of granular flow characteristics is analysed, providing guidelines for the experimental determination of effective dispersivity.

Keywords

Shear-induced dispersion, Granular flows, Solute transport, Effective dispersivity, Gill's analytical method

Funding

MoE (Regular)

Background & Motivation

Dispersion of solutes and particles is fundamental in many industrial and natural processes, including chemical reactors, environmental transport, and geophysical granular flows. While dispersion in fluid flows is well understood through Taylor–Aris theory, solute dispersion in granular flows remains insufficiently explored, motivating analytical investigation of effective dispersivity and transport mechanisms.

Essential Qualifications

MSc in Maths and Physics, MTech in Chemical, mechanical, civil engineering

Desirable Qualifications

MSc in Maths and Physics, MTech in Chemical, mechanical, civil engineering

Key Publications (Last 3 Years)

1. Jyotirmoy Rana, Ashis Kumar Roy, Sudip Debnath, and Ramkarn Patne (2026): Solute dispersion in pulsatile Casson fluid flow with exchange between phases using the extended Gill's approach, Journal of Fluid Mechanics, 1028, A35. Cambridge University Press.
2. Kartick Mahata, Dipika Robi Das, Ramkarn Patne, and Jyotirmoy Rana (2025): Shear-enhanced dispersion in Kolmogorov flow, Physics of Fluids 37(4), AIP Publishing.
3. Kartick Mahata, Jyotirmoy Rana, and Ramkarn Patne (2025): Solute dispersion in Phan-Thien–Tanner (PTT) fluid flows, Physics of Fluids 37(2), AIP Publishing.
4. Santanu Das, Kartick Mahata, Ramkarn Patne, Sanjeev Kumar, and Jyotirmoy Rana (2024): Unsteady solute dispersion in large arteries under periodic body acceleration, Physics of Fluids 36(10), AIP Publishing.
5. Jyotirmoy Rana, Prosanjit Das, Sarifuddin, Prashanta Kumar Mandal, and Ramkarn Patne (2024): Dispersion of a non-uniform solute slug in pulsatile viscoelastic fluid flow, Physics of Fluids 36(9), AIP Publishing.

Broad Proposal Objectives — View Broad Proposal Objectives (PDF)

VERTICAL: SOFT AND ACTIVE MATTER & MECHANICS OF MATERIALS

IDPHD2026004 Collective Dynamics of Active Liquid-Crystal Droplets in Newtonian and Viscoelastic Fluids

Supervisor 1: **Anupam Gupta**
Department: Physics
Email: agupta@phy.iith.ac.in

Supervisor 2: **Ranabir Dey**
Department: Mechanical & Aerospace Engineering
Email: ranabir@mae.iith.ac.in

Abstract

This project develops a predictive numerical framework for active liquid-crystal droplets in Newtonian and viscoelastic fluids. By modelling isotropic and nematic autophoretic droplets, we will investigate how activity, nematic order, hydrodynamic interactions, and fluid rheology govern swimmer motility, collective dynamics, and phase separation, and guide experiments toward regimes exhibiting novel active matter phenomena.

Keywords

Chiral Microswimmer; Viscoelasticity; Collective Behaviour

Funding

MoE (Regular)

Background & Motivation

Active microswimmers often operate in complex biological fluids that exhibit viscoelastic behaviour. While individual swimmer dynamics have been widely studied, the combined role of activity, nematic order, and fluid rheology in shaping collective behaviour remains poorly understood. Developing predictive models for active droplets in complex fluids is therefore essential for understanding emergent active matter phenomena.

Essential Qualifications

Mechanical engineering; Physics; Chemical engineering;

Desirable Qualifications

Fluid mechanics; vector/tensor algebra and calculus; numerical analysis; microfluidics;

Key Publications (Last 3 Years)

1. C. M. Buness, A. Rana, C. C. Maass†, R. Dey†, “Electrotaxis of artificial microswimmers in microchannels”, Phys. Rev. Lett. 133, 158301, 2024 († corresponding authors).
2. R. Dey†, C. M. Buness, B. V. Hokmabad, C. Jin, C. C. Maass†, “Oscillatory rheotaxis of artificial swimmers in microchannels'', Nature Communications, 13 (1), 1-10, 2022 (Selected as Editor’s highlight under Applied Physics and Mathematics). († corresponding authors).
3. B. V. Hokmabad, R. Dey, M. Jalaal, D. Mohanty, M. Almukambetova, K. A. Baldwin, D. Lohse, C. C. Maass, “Emergence of bimodal motility in active droplets'', Physical Review X, 11 (1), 011043, 2021.
4. A. D. Roy, S. S. Sontakke, A. Kumar, R. Dey†, A. Gupta† “Modeling complex motility patterns for autophoretic microswimmers”, arXiv:2512.21756, 2025 († corresponding authors).
5. A. Gupta, D. Vincenzi, “Effect of polymer-stress diffusion in the numerical simulation of elastic turbulence”. J. Fluid Mech., 870, 405-418, 2019.

Broad Proposal Objectives

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VERTICAL: SOFT AND ACTIVE MATTER & MECHANICS OF MATERIALS

IDPHD2026005 From Electrified Jets to Nanofibers: Investigating the Fluid Mechanics of Polymer Electrospinning

Supervisor 1: **Prof. Harish N Dixit**
Department: Mechanical & Aerospace Engineering
Email: hdixit@mae.iith.ac.in

Supervisor 2: **Dr. Satyavrata Samavedi**
Department: Chemical Engineering
Email: samavedi@che.iith.ac.in

Abstract

Electrospinning is a powerful technique that uses strong electric fields to stretch polymer solutions into ultrafine nanofibers used in applications such as filtration, energy storage devices, and biomedical engineering. This project investigates the fluid mechanics of electrified polymer jets using a state-of-the-art electrospinning setup, high-speed imaging with AI/ML-assisted image analysis, rheology, and computational electrohydrodynamic simulations. Students joining this exciting project may pursue experimental investigations or computational modeling, or a combination of both, depending on their interests and background.

Keywords

Electrospinning, Polymeric Nanofibers, Polymer Rheology, Electrohydrodynamics, Real time Imaging

Funding

MoE (Regular)

Background & Motivation

Although electrospinning is widely used to produce nanofibers for industrial applications such as filtration, the mechanisms governing cone–jet formation, jet initiation, jet stability, fiber diameter, and the transition from straight jets to whipping instabilities remain poorly understood. Addressing these challenges is essential for improving the reliability and scalability of electrospinning. This project aims to develop a deeper understanding of the electrospinning process to enable the production of nanofibers with tailored properties for high-performance applications.

Essential Qualifications

B.Tech or M.Tech in Chemical Engineering or Mechanical Engineering or Materials Science & Engineering or Polymer Science and Engineering or Allied areas; Or, MSc in Physics

Desirable Qualifications

B.Tech or M.Tech in Chemical Engineering or Mechanical Engineering or Materials Science & Engineering or Polymer Science and Engineering or Allied areas; Or, MSc in Physics

Key Publications (Last 3 Years)

1. KC Ghanashyam, S Samavedi, HN Dixit, "A Robust Truncated-Domain Approach for Cone--Jet Simulations in Electrospinning and Electrospraying", arXiv:2602.15416 (2026)
2. S Arunachalam, Harish N Dixit*, S Samavedi*, "Establishment of unique cone-shapes and universal shape-parameters toward predicting fiber diameter in polymer electrospinning", Industrial & Engineering Chemistry Research, 63(30), pp. 13238-13251 (2024)
3. C. Gupta, L. D. Chandrala, Harish N Dixit*, An experimental study of flow near an advancing contact line: a rigorous test of theoretical models, Journal of Fluid Mechanics, 1000, A45, (2024)
4. N Joy, D Venugopal, AM Gopinath, S Samavedi*, "Connecting in situ cone/jet length in electrospinning to fiber diameter and drug release for the rational design of electrospun drug carriers", Chemical Engineering Science, 295, 120168 (2024)
5. N Joy, R Anuraj, A Viravalli, Harish N Dixit, S Samavedi*, "Coupling between voltage and tip-to-collector distance in polymer electrospinning: insights from analysis of regimes, transitions and cone/jet features", Chemical Engineering Science, 230, 116200 (2021)

Broad Proposal Objectives

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VERTICAL: SOFT AND ACTIVE MATTER & MECHANICS OF MATERIALS

IDPHD2026006 **AI enabled thermoplasmonic microfluidic platform for programmable manipulation of liquid flow and optical fields on a chip**

Supervisor 1: **Shourya Dutta Gupta**
Department: Materials Science and Metallurgical Engineering
Email: shourya@msme.iith.ac.in

Supervisor 2: **Suhanya D.**
Department: Chemical Engineering
Email: suhanya@che.iith.ac.in

Abstract

This project develops an AI enabled thermoplasmonic microfluidic platform for programmable manipulation of liquid flow and optical fields on a chip. Localized plasmonic heating enables pump-free actuation, while artificial intelligence autonomously optimizes light patterns and flow states for adaptive sensing, mixing, and microscale reaction control.

Keywords

Plasmonics, Microfluidics, Sensing, Light, Nanoparticles

Funding

MoE (Regular)

Background & Motivation

Microfluidic lab-on-chip systems enable precise handling of small fluid volumes but depend on external pumps and rigid control schemes. Thermoplasmonics offers contact-free, light-driven fluid actuation via localized heating. Integrating artificial intelligence enables adaptive, real-time control of complex optothermal flows, enabling autonomous, compact, and reconfigurable microfluidic platforms.

Essential Qualifications

Chemical Engineering, Electrical Engineering, Optics(Physics), Materials Sceince, Biotechnology,

Desirable Qualifications

Bachelors or Masters in Above fields

Key Publications (Last 3 Years)

1. Real-time optical spectroscopy for in situ single-droplet analysis, R Pandillapally, P. Jayakumar, S Dutta-Gupta, S Duraiswamy, Nanoscale Advances (2026)
2. In Situ Growth and Regeneration of Photocatalyst: A Continuous High-Throughput Microphotoreactor, SK Singh, S Duraiswamy, Langmuir (2026)
3. In situ extinction spectroscopy platform for real-time monitoring of nanoparticle synthesis and chemical reactions, AJ Roy, J Pillanagrovi, N Joshi, A Srividhya, SRK Malladi, S Dutta-Gupta, Journal of Optics (2026)
4. Thermally driven resonance tuning in nanobipyramid plasmonic substrates, AJ Roy, SRK Malladi, S Dutta-Gupta, Journal of Materials Chemistry C 13 (28), 14270-14282
5. Multifunctional flexible electrospun polydimethylsiloxane (ePDMS) membranes for soft robotics applications and photocatalytic conversion platforms, IR Reshma, GN Kasinathan, A Tikoo, P Meduri, SN Rath, S Dutta-Gupta, RSC Applied Polymers (2026)

Broad Proposal Objectives — View Broad Proposal Objectives (PDF)

VERTICAL: SOFT & ACTIVE MATTER | MECHANICS OF MATERIALS

IDPHD2026007 Machine Learning–Based Assessment of Structural Behaviour of Metal Cladding Systems under Wind Loading.

Supervisor 1: **Prof. Mahendrakumar Madhavan**
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Supervisor 2: **Dr. Nagarajan Ganapathy**
Department: Biomedical Engineering
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Abstract

This project develops a combining wind uplift experimentation, full-field 3D Digital Image Correlation (DIC) and machine learning to assess the structural behaviour of metal cladding systems under wind loading. Experimental datasets will be used to train predictive models for uplift capacity, failure progression, and performance-based roofing design

Keywords

Cold-Formed Steel, Machine Learning, Wind uplift, Metal cladding systems, 3D Digital Image Correlation, Structural testing

Funding

MoE (Regular)

Background & Motivation

Metal roofing systems in lightweight steel buildings are vulnerable to wind uplift, especially in cyclone-prone regions. Conventional testing is costly and provides limited local response information. Integrating full-field experimental data with machine learning enables improved understanding of failure mechanisms and supports development of predictive tools for resilient roofing design.

Essential Qualifications

Relevant Master's or Bachelor's degree, Relevant Research experience, Machine Learning / Artificial Intelligence, Computer Programming (MATLAB / Python)

Desirable Qualifications

Interdisciplinary Knowledge, Machine Learning Model Development, Laboratory Testing Experience and data analysis.

Key Publications (Last 3 Years)

1. Numerical Study on Retrofitting of Hot Rolled Steel Beams with Cold-formed Steel Encased Channels-Design Concept using Machine Learning Method. Authors: Gaurav Chobe, Sivaganesh Selvaraj and Mahendrakumar Madhavan
2. Design of Cold-Formed Z-Shaped purlin-to-rafter connections subject to pull-through failure. Authors: Haripriya Karthikeyan, Bishal Naik and Mahendrakumar Madhavan
3. Cleat Angle Behavior in C-Shaped Purlin-to-Rafter Connections: Experimental Study and Design Considerations. Authors: Chandragiri Hari Narayana, Bishal Naik and Mahendrakumar Mathialagu Madhavan
4. Automatic Detection of Atrial Fibrillation in ECG Using Co-Occurrence Patterns of Dynamic Symbol Assignment and Machine Learning. Authors: Nagarajan Ganapathy, Diana Baumgärtel and Thomas M. Deserno.
5. Accelerating Diabetic Wound Healing by Modulating the Inflammatory Environment Using Quercetin–Rosemary Oil Lipid Nanoemulsions with Artificial Intelligence-Based Wound Closure Analysis. Mohammad Sadik Ali, Monika Pebam, Hima Sree Buddhiraju, Sreenath Dey, Veeresh Bantal, Nagarajan Ganapathy, Divyadarshini Madhavan and Aravind Kumar Rengan.

Broad Proposal Objectives

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VERTICAL: ROBOTICS, BIOMIMETICS & INSTRUMENTATION

IDPHD2026008 Design and Fabrication of MEMS-TMR Magnetometer for Robotics Applications

Supervisor 1: **Ashok Kumar Pandey**
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Supervisor 2: **Yogesh Kumar Srivastava**
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Abstract

This proposal deals with the development of a room-temperature MEMS-TMR hybrid magnetometer to circumvent 1/f (Flicker) noise. By mechanically modulating magnetic flux using a piezo based MEMS cantilever, the sensor achieves sub-millihertz detection. This precision enables robots to navigate through localized magnetic anomalies, providing a robust, GPS-independent "magnetic sixth sense" for autonomous systems.

Keywords

MEMS based Mechanical Modulation, Tunnel Magnetoresistance (TMR),1/f (Flicker) Noise, Movable Magnetic Flux Concentrator (MMFC)

Funding

MoE (Regular)

Background & Motivation

Magnetic field sensing across various domains requires high sensitivity at ultra-low frequencies in the order of milliHertz range. While Tunneling Magnetoresistance (TMR) sensors offer excellent sensitivity, their performance at sub-Hz frequencies is deteriorated by 1/f (flicker) noise, which exponentially increases near zero frequency, masking weak signals. To suppress this noise, we utilize mechanical modulation through cantilever vibration. By integrating a Movable Magnetic Flux Concentrator (MMFC) on a piezo-driven MEMS cantilever, we physically "chop" the magnetic field. This shifts the target baseband signal to the cantilever's resonance frequency (f0), moving it away from the 1/f noise floor into a high-signal-to-noise regime. For robotics, this innovation acts as a "magnetic sixth sense." In GPS-denied environments such as underwater AUVs or autonomous warehouse systems - robots can navigate by mapping localized magnetic anomalies. This provides a robust, covert, and unjammable localization strategy, replacing drift-prone IMU/odometry methods with stable, absolute magnetic referencing.

Essential Qualifications

BE/BTech/BS/MSc/MTech with First Class as per Institute norm.

Desirable Qualifications

Multiphysics; Microfabrication; Finite Element, Mechanical and Electrical Characterization

Key Publications (Last 3 Years)

1. Lalsingh Devsoth and Ashok Kumar Pandey, "Hydrodynamic forces in shape morphed non-uniform cantilever beam resonator," Journal of Applied Physics, 138(3), 2025
2. Jani, N., Tirupathi, R., Menon, P.K. et al. Modelling and optimization of compound lever-based displacement amplifier in a MEMS accelerometer. Microsyst Technol 31, 1337–1356 (2025). https://doi.org/10.1007/s00542-024-05757-1
3. Sai Kishore Jujjuvarapu, Lalsingh Devsoth, Ashok Akarapu, Prem Pal and Ashok Kumar Pandey, "Frequency and damping analysis of hexagonal microcantilever beams," Sensors and Actuators A: Physical, Volume 375, 115542, 1-18, 2024
4. Vanlal Rinfela, Bhawana Andola, Rajour Tanyi Ako, Naveen Periketi, Bhaswati Biswas, Madhu Bhaskaran, Chandrasekhar Murapaka, Anil Kumar Chaudhary, Sharath Sriram, Prem Pal, Yogesh Kumar Srivastava; Deep-subwavelength terahertz sensing with an ultrathin flexible metasurface. Appl. Phys. Lett. 23 February 2026; 128 (8): 081701.
5. Yashwant Kumar, Vanlal Rinfela, Bhawana Andola, Namitha Nandakumar, Prem Pal, Abhishek Kumar, Yogesh Kumar Srivastava; Extremely high-Q Mie voids for ultrasensitive terahertz metasensor. J. Appl. Phys. 28 September 2025; 138 (12): 123104.

Broad Proposal Objectives

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VERTICAL: ROBOTICS, BIOMIMETICS & INSTRUMENTATION

IDPHD2026009 Coherent Beam Combining–Based Adaptive Laser Beam Shaping for Advanced Photonics Applications

Supervisor 1: **Dr. Vishnu R Unni**
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Supervisor 2: **Dr. Nithyanandan Kanagaraj**
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Abstract

This proposal presents an AI/ML-driven coherent beam combining (CBC) framework for adaptive laser beam shaping in advanced photonics applications. By integrating real-time phase retrieval, correction, and predictive feedback control, the system aims to enhance beam quality, scalability, and robustness for manufacturing, communications, and scientific instrumentation under dynamic environmental and operational conditions.

Keywords

Beam Shaping, Coherent Beam Combination, Manufacturing,

Funding

Project-funded PhD position

Background & Motivation

Advanced photonic technology demands precise laser quality, scalability, and stability. Conventional beam-shaping and phase-control techniques struggle with dynamic disturbances and scaling limits. Emerging AI/ML methods offer adaptive, data-driven optimization for coherent beam combining, enabling real-time phase correction, enhanced efficiency, and resilient operation across diverse advanced photonics applications.

Essential Qualifications

UG/PG in Mechatronics, Mechanical Engineering, Engineering Physics, Physics, Electrical Engineering, Instrumentation, AI, CSE and related areas

Desirable Qualifications

Experience in Embeedded system, Control Systems, Photonics, Laser Technology, AI/ML, Instrumentation

Key Publications (Last 3 Years)

1. B Jacob, JR Jegaraj, N Kanagaraj, An all-optical passive device based on wavelength-adaptive diffractive neural network for dynamic beam shaping, "Optics and Lasers in Engineering 201, 109703 (2025)
2. Yashwanth Mohan Kumar, Harishankar Manoharan, Vishnu Unni, Nithyanandan Kanagaraj, "A System And Method For Controlling State Of Array Of Coherent Sources Of Electromagnetic Waves", Indian Patent Granted (202441040191).
3. M Kumar, N Kanagaraj, "Effects on beam quality due to misalignment errors in beam combination systems, " Optics & Laser Technology 194, 114415 (2025).
4. T Akash Domnic, S Khushboo, K Nithyanandan, “Physics Based Phase Control in Coherent Beam Combining Systems” Journal of Lightwave Technology 43 (2), 824-831 (2025)
5. DK Murugan, R Joseph, N Kanagaraj, "Transformer Encoder–Decoder Framework for Nonlinear Pulse Evolution and Inverse Modeling" Advanced Photonics Research 6 (11), 2500149 (2025).

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026010 Development of organic semiconductor materials and devices for healthcare applications

Supervisor 1: **Dr. Venkata Rao Kotargiri**
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Supervisor 2: **Suresh Kumar Garlapati**
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Abstract
Development of a highly sensitive, wearable multi-sensor array using organic semiconductors (NDI and PDI) and organic field-effect transistors on flexible plastic substrates to detect the biomarkers of diabetic complications and chronic kidney diseases.

Keywords
Organic semiconductors, field-effect transistors, sensors, healthcare monitoring

Funding
MoE (Regular)

Background & Motivation

The biological signals of the human body provide valuable information about an individual's health, and continuous monitoring of these signals (or biomarkers) is essential for early diagnosis. However, the commercially available medical devices are not real-time, invasive, bulky, and expensive. Wearable electronic devices based on organic electronics can circumvent these limitations and offer additional benefits, such as reduced medical expenses and greater user comfort.

Essential Qualifications

M.Sc. in Chemistry or Physics/ M.Tech in Materials Science or Materials Engineering or Metallurgical Engineering or Nanotechnology or Relevant areas

Desirable Qualifications

Experience in synthesis routes, characterization of materials, fabrication of devices is desirable

Key Publications (Last 3 Years)

1. Ingle DS, Babu DJ, Venkata Rao K. Synthesis of Near-Infrared-Absorbing Superhydrophilic Conjugated Porous Polymer via Postsynthetic Modification for Efficient Solar Steam Generation. ACS Applied Energy Materials. 2025 Jun 7;8(12):8500-7.
2. Nandgaye AS, Ghosh K, Yamijala SS, Rao KV. An Expeditious Synthesis of Near-Infrared-Absorbing Imide-Based Graphene Nanoribbons and Their Photothermal Properties. Angewandte Chemie. 2025 Feb 10;137(7):e202418955.
3. Pramatha SR, Srideep D, Pattnaik U, Sahu R, Suresh DI, Yadav AC, Muduli C, Reddy SK, Senanayak SP, Venkata Rao K. Secondary nucleation guided noncovalent synthesis of dendritic homochiral superstructures via growth on and from surface. Nature Communications. 2024 Dec 30;15(1):10808.
4. Chowdhury S, Eranki A, Garlapati SK. Low-Cost Desktop Printed Sensors for Therapeutic Ultrasound Applications. IEEE Sensors Journal. 2024 Oct 4;24(23):39719-26.
5. Ozer E, Kufel J, Biggs J, Rana A, Rodriguez FJ, Lee-Clark T, Sou A, Ramsdale C, White S, Garlapati SK, Valliappan P. Malodour classification with low-cost flexible electronics. Nature Communications. 2023 Feb 11;14(1):777.

Broad Proposal Objectives — View Broad Proposal Objectives (PDF)

VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026011 **The Intrinsic Electronic Stability Limit of Solid-State Battery Electrolytes from DFT and Machine Learning Simulations**

Supervisor 1: **Prof. Bhabani Shankar Mallik**
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Supervisor 2: **Prof. V. Kanchana**
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Abstract

The development of high-voltage solid-state batteries is hindered by electronic leakage and degradation. The proposal will address the issues through electronic index and Stability-Conductivity correlation to quantify the trade-off between ionic transport and electronic breakdown of solid-state electrolytes using density functional theory-based machine learning simulations. This framework enables rational band-gap engineering, enabling a transition from empirical trial-and-error to predictive design.

Keywords

Solid state battery; Electrolytes; DFT; Machine learning simulations; Electronic and Dynamic Properties

Funding

MoE (Regular)

Background & Motivation

Solid-state batteries promise superior safety and energy density, yet high-voltage commercialization is hindered by poorly understood electronic breakdown. While traditional screening focuses on ionic conductivity, internal leakage through defect-induced mid-gap states remains a critical barrier. This project aims to establish fundamental electronic stability limits to enable rational, high-performance electrolyte design using density functional theory and machine learning simulations.

Essential Qualifications

M.Sc. in Chemistry or Physics

Desirable Qualifications

Knowledge of computational methods is preferable, not essential

Key Publications (Last 3 Years)

Publications of Bhabani S. Mallik

1. K Ions Migrate via. Cog-Wheel Mechanism in Solid Electrolyte Vanadium Pyrophosphates: Fact or Fiction? R. Panigrahi and Bhabani S. Mallik*, J. Phys. Chem. C, 2025, 129, 16985
2. Structure and ionic dynamics of Mn- and Fe-based Ca-ion battery electrode materials from molecular simulations, R. Panigrahi and Bhabani S. Mallik*, Ionics, 2025, 31, 8073
3. Evaluation of Spinel-Type Compounds as Potential Intercalation Hosts for Mg-ion Batteries, R. Panigrahi and Bhabani S. Mallik*, J. Phys. Chem. C, 2025, 129, 5326-5336
4. Ionic conduction and cathodic properties of CaMO3 (M=Fe and Mn) electrode materials via molecular dynamics and first-principles simulations, R. Panigrahi and Bhabani S. Mallik*, J. Phys. Chem. Solids, 2025,196, 112384
5. Correlated Mg-ion and Electron Transport in Polyanionic Co and Ni Silicate Electrodes: A Paddle Wheel-like Rotation-induced Process, R. Panigrahi and Bhabani S. Mallik*, J. Phys. Chem. C,2025, 129, 95

Publications of V. Kanchana

1. Magnetic, thermoelectric, and electrical transport properties of CsMn4As3 Sushree Sarita Sahoo, H -J Koo, M -H Whangbo, G Vaitheeswaran and V Kanchana*, J. Phys.: Condens. Matter, 2025, 3,7205801

	2. Investigation of cathode properties of two-dimensional NbS2Cl2 for Li and Na-ion batteries using density functional theoryArul Raj Natarajan, Bhalchandra S Pujari, G Vaitheeswaranand V Kanchana*,Electron. Struct., 2024, 6, 025004. 3. High thermoelectric performance of layered LaAgXO (X = Se, Te) from electrical and thermal transport calculations,Arul Raj Natarajan, L. Ponvijayakanthan, Mayanak K. Gupta , Ranjan Mittal , David J. Singh , and V. Kanchana, Physical Review Materials, 2023, 7, 025405. 4. Bulk and monolayer thermoelectric and optical properties of anisotropic NbS2Cl2,Arul Raj Natarajan, Mayanak K. Gupta , Ranjan Mittal, V. Kanchana, Materials Today Communications, 2023, 34, 105309.
Broad Proposal Objectives	**View Broad Proposal Objectives (PDF)**

VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026012 DFT-Guided Design of Organic-Inorganic Hybrid Electrodes for High-Performance Supercapacitors

Supervisor 1: **Dr. Koyel Banerjee Ghosh**
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Supervisor 2: **Dr. Shelaka Gupta**
Department: Chemical Engineering
Email: shelaka@che.iith.ac.in

Abstract

This project proposal aims to explore organic-inorganic hybrid electrode materials for next-generation energy storage applications. Density Functional Theory (DFT) simulations will be used to analyze electronic structure, density of states, ion-binding energies, and charge-storage mechanisms. Doping strategies will be modelled to reduce bandgaps and improve conductivity as well as efficiency. Comprehensive physicochemical and electrochemical characterization will be conducted to evaluate the efficiency and long-term electrochemical energy storage performance.

Keywords

organic inorganic hybrid electrode, energy storage, DFT calculations,

Funding

MoE (Regular)

Background & Motivation

Supercapacitors connect the performance range of conventional capacitors and batteries. However, its extensive applications are limited by low energy density due to electrode and electrolyte constraints. It has been found that organic-inorganic hybrid electrodes integrate the high capacitance of inorganic materials with the tunability and flexibility of organic components. Hence, in this project, we will use the Density Functional Theory screening and experimental validation to evolve efficient and stable hybrid electrodes.

Essential Qualifications

M.Sc in Chemistry with Mathematics at the B.Sc level, M.Tech in Chemical Engineering

Desirable Qualifications

Same as mentioned in Essential Qualifications

Key Publications (Last 3 Years)

1. Dibyendu Barik, Utkarsh Utkarsh, Koyel Banerjee Ghosh*, “Exploring Electrodeposited Cobalt-based Coordination Polymer for the Advancement of Supercapacitor Performance.” Journal of Materials Chemistry C, 2025, 13(46), 23189-23201.
2. Utkarsh Utkarsh, Sachidananda Sahu, Anujit Balo, Dibyendu Barik, Koyel Banerjee Ghosh*, “Tailoring the electrocatalytic activity of electrodeposited Co/Fe-based catalyst inducing spin polarization exploiting chiral-induced spin selectivity”, ACS Applied Energy Materials, 8(3), 2025, 1722–1730.
3. Aashi D. Parekh, Pallavi Dandekar, Uzma Anjum, Shelaka Gupta* "Elucidating the role of solvent in C=C bond hydrogenation of maleic acid at metal-solvent interface by AIMD and DFT simulations" Journal of Catalysis 448 (2025) 116212.
4. Govind Porwal, Pallavi Dandekar, Twinkle Gorai, Tuhin Suvra Khan, M. Ali Haider, Shelaka Gupta,* , C.P. Vinod* Facet dependence for solvent-modulated proton-coupled electron transfer in furfural acetalization on Pd nanostructure.

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026013 Understanding Deformation Physics in Dual-Phase High Entropy Alloys: Experimentation and Modelling

Supervisor 1: **Pinaki Prasad Bhattacharjee**
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Supervisor 2: **Chandra Prakash**
Department: Mechanical & Aerospace Engineering
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Abstract
Dual-phase high entropy alloys, which often combine hard and soft phases, are attractive for high strength and ductility. Their deformation behavior fundamentally affects the microstructure and properties but is not yet quite understood. Herein, we aim to investigate the deformation physics of HEAs by combining in-depth microstructural characterization with crystal plasticity finite element modelling.

Keywords
high entropy alloys, microstructure, crystal plasticity, finite element modelling, mechanical behavior

Funding
MoE (Regular)

Background & Motivation

For producing cost-effective HEAs from Cu-rich input scraps, understanding the role of Cu is important. Cu accentuates dual-phase structures comprising two distinct FCC phases, reflecting thermodynamic realities. The deformation behavior of such alloys is quite intriguing but has been little studied, motivating us to propose an experimental-modelling approach herein.

Essential Qualifications
high entropy alloys, microstructure, crystal plasticity, finite element modelling, mechanical behavior

Desirable Qualifications
Metallurgical Engineering, Mechanical Engineering (Design or Manufacturing specialization), Production Engineering

Key Publications (Last 3 Years)
Under review

Broad Proposal Objectives
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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026014 Higher-Order Topological and Non-Hermitian Physics in Mechanical and Electromechanical Platforms

Supervisor 1: **Manisha Thakurathi**
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Supervisor 2: **Sai Aditya Raman Kuchibhatla**
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Abstract

This project investigates higher-order topological physics and non-Hermitian physics through experimental studies on classical mechanical or electromechanical platforms. By integrating concepts from topological and non-Hermitian physics with wave mechanics, it explores robust wave localization and unconventional energy transport in engineered lattices using analytical modeling, numerical multiphysics simulations and table-top experiments.

Keywords

Topological physics, non-Hermitian physics, elastic waves, phononic lattices, vibration localization

Funding

MoE (Regular)

Background & Motivation

Recent advances in topological and non-Hermitian physics reveal novel mechanisms of localization and energy transport, such as corner or hinge modes and Non-Hermitian Skin Effect (NHSE). Extending these ideas to elastic wave mechanics offers experimental platforms to validate new theories and offers new insights into robust mechanical wave control and metamaterial functionalities of smart structures/systems.

Essential Qualifications

Condensed Matter Physics, Quantum Mechanics, Waves and Vibrations, Numerical Modeling, Scientific programming

Desirable Qualifications

Finite Element method (using COMSOL or other commercial packages), Knowledge of Topological Band Theory or Non-Hermitian Physics, Basics of data acquisition and instrumentation.

Key Publications (Last 3 Years)

1. Dash, G. K., Bid, S., & Thakurathi, M. (2024). Floquet exceptional topological insulator. Physical Review B, 109(3), 035418.
2. Bid, S., Dash, G. K., & Thakurathi, M. (2023). Non-Hermitian higher-order Weyl semimetal with surface diabolic points. Physical Review B, 107(16), 165120.
3. Kuchibhatla, S. A. R., Gupta, A., Miniaci, M., & Leamy, M. J. (2025). Experimental demonstration of tunable spectral flow of elastic localized modes. Applied Physics Letters, 127(19).
4. Kuchibhatla, S. A. R., & Leamy, M. J. (2024). Experimental demonstration of an electroacoustic transistor. Applied Physics Letters, 124(24).

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026015 Synthesis and fabrication of self-healing, organic semiconductor devices.

Supervisor 1: **Prof. C Malla Reddy**
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Supervisor 2: **Dr. Shubhadeep Bhattacharjee**
Department: Electrical Engineering
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Abstract

This project focuses on the synthesis and fabrication of self-healing organic semiconductors for advanced devices. It aims to enhance device longevity and reliability in dynamic environments. The approach utilizes electrostatic potential-driven repair in polar crystalline semiconductors. We will synthesize the semiconductor organic crystals, fabricate and characterize devices from these materials for possible applications in bioelectronics.

Keywords

Neuromorphic Computing, Crystal Engineering, Organic Electronics, Cleanroom Fabrication and Characterization, Semiconductor Devices

Funding

MoE (Regular)

Background & Motivation

Self-healing organic semiconductors hold immense potential for bioelectronic applications, where device longevity, reliability, and biocompatibility are crucial. Bioelectronic devices, such as biosensors, neural interfaces, and implantable electronics, often operate in dynamic and mechanically demanding environments. Mechanical damage can lead to device failure, compromising performance and patient safety. The newly introduced electrostatic surface potential-driven self-healing mechanism enables ultrafast, near 100% autonomous repair in polar crystalline materials, ensuring long-term functionality without external intervention. Additionally, the ease of chemical functionalization in organic semiconductors allows for tunable electronic and interfacial properties, enabling tailored performance for specific bioelectronic applications. This advancement paves the way for more robust, self-sustaining bioelectronic systems, reducing maintenance requirements and enhancing device lifespan for medical and wearable applications.

Essential Qualifications

BE/BTech/MTech Electrical, electronics, materials science, nanotechnology or related fields. MSc. in Chemistry or Physics

Desirable Qualifications

Interest in interdisciplinary research, experience with organic synthesis OR semiconductor device fabrication and characterization.

Key Publications (Last 3 Years)

1. Bhunia, S., Chandel, S., Karan, S. K., Dey, S., Tiwary, A., Das, S., Kumar, N., Chowdhury, R., Mondal, S., Ghosh, S., Mondal, A., Khatua, B. B., Ghosh, N & Reddy, C. M. (2021), Science, 373, Issue 6552, pp. 321-327.
2. Mondal, S., Tanari, P., Roy, S., Bhunia, S., Chowdhury, R., Pal, A.K., Datta, A., Pal, B. and Reddy, C.M., 2023. Autonomous self-healing organic crystals for nonlinear optics. Nature Communications, 14(1), p.6589.
3. Samanta, Ranita, Susobhan Das, Saikat Mondal, Tamador Alkhidir, Sharmarke Mohamed, Satyaprasad P. Senanayak, and C. Malla Reddy. "Elastic organic semiconducting single crystals for durable all-flexible field-effect transistors: insights into the bending mechanism." Chemical Science 14, no. 6 (2023): 1363-1371.
4. Weston, A, ... Bhattacharjee. S, Shuigang Xu, Héctor Corte-León et al. "Interfacial ferroelectricity in marginally twisted 2D semiconductors." Nature nanotechnology 17, no. 4 (2022): 390-395.
5. Peddaboina, L., Agrawal, K., Kumar, P., Hegde, G., Badami, O. and Bhattacharjee, S., A Variability-Aware Behavioral Model of Monolayer MoS2 RRAM for Tunable Stochastic Sources. Advanced Theory and Simulations, p.2401235.

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026016 **Accelerated High Temperature Creep of Engineering Alloys using Experiments, Finite Element Methods, and Data-Driven Models**

Supervisor 1: **Dr Viswanath Chinthapenta**
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Supervisor 2: **Dr Rajesh Korla**
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Abstract

High-temperature alloys are essential in the development of hypersonic/nuclear technologies. However, creep deformation dictates its overall behaviour during service. Creep is sensitive to microstructure. Hence, in this proposed work, the focus is on understanding the creep behaviour of high-temperature alloys using creep experiments, Finite element modeling, and data-driven models.

Keywords

Creep, High Temperature Alloys, Rupture Characterization, Finite Element Methods, AI/ML

Funding

MoE (Regular)

Background & Motivation

The structural stability of heat-exchangers, furnaces, etc., is compromised by persistent exposure to high temperatures at low loads. Any downtime of this leads to safety issues or production losses. To address these high-temperature creep is of interest. However, its characterization is challenging due to experimental limitations in testing at high-temperatures.

Essential Qualifications

(1) Mtech in Mechanical/Aerospace/Metallurgy/Material Science (2) Btech in Mechanical/Aerospace/Metallurgy/Material Science with First class

Desirable Qualifications

Knowledge of Finite element methods. Knowledge of Mechanical Behaviour Comfortable with basic experiments for Mechanical characterization Comfortable with the basic FEM in ABAQUS or ANSYS

Key Publications (Last 3 Years)

1. Sairam Kotla, Phaniraj MP, Rajesh Korla, Role of Molybdenum in High-Temperature Uniaxial Tensile Deformation Behaviour of Fe-30Mn-5Al-1C-xMo Lightweight, Metal MaterTran A, 56 (2025) 1799-1816
2. Kannan A Rajesh, Shanmugam N Siva, Sanjeeviprakash K, Palguna Yasam, Korla Rajesh, Lee Wonjoo, Jeong Yu Hyeong, Yoon Jonghun, Room and high-temperature tensile properties of austenitic stainless steel 321 fabricated by wire arc additive manufacturing, Journal of Materials Research and Technology, 36 (2025) 3996-4004.
3. Palguna Yasam, Kotla Sairam, Korla Rajesh, High temperature deformation behavior of Al0.2CoCrFeNiMo0.5 high entropy alloy: Dynamic strain ageing, J Alloys and Comp, 930, 167422, 2023.
4. Chandan Kumar, Sarathchandra Reddy, Nandha Kumar Eswaramoorthy, Praveen Ravanappa, Viswanath Chintapenta, Dheepa Srinivasan, Praveen Kumar. Microstructure optimization for improving creep resistance of additively manufactured Ni-based superalloy IN939 through heat treatment. Journal of Materials Science. 60, pp. 1545-1560, 2025. doi.org/10.1007/s10853-024-10337-9
5. A Khalad, G Telasang, K Kadali, PN Zhang, W Xu, V Chinthapenta. A generalized machine learning framework for data-driven prediction of relative density in laser powder bed fusion parts. The International Journal of Advanced Manufacturing Technology 135 (9), 4147 – 4167, 2024. doi.org/10.1007/s00170-024-14735-w

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026017 Defect Engineering of Smart Polymer Composites Via Multiscale Simulations

Supervisor 1: **Balaji Iyer Vaidyanathan Shantha**
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Supervisor 2: **Subhradeep Chatterjee**
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Abstract

Presence of defects is ubiquitous in polymer composites, PCs, and it affects their mechanical properties. A fundamental question is "Can we control/engineer defects to enhance mechanical performance of polymer composites?". The objective of our project is to establish key design rules for systematically introducing defects that trigger desirable mechanical response.

Keywords

Polymer Composites, Multiscale Simulations, Rheology, Mechanics

Funding

MoE (Regular)

Background & Motivation

Design of PCs is a multi-billion-dollar industry that impacts a wide variety of sectors like automotives, space and biomedicine. Presence of defects in the polymers or fillers is known to affect composite structure and mechanical properties. Developing frameworks for engineering defects that enhance PCs properties facilitate design of smart composites.

Essential Qualifications

M.E./M.Tech. in Polymer Science & Engineering or Chemical Engineering or Mechanical Engineering or Materials Science & Engineering, or a related engineering discipline, or M.Sc. Physics.

Desirable Qualifications

Knowledge C/C++, MATLAB or Mathematica

Key Publications (Last 3 Years)

1. Roy T. R., Dutta-Gupta S., and Iyer B. V. S., Deformation Induced Evolution of Plasmonic Response in Polymer Grafted Nanoparticle Thin Films, Nanoscale, DOI:10.1039/D4NR00789A, (2024).
2. Radha A., Peddiraju V. C., Korla R., Chatterjee S., B2 Precipitation in Al0.2CoCrFeNi with Enhanced Microstructural Stability and Mechanical Properties, Metallurgical and Materials Transactions A, DOI: https://doi.org/10.1007/s11661-025-07912-3 (2025).
3. Haritha P. and Iyer, B. V. S., Local dynamics in functionalized polymer grafted nanoparticle systems with weak and strong functional anisotropy, Soft Matter, DOI: 10.1039/D4SM01466A (2025).

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026018 Data-Driven Modelling and Uncertainty Quantification of Cold-Sprayed Materials for Structural Repair

Supervisor 1: **Biswarup Bhattacharyya**
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Supervisor 2: **Anirban Naskar**
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Abstract

Cold spray offers a promising solid-state solution for repairing aging steel infrastructure, but uncertainties in bonding and microstructure affect reliability. This project develops a data-driven, multiscale framework integrating experiments, microstructure-informed finite element modelling, and uncertainty quantification to predict mechanical performance and reliability of cold-sprayed repairs, enabling risk-informed structural maintenance strategies.

Keywords

Cold Spray Repair; Data-Driven Modelling; Uncertainty Quantification; Microstructure–Property Relationships; Structural Reliability

Funding

MoE (Regular)

Background & Motivation

Aging bridges and civil infrastructure require reliable repair solutions, yet conventional techniques often introduce residual stresses and durability concerns. Cold spray offers a promising solid-state alternative for metallic repair without heat-induced damage. However, uncertainties in bonding, porosity, and material variability limit its structural reliability, motivating data-driven modelling and uncertainty quantification approaches.

Essential Qualifications

B.Tech in Civil Engineering / Mechanical Engineering / Aerospace Engineering / Applied Mechanics / Production Engineering / allied disciplines and/or M.Tech in Structural Engineering (Civil), Applied Mechanics, Aerospace Engineering, Mechanics and Design, Manufacturing Engineering, or related fields.

Desirable Qualifications

FEM, Computational Mechanics, Scientific Programming (Python/MATLAB), Materials Characterization.

Key Publications (Last 3 Years)

1. Sudipta Ghosh, Vishnu Kumaresan, Abhijit Sadhu, Santosh Gupta, Vipeesh Gandhi S, Sachidananda Behera, Anirban Naskar, Preliminary Deposition Behaviour of an In-House Developed Co-Axial Laser-Assisted Cold Spray System, International Cold Spray Conference & Expo 2026.
2. Hoda, S. and Bhattacharyya, B. (2026), "Online POD–Kriging surrogate for efficient uncertainty quantification of dynamical systems", Probabilistic Engineering Mechanics, Vol. 83, 103886
3. Bhattacharyya, B. (2023), “On the use of sparse Bayesian learning-based polynomial chaos expansion for global reliability sensitivity analysis”, Journal of Computational and Applied Mathematics, Vol. 420, 114819
4. Bhattacharyya, B. (2021), “Uncertainty quantification and reliability analysis by an adaptive sparse Bayesian inference based PCE model”, Engineering with Computers, Vol. 38, pp. 1437-1458
5. Bhattacharyya, B., Jacquelin, E. and Brizard, D. (2020), “A Kriging-NARX model for uncertainty quantification of nonlinear stochastic dynamical systems in time domain”, ASCE Journal of Engineering Mechanics, Vol. 146, No. 7, pp. 1-21

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026019 **Real-Time Thermal Monitoring and Diffusion Engineering for High-Performance Joints in Additively Manufactured Components**

Supervisor 1: **Dr. Mayur Vaidya**
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Supervisor 2: **Dr. Gopinath M**
Department: Mechanical & Aerospace Engineering
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Abstract

This project aims to develop a systematic understanding of diffusion-controlled joining in additively manufactured alloys by integrating real-time process monitoring, microstructural control, and advanced characterization. The influence of engineered microstructures on diffusion characteristics and joint performance will be investigated through controlled joining experiments in AM–AM and AM–wrought configurations.

Keywords

Additive manufacturing, materials joining, interdiffusion, characterization

Funding

MoE (Regular)

Background & Motivation

Additively manufactured materials typically exhibit cellular or dendritic solidification structures, high dislocation densities, residual stresses, melt pool heterogeneity, and chemical microsegregation. These characteristics strongly influence interdiffusion behavior, reaction layer formation, and the evolution of intermetallic or secondary phases at the joint interface and demand systematic investigation of diffusion-controlled joining.

Essential Qualifications

BTech or MTech in Mechanical Engineering, Production Engineering, Metallurgy, Material Science or allied fields

Desirable Qualifications

Keen interest in additive manufacturing and microstructural analysis

Key Publications (Last 3 Years)

1. K.C. Nuli, Tamanna H. Panigrahi, J. Chandana, Guruvidhyatri K, J. Joardar, P.P. Bhattacharjee & M. Vaidya (2026). Interdiffusion driven phase growth in Cr26Co20Fe20Mn20Ni14/Al high entropy alloy diffusion couple. Advanced Engineering Materials, e202501921.
2. B. Yadav, A. Burla, G. Mohan Muralikrishna, N. Chandrasekaran, K.G. Pradeep, M. Vaidya, G. Wilde, S.V. Divinski (2026). Retarded relaxation of grain boundaries' non-equilibrium state in medium-entropy CoFeNi alloy probed by radiotracer diffusion, Scripta Materialia, 275, 117162.
3. K.C. Nuli, Guruvidhyatri K, P.P. Bhattacharjee & M. Vaidya (2026). Temperature effects on the oxidation behavior of Al0.3Cr1.3Co1Fe1Mn1Ni0.7 multi-phase complex concentrated alloy. Intermetallics, 188, 109076.
4. Khandai, B. K., Shukla, S., & Muvvala, G. (2024). Real-time monitoring of temperature gradients and bending mechanism in multi-scan laser forming process. Journal of Manufacturing Processes, 119, 975-986.
5. 5. Jha, A., Ramji, M., Torris, A., & Gopinath, M. (2026). Strategies to mitigate interlayer porosity in the laser-directed energy deposition process. Journal of Manufacturing Science and Engineering, 1-37.

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026020 Designing Two-Dimensional Layered Materials in Therapeutics: A computational and Generative-AI Approach

Supervisor 1: **Arup Mahata**
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Supervisor 2: **G. Narahari Sastry**
Department: Biotechnology
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Abstract
Two-dimensional layered materials show strong potential for biomedical applications, but rational discovery remains challenging due to vast chemical space and limited screening strategies. This work addresses this challenge by integrating generative AI and DFT to predict key material properties and accelerate the discovery of stable, efficient therapeutic materials.

Keywords
2D layered materials, DFT, Gen-AI, Biomedical applications

Funding
MoE (Regular)

Background & Motivation

2D materials possess high surface area, tunable electronic properties, and flexible surface chemistry, making them promising for therapeutic applications. However, systematic design strategies remain limited. Integrating data-driven ML with DFT calculations and generative AI can accelerate discovery, enabling rational design of stable, efficient, and biocompatible materials for advanced biomedical technologies.

Essential Qualifications

Master degree in Chemistry/Biological Science/Materials Science/Nanoscience

Desirable Qualifications

Master degree in Chemistry/Biological Science/Materials Science/Nanoscience

Key Publications (Last 3 Years)

1. D. Sarma, Arup Mahata*, Facet Engineering in Halide Perovskite Nanocrystals for Modulating Energy-Level Alignment and Emission Behavior, ACS Nano, 2026, 20, 918–930.
2. P. Chugh, Arup Mahata*, Quantifying the role of N-position in imine-based covalent organic frameworks for photocatalytic water splitting, Chem. Commun, 2026, 62, 1891-1894.
3. P. Chugh, D. Sarma, Arup Mahata*, Linker Engineering in β-Ketoenamine-Based Covalent Organic Frameworks for Photocatalytic Water Splitting, J. Phys. Chem. C, 2025, 129, 13194-13202.
4. L. John, H. J. Mahanta, Y. Soujanya, G Narahari Sastry*, Assessing machine learning approaches for predicting failures of investigational drug candidates during clinical trials, Comput. Biol. Med., 2023, 153, 106494.
5. A. S. Gaur, S. Nagamani, L. Priyadarsinee, H. J. Mahanta, R. Parthasarathi, G Narahari Sastry*, Galaxy for open-source computational drug discovery solutions, 2023, 18, 579-580.

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026021 Tailoring Halide Perovskites for energy storage and conversion applications

Supervisor 1: **Dr. Suresh Perumal**
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Supervisor 2: **Prof. Sivakumar Vaidyanathan**
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Abstract
The current scenario of thermoelectric (TE) research for waste heat recovery relies on costly and toxic materials. Recently, the eco-friendly metal perovskite halides (A2BX6:Cs2SnI6) with low thermal conductivity and large Seebeck coefficient have seen a great attention in TE community. This proposal aims to design and engineer such class of materials for near-room-temperature thermoelectric applications.

Keywords
Halide Perovskites, Thermoelectrics, LEDS

Funding
MoE (Regular)

Background & Motivation

The clean energy technologies have been put forward by scientists due to increased energy demand. Most automobiles and industries release thermal energy as untapped waste heat, which can be converted into usable electricity by thermoelectric (TE) materials. The heat-to-electricity conversion efficiency depends on the figure of merit, zT. Due to the interdependency nature of electronic and thermal properties, the conversion efficiency is always low, and materials that show relatively large conversion efficiency are relatively toxic and costly. So, a search for low-cost and eco-friendly materials with high zT remains a challenging task. So, we attempt to design various classes of metal perovskite halides (A2BX6) with improved electrical properties for thermoelectric application near room temperature.

Essential Qualifications

M.Tech (Nanoscience, Energy Science and Technologies, and Materials Science) OR M.Sc (Chemistry/Physics/Materials Science) with valid GATE/CSIR-NET

Desirable Qualifications

M.Tech or M.Sc (Physics/Chemistry/Materials Science) with valid GATE/CSIR-NET

Key Publications (Last 3 Years)

Dr Suresh Perumal:

1. Usharani Valaparla, Subhajit Sau, Manojkumar Moorthy, Sinorul Haque, Tanmoy Ghosh, Amarnath R Allu, Subhradeep Chatterjee, V Kanchana, Suresh Perumal, Off-stoichiometry-driven electronic structure modulation leads to high thermoelectric performance in n-type InSb: an experimental study with theoretical insights, J. Mater. Chem. A, 2026, 14, 8120-8131.
2. Akshara Dadhich, Kaushalya Kumari, Achintya Kumar Patra, Bhuvanesh Srinivasan, Suresh Perumal, MS Ramachandra Rao, Kanikrishnan Sethupathi, Realizing high thermoelectric performance in MXene-incorporated Yb0.4Co3.96Ti0.04Sb12 via carrier and phonon engineering, Journal of Materials Chemistry A, 13, 16770-16784, 2025.
3. Moorthy, Manojkumar; Govindaraj, Prakash; Parasuraman, Rajasekar; Bhui, Animesh; Gadhavajhala, Sri Sai Samhitha; Srinivasan, Bhuvanesh; Venugopal, Kathirvel; Perumal, Suresh*, Sulfur vacancies driven band splitting and phonon anharmonicity enhance the thermoelectric performance in n-type CuFeS2, ACS Appl. Energy Mater., 7, 5, 2008–2020, 2024.
4. Akshara Dadhich, Madhuvathani Saminathan, Kaushalya Kumari, Suresh Perumal*, MS Ramachandra Rao*, K Sethupathi*, Physics and Technology of Thermoelectric Materials and Devices, J. Phys. D: Appl. Phys., 56, 333001, 2023.

	5. Manojkumar Moorthy, Bhuvanesh Srinivasan, David Berthebaud, Rajasekar Parasuraman, Suresh Perumal*, Enhanced Thermoelectric Performance and Mechanical Property in Layered Chalcostibite CuSb1−xPbxSe2, ACS Appl. Energy Mater. 6, 2, 723-730, 2023. Prof Sivakumar Vaidhyanathan: 1. Subramaniyam Kalaivanan, Sibani Mund, Gopendra Muduli, Kumar Siddhant, Arushi Rawat, François Réveret, Federico Cisnetti, Osamu Tsutsumi, Sivakumar Vaidyanathan,* and Ganesan Prabusankar, A Copper(I)-Carbene Complex With High Quantum Yield for White Light Emitting Application, Advanced Optical Materials, 2026, DOI:10.1002/adom.202503640 2. Swetha Maredi, Rohit B, Takashi Nakanishi, and Sivakumar Vaidyanathana*, Hetero Atom (Nitrogen) replaced by Phenyl Insertion in Molecular Eu-complex Facilitated Sun Light-like Emission for Sustainable White LEDs and Non-Contact Thermometer, Inorg. Chem. Front., 2026, doi.org/10.1039/D5QI02371H, 3. Bhabana Debata, Khitisruta Nayak, Manjit Dehury, Sabita Patel and Sivakumar Vaidyanathana*, HLCT/HLCT-AIE-Enabled Donor-Acceptor System through Locking and Unlocking Strategy and Its Versatile Applications, J. Mater. Chem. C, 2026, doi.org/10.1039/D5TC03639A. 4. Diksha Thakur, Biswaranjan Sahu, Wijak Yospanya, Reiko Oda, Sivakumar Vaidyanathana*, Linkage Isomers and Their Enantiomeric Siblings as CPL-TADF Emitters: Modulating Chirality and Enhancing Dissymmetry Factor Through N- and O-Linked Carbazoles, J. Mater. Chem. C, 2026: 10.1039/D5TC04098A. 5. Bhabana Priyadarshini Debataa, Sabita Patel, and Sivakumar Vaidyanathan*, Fluorophores with Imidazole Building Blocks and Their Multifunctional Platforms for Optoelectronics, Chemo-Sensing, and Security Applications: Recent Advances and Future Perspectives, J. Mater. Chem. C, 2026: 10.1039/D5TC03845F
Broad Proposal Objectives	**View Broad Proposal Objectives (PDF)**

VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026022 **Computational Designing of Novel Transition Metal Based Spin-Crossover Material for Spintronics and Thermoelectric Applications**

Supervisor 1: **Dr. Saurabh Kumar Singh**
Department: Chemistry
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Supervisor 2: **Prof. Manish K. Niranjan**
Department: Physics
Email: manish@phy.iith.ac.in

Abstract

Spin-crossover complexes exhibit magnetic bistability when exposed to external stimuli, such as light, pressure, and temperature, thereby showing promising applications for multimodal gas sensing and molecular wires. In this project, we aim to study the SCO behaviour in Fe(II) and Co(II)-based molecules, extended 2D and 3D networks, and their applications in molecular electronics and gas sensing using density functional theory.

Keywords

Spin-crossover Molecules, Magnetic bistability, Density functional theory, NEGF, gas-sensing, and magnetic MOFs.

Funding

MoE (Regular)

Background & Motivation

Spin-crossover complexes exhibit bistability when exposed to external stimuli such as light, pressure, temperature, x-ray radiation, and magnetic fields. The combination of electrical conductivity and the SCO phenomenon in a single material has been a long-sought goal of the scientific community, as electrical current would provide a more viable means of reading signals in SCO devices. Here, we aim to study the SCO behaviour in Fe(II) and Co(II)-based molecules, extended 2D and 3D networks, and their applications in molecular electronics and gas sensing using density functional theory.

Essential Qualifications

M.Sc (Physics), M.Sc. (Chemistry)

Desirable Qualifications

M.Sc (Physics), M.Sc. (Chemistry) with experience in the computational modelling.

Key Publications (Last 3 Years)

1. A. Ghosh et al., Accurate surface and interfacial properties from a nonempirical range-separated dielectric-dependent hybrid functional" Physical review B, 2026, 113, 085122.
2. Kumari et al., Nanostructuring of Dysprosocenium Single-Ion Magnets through Encapsulation in MOFs: A Promising Approach to Achieve High Axiality and Ambient Stability with Long-Range Ordering, Inorg. Chem. 2025, 64, 18254–18264.
3. A. Ghosh et al., Accurate and efficient prediction of the band gaps and optical spectra of chalcopyrite semiconductors from a nonempirical range-separated dielectric-dependent hybrid: Comparison with many-body perturbation theory" Physical review B, 2024, 109, 045133.
4. Kumari et al. Single-ion magnet behaviour in highly axial lanthanide mononitrides encapsulated in boron nitride nanotubes: a quantum chemical investigation, Dalton Trans., 2025, 54, 4715.
5. Tarannum et al., “Electronic structure, covalency and magnetic anisotropy in [AnCp3] (where An = Th-Cf) complexes: Insights from first principle calculation, Chem Asian J. 2025, 0, e00278

Broad Proposal Objectives — View Broad Proposal Objectives (PDF)

VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026023 **Multi-phase CFD and Coupled CFD-DEM models for flow of complex suspensions with an application for 3D Concrete Printing**

Supervisor 1: **Narasimha Mangadoddy**
Department: Chemical Engineering
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Supervisor 2: **Prof. K V L Subramanyam**
Department: Civil Engineering
Email: kvls@ce.iith.ac.in

Abstract

Predicting the flow of complex suspensions made of irregularly shaped inclusions is essential to develop applications that require rheology control for the extrusion-based layer deposition process used in 3D Concrete Printing (3DCP). The advances in the proposed work include the development of a CFD-DEM computational framework and multi-phase CFD granular flow framework to enable two coupling in a suspension made with non-Newtonian fluid and spherical as well as irregular-shaped inclusions.

Keywords

Multi-phase CFD, DEM, and coupled CFD-DEM, 3D Concrete Printing

Funding

MoE (Regular)

Background & Motivation

Prof. Narasimha and Prof. KVLS came together with a common interest to foster the development of coupled CFD-DEM code as well as multi-phase CFD granular flow strategy to understand the flow in complex suspensions such as concrete for developing the 3D Concrete printing application. Numerical simulations that allow two-way coupling will provide insights into the relative movements of suspension components under different flow regimes and lead to better material design.

Essential Qualifications

B.Tech/M.Tech in Chemical Engineering or Civil Engineering specialized in Computational Fluid Dynamics, Rheology, DEM & Numerical methods

Desirable Qualifications

Multi-phase CFD, Numerical Simulation, rheology of suspensions, DEM

Key Publications (Last 3 Years)

Narasimha Mangadoddy

1. Aman Mittal, Narasimha Mangadoddy, Raja Banerjee, 2025, GPU based Discrete Element Modeling for Convex Polyhedral shape particles: Development and Validation, Powder Technology, Volume 449, 15 January 2025, 120407 (Impact factor 4.9)
2. Aman Mittal, Narasimha Mangadoddy, Raja Banerjee, 2024, Advances in granular flow modeling: GPU-based multi-sphere DEM approach and tumbling mill dynamics, Powder Technology, 2024, 444, 120024 (Impact factor 4.9)
3. Aman Mittal, Mayank Kumar, Narasimha Mangadoddy, A coupled CFD-DEM model for tumbling mill dynamics - effect of lifter profile, Powder Technology, 2024, 433, 119178, doi.org/10.1016/j.powtec.2023.119178 (Impact factor 4.9)
4. Vakamalla Teja Reddy, Mangadoddy Narasimha, A comprehensive dense slurry CFD model for performance evaluation of industrial hydrocyclones, Industrial & Engineering Chemistry Research, August 2021, 60, 12403–12418, (Impact factor 3.8)
5. Aman Mittal, Narasimha Mangadoddy, Raja Banerjee, Development of Three-Dimensional GPU DEM Code – Benchmarking, Validation and Application in Mineral Processing, Journal of Computational Particle Mechanics, 2023, 10(6), pp. 1533–1556 (Impact factor 2.8)

	K.V.L. Subramaniam 1. Kamakshi, T., and Subramaniam, K.V.L., (2024) Formulating printable concrete mixtures based on paste rheology and aggregate content: Application to alkali-activated binders, in Cement and Concrete Research. 184 (2024) 107611, (DOI: 0.1016/j.cemconres.2024.107611) 2. Kamakshi, T., and Subramaniam, K.V.L., (2024) Rheology Control and 3D Concrete Printing with Fly ash-based Aqueous Nano-silica Enhanced Alkali-activated Binders, Materials and Structures. 57:106. DOI: 10.1617/s11527-024-02385-z. 3. Kondepudi, K., and Subramaniam, K.V.L. (2022) "Alkali-activated fly ash-blast furnace slag blend rheology: Evaluation of yield and Maxwell responses," Cleaner Engineering and Technology. 100398 4. Kondepudi, K., and Subramaniam, K.V.L., (2021) "Formulation of Alkali-Activated Fly Ash-Slag Binders for 3D Concrete Printing," Cement and Concrete Composites. Volume 119, May 2021, 103983 (DOI: 10.1016/j.cemconcomp.2021.103983) 5. Kondepudi, K., and Kolluru V.L. Subramaniam, (2019) "Rheological characterization of low-calcium fly ash suspensions in alkaline silicate colloidal solutions for geopolymer concrete production," Journal of Cleaner Production, 234, 690-701 (DOI: 10.1016/j.jclepro.2019.06.124).
Broad Proposal Objectives	**View Broad Proposal Objectives (PDF)**

VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026024 On multiscale topology optimization with design-dependent pressure loading

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Supervisor 2: **Dr. Aiyappan Srinivasan**
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Abstract

Topology optimization determines optimal material distribution in a design domain. In various applications, loads depend on design evolution, creating design-dependent loading challenges. This work proposes a multiscale topology optimization framework integrating pressure-boundary detection, homogenization-based microstructure design, and consistent sensitivity analysis, enabling efficient optimization of structures subjected to design-dependent pressure loads.

Keywords

Topology Optimization, Mutiscale Modeling, Compliance Minimization, Homogenization method

Funding

MoE (Regular)

Background & Motivation

Topology optimization is an important computational tool for designing efficient structures. However, many applications involve design-dependent loads, in which pressure evolves with the structural boundary, creating modelling challenges. Multiscale topology optimization further enables tailored material behaviours. Developing a unified framework addressing both aspects is therefore essential for advanced engineering applications.

Essential Qualifications

Good in continuum mechanics, Finite element methods, Mathematics and coding

Desirable Qualifications

B.Tech in Mechanical/ M.Tech in Mechanical/MSc in Mathematics

Key Publications (Last 3 Years)

1. TOPress: a MATLAB implementation for topology optimization of structures subjected to design-dependent pressure loads, Structural and multidisciplinary optimization 66 (4), 97: DOI: 10.1007/s00158-023-03533-9
2. Homogenization of Helmholtz equation in a periodic layer to study Faraday cage-like shielding effects, Complex Variables and Elliptic Equations, 2024, Vol. 69, NO. 4, 607–625 DOI: 10.1080/17476933.2022.2155637
3. Homogenization of a locally periodic oscillating boundary, Applied Mathematics & Optimization, (86)14, 2022, DOI: 10.1007/s00245-022-09873-0
4. Diversity-Based Topology Optimization of Soft Robotic Grippers, Advanced Intelligent Systems 6 (4), 2300505, DOI: https://doi.org/10.1002/aisy.202300505

Broad Proposal Objectives

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VERTICAL: NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

IDPHD2026025 SPARSH: Soft Physical systems for Adaptive Robotics and Sensing in Healthcare

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Supervisor 2: **Sushmee Badhulika**
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Abstract
The SPARSH project aims to develop bioinspired soft robotic systems that seamlessly integrate with the human body to revolutionize the healthcare system using the tools of mechanics and materials.

Keywords
Soft Robotics; Flexible electronics; Continuum Mechanics; Sensors; Nanotechnology

Funding
MoE (Regular)

Background & Motivation

By drawing inspiration from nature, we aim to create advanced soft polymeric devices that adapt to the body's movements, provide real-time health data, and operate with minimal external power, enabling safer and more effective diagnostic and therapeutic interventions.

Essential Qualifications

BE/BTech/M.E/MTech in Mechanical/Aerospace/Electrical/Electronics/Mechatronics/Robotics/ Nanotechnology/Materials Science and Engineering, and other allied areas relevant to the project. OR M.Sc. or equivalent in Electronics / Electronic Sciences (EL) / Physics (PH) / Nanotechnology / Material Science **Candidates without M.E./M.Tech. must also fulfill at least one of the following additional requirements -Valid GATE score in EC, EE, IN, PH, MT, ME, AE or XE -Valid JEST score in Physics - Junior research fellowship (JRF) of CSIR/UGC or DST INSPIRE fellowship

Desirable Qualifications

Prior experience in fabrication/computational mechanics/robotics

Key Publications (Last 3 Years)

1. Yadav, V.K. and Gupta, P., 2024. A strain-gradient elastic theory for special Cosserat rods. International Journal of Solids and Structures, 291, p.112696.
2. Mishra, P. and Gupta, P., 2025. Modeling direct and converse flexoelectricity in soft dielectric rods with application to the follower load. Journal of the Mechanics and Physics of Solids, 195, p.105956.
3. K.K. Rao, N.K. Das, S. Badhulika. Piezoelectric ZrS_2/PVDF/PPy Nanofiber-based Self-Powered Pressure Sensor for Wearable Human-Machine Interfaces and Smart Glove for Minimising Handling Errors in Pick and Place Applications. Advanced Materials Technologies, 2026, e02503
4. M.S. Deepak, N.K. Das, S. Badhulika*. PDMS/Co-MOF/V2C MXene Composite Based Triboelectric Nanogenerator for Joint Movement Monitoring in Orthopaedic Injuries and Danger Alert Detection System for Visually Impaired. Advanced Materials Technologies, 2025, 10, 17, e00388
5. N. K. Das, M. Ravipati, S. Badhulika*. Nickel Metal-Organic Framework/PVDF Composite Nanofibers based Self-Powered Wireless Sensor for Pulse Monitoring of Underwater Divers via Triboelectrically Generated Maxwell- Displacement Current. Advanced Functional Materials, 2023, 33, 37, 2303288

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026026 Understanding of intercalation mechanisms of multivalent metal-ions across MXene Galleries

Supervisor 1: **Rama Srinivas Varanasi**
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Supervisor 2: **Narendra Kurra**
Department: Chemistry
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Abstract

We aim to elucidate the atomic-scale mechanisms governing multivalent metal-ion intercalation in MXenes. Atom probe tomography, complemented by transmission electron microscopy and in situ scanning probe techniques, will reveal nanoscale chemistry, surface effects, and volumetric evolution. These insights enable design of robust electrodes that accommodate volume changes, enhancing cycling stability.

Keywords

MXenes, Atom Probe Tomography, Multiscale Microscopy, Energy Storage

Funding

MoE (Regular)

Background & Motivation

MXenes constitute family of two-dimensional transition metal carbides, nitrides, and carbonitrides aimed at electrode materials for batteries and supercapacitors. Limited fundamental atomic scale studies impedes the progress of MXene materials as charge storage hosts for multivalent metal-ions. Multiscale microscopy helps clarify structure-chemistry-property relationships, enabling effective materials design.

Essential Qualifications

MSc (or equivalent) in Chemistry or B.Tech/M.Tech (or equivalent) in Material Science or Metallurgical Engineering

Desirable Qualifications

Experience with microscopy or batteries

Key Publications (Last 3 Years)

Nano scale chemistry using Atom Probe Tomography:

1. Temperature and misorientation-dependent austenite nucleation at ferrite grain boundaries in a medium manganese steel: role of misorientation-dependent grain boundary segregation; RS Varanasi, O Waseda, FW Syed, P Thoudden-Sukumar, B Gault, J Neugebauer, D Ponge. Acta Materialia, 296, 121242 (2025) (I.F. 9.3)
2. Novel Fe-Mo intermetallic composite synthesized via novel diffsional-displacive mixed-mode transformation; RS Varanasi, M Koyama, S Kiranbabu, R Schnitzer, H Saitoh, R Utsumi, E Akiyama. Materials Characterization, 114287 (2024) (I.F. 5.5)

MXenes:

1. Rituprava Dash, Shubham Bhoi, Soujanya H. Goudar, Kotagiri Venkata Rao*, Narendra Kurra*, Liquid crystal MXene stabilized cationic naphthalene diimide charge host for ammonium ion storage. J. Power Sources (I.F. 7.9), 2026, 670, 239511.
2. Suman Yadav and Narendra Kurra*, Pseudocapacitive Charge Storage Dynamics of Vanadium Carbide MXene in Water-In-Salt Calcium-Ion Electrolyte, Small (I.F. 12.1), 2025, 21, 2503657
3. Suman Yadav and Narendra Kurra*, Diffusion kinetics of ionic charge carriers across Ti3C2Tx MXene-aqueous electrochemical interfaces, Energy Storage Materials (I.F. 20.2), 2024, 65, 103094

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026027 Developing Improved Aeration Systems for Biological Wastewater Treatment Processes

Supervisor 1: **DEBRAJ BHATTACHARYYA**
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Supervisor 2: **RAJA BANERJEE**
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Abstract
Aeration equipment accounts for 40-60% of energy use in wastewater treatment plants. This Ph.D. project aims to develop and optimize aeration/diffuser systems for more efficient, cost-effective aerobic bio-treatment, using lab/pilot-scale experiments, CFD modeling, and Life Cycle Assessment to evaluate carbon footprint and environmental impact.

Keywords
Aeration, Diffuser, CFD, LCA, Wastewater Treatment

Funding
MoE (Regular)

Background & Motivation	Aeration systems consume up to 60% of wastewater treatment energy, driving significant carbon emissions and operational costs. Improving aeration efficiency is critical to sustainable wastewater management. This research is motivated by the urgent need to develop cost-effective, energy-efficient aeration solutions that reduce environmental impact and advance greener treatment technologies.

Essential Qualifications
First-class or division in Bachelor's (B.E./B.Tech) and Master's (M.E./M.Tech) degrees in Environmental, Civil, Chemical, or Mechanical Engineering. A strong background in Computational Fluid Dynamics is also essential to contribute to the advanced modeling and simulation aspects of the project.

Desirable Qualifications
First-class or division in Bachelor's (B.E./B.Tech) and Master's (M.E./M.Tech) degrees in Environmental, Civil, Chemical, or Mechanical Engineering. A strong background in Computational Fluid Dynamics is also essential to contribute to the advanced modeling and simulation aspects of the project.

Key Publications (Last 3 Years)	No
Broad Proposal Objectives	View Broad Proposal Objectives (PDF)

VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026028 Waste-to-value: Recycling plastic waste into fuels using biomass-waste-derived advanced functional catalysts

Supervisor 1: **Dr. Sudarsanam Putla**
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Supervisor 2: **Prof. Giridhar Madras**
Department: Chemical Engineering
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Abstract

This project aims to develop industrially useful methods for converting both plastic waste and biomass waste into fuels and materials. Low-cost metals/metal oxides will be impregnated into porous carbon prepared from biorefinery waste (lignin) to develop advanced functional catalysts for selectively recycling plastic waste (polyolefins) into fuels (petrol, diesel, or jet fuel). Process scalability, economic viability, and environmental sustainability will be systematically optimized to advance the circular plastic economy.

Keywords

Plastic waste recycling, biomass waste-derived porous carbon, advanced functional catalysts, fuels, circular plastic economy

Funding

MoE (Regular)

Background & Motivation

Plastic is a vital material for our society, but its widespread use generates significant waste that causes severe environmental impacts. The strong bonds and robust polymeric structure make the plastic (especially polyolefins) highly recalcitrant to degradation at ambient conditions. Thus, recycling plastic waste into useful fuels (petrol, diesel, or jet fuel) is considered a "Dream Process" within the framework of a circular economy. To achieve this, we aim to develop advanced catalytic materials derived from biorefinery waste (lignin) and low-cost metals/metal oxides to enable a sustainable circular plastic economy.

Essential Qualifications

1. MSc in Chemistry or BTech/MTech in Materials Science/Chemical Engineering/Biotechnology with min 60% marks.
2. Gate or Net qualification.
3. Knowledge in heterogeneous catalysis/nanomaterials.
4. Knowledge in biomass chemistry.
5. Spectroscopy/microscopy analytical techniques.

Desirable Qualifications

1. Expertise in heterogeneous catalysis.
2. Synthesis of nanomaterials.
3. Analysis of solid materials' properties.
4. Handling of high-pressure reactors.

Key Publications (Last 3 Years)

1. B. Swapna, P. Subha, A. Ramesh, S. Challapalli, G. Madras, P. Sudarsanam*, Chemical Recycling of Mixed-Color Polyethylene Terephthalate Plastic Waste Using a Colorant-Tolerant, Reusable Magnetic MnOx/Fe3O4 Nanocatalyst, ACS Applied Nano Materials, 2025, 8, 46, 22352–22364. https://doi.org/10.1021/acsanm.5c04216.
2. B. Swapna, C. Fiba, M. Bobby Barnabas, R. Suryanaraya, P. Sudarsanam*. Catalytic imidazolysis of PET plastic waste using self-assembled NbOx nanorods, Chemical Communications, 2025, 61, 8847-8850. https://doi.org/10.1039/D5CC01819F. Highlighted on the back cover page
3. B. Swapna, M. Bobby Barnabas, P. M. Gogoi, P. Bharali, G. Madras, P. Sudarsanam*. Morphology-tuned MnOx/TiO2 nanocatalysts for recycling PET plastic waste with biomass-derived ethylene glycol, Nanoscale, 2025, 17, 10620-10631. https://doi.org/10.1039/D4NR05373G.

	4. B. Swapna, S.B. Putla, A. Ramesh, Ch. Subrahamanyam, G. Madras, P. Sudarsanam*, Catalytic recycling of PET waste bottles into a value-added amide monomer using a heterogeneous niobium pentoxide nanocatalyst, Sustainable Energy Fuels, 2024, 8, 5170-5180. https://doi.org/10.1039/D4SE01136H. highlighted on the front cover page. 5. B. Swapna, N. Singh, S. Patowary, P. Bharali, G. Madras, P. Sudarsanam*, Efficient glycolysis of used PET bottles into a high-quality valuable monomer using a shape-engineered MnOx nanocatalyst, Catalysis Science & Technology, 2024, 14, 5574-5587. https://doi.org/10.1039/D4CY00823E. highlighted on the back cover page. 6. Phyu Phyu Mon, Phyu Phyu Cho, L. Chandana, V.V.S.S. Srikanth, Giridhar Madras, Subrahmanyam Ch*, Biowaste-derived Ni/NiO decorated-2D biochar for adsorption of methyl orange, Journal of Environmental Management, 344, 2023, 118418. https://doi.org/10.1016/j.jenvman.2023.118418 7. Phyu Phyu Mon, Phyu Phyu Cho, L. Chanadana, K.V. Ashok Kumar, Saiyam Dobhal, T. Shashidhar, Giridhar Madras, Ch. Subrahmanyam*, Bio-waste assisted phase transformation of Fe3O4/carbon to nZVI/graphene composites and its application in reductive elimination of Cr(VI) removal from aquifer, Separation and Purification Technology, 306, Part A, 2023, 122632. https://doi.org/10.1016/j.seppur.2022.122632 8. N. B. SM, M. U. Rao, G. Madras, C. Subrahmanyam*, Solution Combustion Synthesized Ni-Based Catalysts for Dry Reforming of Methane Reaction Using Dielectric Barrier Discharge Reactor. ChemCatChem 2025, 17, e202500048. https://doi.org/10.1002/cctc.202500048 9. Rangappa, H.S., Mon, P.P., Jayaraman, B. et al. Industrial waste-derived biochar composites for the removal of water-borne 4-nitrophenol: assessing cost-effectiveness and sustainability. Environ Sci Pollut Res 32, 22544–22559 (2025). https://doi.org/10.1007/s11356-025-36992-2. 10. Phyu Phyu Cho, Phyu Phyu Mon, Mohit Kumar, Giridhar Madras, Ch. Subrahmanyam, 11. Rational BiMoO nanospheres decorated g-C3N4 for photocatalytic performance of dye degradation, Surfaces and Interfaces, 50, 2024, 104522. https://doi.org/10.1016/j.surfin.2024.104522
Broad Proposal Objectives	**View Broad Proposal Objectives (PDF)**

VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026029 Tabletop Hybrid Laser Accelerators

Supervisor 1: **Bhuvanesh Ramakrishna**
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Abstract

The interaction of intense laser pulses with matter is opening up new frontiers in physics via the production of extreme pressures, temperatures, and intense electric and magnetic fields. This project will use high-power lasers for exploring the properties of hot, dense matter and the production of high-energy particles and radiation and the development of schemes for tabletop ion acceleration.

Keywords

Lasers, radiation, accelerators, Tabletop, ion beams

Funding

MoE (Regular)

Background & Motivation

Compact laser-based ion accelerators of the type that we are developing in this project could have major impact as a next generation, cost-effective technology for medical accelerators. Furthermore, the sources can be used to produce multiple types of radiation in synchronized pulses, which would enable multiple types of imaging and therapy at the same time. The unique properties of the high-energy laser-driven ion beams that we are developing are therefore likely to have widespread application in other fields.

Essential Qualifications

MSc Physics or Photonics or MTech Electrical or Electronics or Mechanical or opto electronics and Lasers or Applied Mechanics

Desirable Qualifications

Optics, Instrumentation, Photonics, Lasers, electronics

Key Publications (Last 3 Years)

1. Generation of giga-electron-volt proton beams by micronozzle acceleration Murakami, M, Balusu, D, Maruyama, S., Murakami, Y, Ramakrishna, B Scientific Reports 025, 15(1), 19112
2. High-density positron beam generation via Breit–Wheeler and trident processes using ultra-intense lasers Chintalwad, S., Morris, S., Ramakrishna, B. Journal of Plasma Physics, 2025, 91(1), E14
3. Investigating the influence of ionization on high-harmonic generation in Ar–Ne and Ar–Kr gas mixtures driven by kHz laser pulsesChintalwad, S. Ramakrishna, B. Van Dao, L. European Physical Journal D , 2024, 78(10), 127
4. Simulation studies of γ-ray radiation in laser-plasma interactions with structured targets Chintalwad, S., Krishnamurthy, S, Morris, S., Van Dao, L., Ramakrishna, B. Fundamental Plasma Physics , 2024, 10, 100038
5. Balusu, D., Krishnamurthy, S., Murakami, M., Ramakrishna, B. Ion acceleration from aluminum foil coated with a gold nanolayer irradiated by ultrashort laser pulses (2024) Physics of Plasmas, 31 (1), art. no. 013107, .

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026030 Integrated Electrochemical CO_2 Capture and Conversion

Supervisor 1: **Dr. Deepu J. Babu**
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Supervisor 2: **Dr. Pritha Chatterjee**
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Abstract

Electrochemical swing carbon capture has recently emerged as a promising alternative, in which CO_2 adsorption and desorption are controlled by switching the electrode polarity. In this project, we propose to explore an integrated capture–utilization pathway by coupling electrochemical CO_2 capture with its subsequent conversion within a single process.

Keywords

Carbon capture, CO2 utilization, CCUS, Electrochemistry

Funding

MoE (Regular)

Background & Motivation

Carbon capture is a key mitigation strategy for combating global warming and its effects on climate change. To ensure sustainability, CO_2 capture technology must be highly energy-efficient to reduce its own carbon footprint. However, conventional methods such as absorption and pressure/temperature swing adsorption fall short in this aspect. Electrochemical swing carbon capture is a novel and energy-efficient CO2 capture technology wherein the adsorption/desorption is brought about by switching the polarity. In this project, we would like to explore the possibility of a capture-utilization pathway by combining CO2 capture with the CO2 conversion step in a single process.

Essential Qualifications

B.Tech./M.Tech. in Materials Science, Chemical Engineering, Environmental Engineering, MSc in Chemistry, Nanoscience, Environmental or any other relevant areas

Desirable Qualifications

Electrochemistry knowledge, Experience with building experimental setups, hands-on experience with GC and characterization techniques like SEM, BET, TG, XRD etc.

Key Publications (Last 3 Years)

1. Hao, J.; Gebolis, P. M.; Gach, P. M.; Chevalier, M.; Bondaz, L. S.; Kocaman, C.; Hsu, K.-J.; Bhorkar, K.; Babu, D. J.; Agrawal, K. V. Scalable Synthesis of CO2-Selective Porous Single-Layer Graphene Membranes. Nat Chem Eng 2025, 2 (4), 241–251.
2. Liu, Q.; Miao, Y.; Villalobos, L. F.; Li, S.; Chi, H.-Y.; Chen, C.; Vahdat, M. T.; Song, S.; Babu, D. J.; Hao, J.; et al. Unit-Cell-Thick Zeolitic Imidazolate Framework Films for Membrane Application. Nat. Mater. 2023, 22 (11), 1387–1393.
3. Goudar, S. H.; Dash, R.; Babu, D. J.; Kurra, N.; Venkata Rao, K. Rational Design Strategy for the Synthesis of Hyper-Cross-Linked Polymers Using Dipolar π-Systems and Proton Sorption Induced Pseudocapacitance. ACS Appl. Energy Mater. 2025, 8 (7), 4494–4500.
4. Krishna Chaitanya, N., Nair, P. S., Rajpurohit, A., & Chatterjee, P. (2024). Impact of cell voltage on synthesis of caproic acid from carbon dioxide and ethanol in direct current powered microbial electrosynthesis cell. Bioresource Technology, 412. https://doi.org/10.1016/j.biortech.2024.131383
5. Chaitanya, N. K., Thulluru, L. P., & Chatterjee, P. (2023). Optimization of Long-Chain Fatty Acid Synthesis from CO2 Using Response Surface Methodology. Journal of Hazardous, Toxic, and Radioactive Waste, 27(4). https://doi.org/10.1061/JHTRBP.HZENG 1229
6. Chaitanya, N. K., Rajpurohit, A., Nair, P. S., & Chatterjee, P. (2023). Electrochemical synthesis of propionic acid from reduction of ethanol and carbon dioxide at various applied potentials. Biochemical Engineering Journal, 194. https://doi.org/10.1016/j.bej.2023.108896

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026031 **Next-Generation Engineered Isoporous Membrane: Polymer Formulations for Sustainable Water Purification and Resource Recovery**

Supervisor 1: **Dr. Ambika S**
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Supervisor 2: **Dr. Alan R Jacob**
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Abstract

This research project focuses on the modulating rheology of polymer precursor formulations for fabricating isoporous membranes with well-defined pore size and geometry for water treatment and resource recovery applications. The performance of the resultant membrane will be evaluated for solute-specific selectivity, durability, mechanical stability, and long-term fouling resistance for use in environmental engineering applications.

Keywords

Next Generation Advanced Membranes, Rheology of Formulations, Clean Water, High-Purity Resource Recovery

Funding

MoE (Regular)

Background & Motivation

Conventional membranes have a broad dispersion of pore structures, which limit the performance of membranes in specific separation processes, specifically, in water treatment and resource recovery. Hence, there is a need to fabricate membranes with uniform and tunable pore size and pore distribution. Optimizing rheological properties polymers formulation can provide a good handle on controlling the pore structures during the fabrication of membranes. These isoporous membranes offer high functionality in the specific separation of water pollutants and recovery of useful/valuable resources from aqueous solutions. Furthermore, it is also important to assess the durability and stability of the developed membrane compared to conventional membranes to support resource utilization and environmental sustainability considerations.

Essential Qualifications

Essential & minimum qualifications: First Class in M.Tech./M.E. in Civil Engineering (with specialization in Environmental Engineering), Environmental Engineering, Chemical Engineering, Polymer Technology, Materials Engineering, Nanotechnology, Sustainability Engineering, and Waste Management Engineering/technology. OR, First Class in M.Sc. in Chemistry, Polymer Science, Environmental Science, Materials Science, and Nanoscience/technology.

Desirable Qualifications

Hands-on experience and knowledge in Synthesis and Characterization of Nanomaterials/Membranes/Polymer/Products for Engineering Applications

Key Publications (Last 3 Years)

1. Ambika S et al., Management of tannery waste effluents towards the reclamation of clean water using an integrated membrane system: A state-of-the-art review, Environmental Research, 229, 15 July 2023, 115881 https://doi.org/10.1016/j.envres.2023.115881 IF-7.7
2. Ambika S et al., Synergistic Photo electrocatalytic Removal of Ciprofloxacin using WO3-gC3N4 Coated Grafoil Electrode: Insights into pH-Driven Kinetics and Mechanism, Chemical Engineering Journal, 2025 https://doi.org/10.1016/j.cej.2025.164063 IF-13.2
3. Ambika S et al., Photocatalytic treatment of agricultural runoff water using Bi2O3-ZrO2: A novel approach to mitigating persistent organic pollutants and nutrient contaminants, Journal of Environmental Chemical Engineering, 13 (3), 2025, 116620, https://doi.org/10.1016/j.jece.2025.116620 IF-7.2

	4. Alan et al., Pectin emulsions and emulgels: Bridging the correlation between rheology and microstructure. Kavya, A. R. Jacob, P. Nisha Food Hydrocolloids 143 (2023) 108868 5. Alan et al., On the Nature of Flow Curve and Categorization of Thixotropic Yield Stress Materials, Journal of Rheology 67 (2023) 461-477 6. Alan et al., Rheological signatures of aging in hard sphere colloidal glasses Physics of Fluids 31 (2019), 087103
Broad Proposal Objectives	**View Broad Proposal Objectives (PDF)**

VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026032 Co-Designing Serious Games to Build Climate Resilience in Vulnerable Last Mile Communities

Supervisor 1: **Md Haseen Akhtar**
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Abstract

This PhD research co-designs serious games with last-mile communities near Hyderabad to bridge scientific climate knowledge and local action. Using a Research through Design methodology, it combines participatory workshops, LLM-assisted scenario generation, and mixed-methods evaluation to shift climate adaptation from passive dissemination toward active, community-led civic engagement.

Keywords

Serious games; Participatory and co-design, Climate resilience, Research through Design, Design for Last Mile

Funding

MoE (Regular)

Background & Motivation

Climate change threatens vulnerable communities worldwide, yet adaptation strategies remain top-down and technically inaccessible to those most at risk. Serious games can bridge this gap by making complex risk scenarios interactive and engaging. This PhD proposal co-designs participatory games with climate-vulnerable communities to foster risk-based thinking and locally grounded adaptation.

Essential Qualifications

Participatory design, Climate risk literacy, Mixed-methods research, Game design and development, Community engagement

Desirable Qualifications

Large language model applications, Science communication, Design research methods, Programming skills, Design aptitude

Key Publications (Last 3 Years)

1. Akhtar MH, Ramkumar J. Learning from socially driven frugal innovation to design the future of healthcare: a case of mobile Primary Health Center. Health Care Sci. 2024; 3: 19–31. https://doi.org/10.1002/hcs2.80
2. Akhtar, M. H., & Ramkumar, J. (2024). Does rural India need a new primary healthcare delivery model? Design for Health, 8(1), 93–112. https://doi.org/10.1080/24735132.2023.2296732
3. M. H. Akhtar, K. Mendoza, M. Anderson, P. Anderson and J. Ramkumar, "Pack. Deploy. Heal: Reimagining Healthcare Delivery for Resource Constrained Settings Through Design Innovation," 2025 IEEE Global Humanitarian Technology Conference (GHTC), Golden, CO, USA, 2025, pp. 1-8, doi: 10.1109/GHTC66843.2025.11266086.
4. Saha, A., & Ravela, S. (2024). Statistical-physical adversarial learning from data and models for downscaling rainfall extremes. Journal of Advances in Modeling Earth Systems, 16(6), e2023MS003860.
5. Salas, J., Saha, A., & Ravela, S. (2023). Learning inter-annual flood loss risk models from historical flood insurance claims. Journal of Environmental Management, 347, 118862.

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026033 **Designing of Transition Metal grafted on Porous Matrix as Efficient Catalysts for Electro- and Photocatalytic Conversion of CO_2 to Chemicals**

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Supervisor 2: **Prof Debaprasad Shee**
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Abstract

CO2 conversion into value-added fuels and chemicals via electrochemical, photochemical, or photoelectrochemical reduction offers a promising route for renewable energy and carbon mitigation. This project aims to develop bioinspired heterogeneous catalysts by immobilizing molecular catalysts onto porous frameworks to achieve efficient, selective, and sustainable CO2 reduction to produce chemicals.

Keywords

Carbon capture and utilization (CCUS), Transition metal catalysts, porous materials, electro-photo chemistry, renewable feedstock

Funding

MoE (Regular)

Background & Motivation

Growing release of CO2 is a major driver of climate change, contributing to global warming, sea-level rise, and other environmental crises. Converting CO2 into value-added fuels and chemicals through sustainable electrochemical, photochemical, or photoelectrochemical reduction represents a promising strategy for both renewable energy generation and carbon mitigation.

Essential Qualifications

MSc in Chemistry with valid GATE/NET score, MTech in Chemical Engineering or Material Science and Engineering

Desirable Qualifications

MSc in Chemistry with valid GATE/NET score, MTech in Chemical Engineering or Material Science and Engineering

Key Publications (Last 3 Years)

1. Johnson, B. A.; Maji, S.; Agarwala, H.; White, T. A.; Mijangos, E.; Ott, S. Activating a Low Overpotential CO2 Reduction Mechanism by a Strategic Ligand Modification on a Ruthenium Polypyridyl Catalyst. Angew. Chem., Int. Ed. 2016, 55, 1825– 1829,
2. B. A. Johnson, H. Agarwala, T. A. White, E. Mijangos, S. Maji and S. Ott, Chem. Eur. J., 2016, 22, 14870–14880.
3. B. Giri, A. Mahata, T. Kella, D. Shee, F. De Angelis, S. Maji, J. Catal. 2022, 405, 15.
4. Chandewar, P. R.; Shee, D. Role of copper and cerium species in Cu/CeZSM catalysts for direct methane to methanol reaction: Insights of structure–activity relationship. J. Catal. 2025, 442, 115916.
5. K. S. Karumban, A. Muley, B. Giri,S. Kumbhakar, T. Kella, D. Shee, S. Maji, Inorg. Chim. Acta 2022, 529, 120637.

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026034 Design and Fabrication of Electrospun Ferroelectric/2D Materials Composites for Architectures Upgraded TENG Devices

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Supervisor 2: **Chandra Shekhar Sharma**
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Abstract

Triboelectric nanogenerators (TENGs) are emerging as promising devices for sustainable mechanical energy harvesting. This project proposes the development of electrospun ferroelectric and 2D materials (3D-2D hybrids i.e. lead free BT, NBT, BCZT and 2D materials like Graphene, MoS2, WS2 etc) composite nanofibers to enhance dielectric polarization, surface charge density, and mechanical flexibility for high-performance triboelectric nanogenerator for energy harvesting applications.

Keywords

Triboelectric nanogenerator (TENG), 3D-2D Hybrid Materials, Electrospinning, Energy Harvesting

Funding

MoE (Regular)

Background & Motivation

Prof. Saket Asthana's group specializes in ferroelectric and functional materials for energy harvesting, enabling high polarization and enhanced charge density. Prof. Chandra Shekhar Sharma' s group is pioneering in electrospun nanofibers, carbon nanostructures, and advanced materials for energy and environment applications. Their combined expertise enables fabrication of flexible ferroelectric/2D material-based triboelectric nanogenerators.

Essential Qualifications

Masters in Physics/Chemistry/ Materials Science OR M.Tech in Materials Science/ Metallurgy/ Energy Science/Ceramics Engineering OR BTech in Metallurgy/ Materials Science/ Energy Science/Ceramics Engineering

Desirable Qualifications

Ideally, the candidate should have strong basics in materials science and solid-state physics (preferably with reasonable mathematical/analytical skills).

Key Publications (Last 3 Years)

1. Chahal, S., Kundugolmath, R., Shinde, S.L. and Asthana, S., 2025. 2D-WS2-Coated Architectural Modified Cellulose Paper-Based Photosensitive Triboelectric Nanogenerators. ACS Applied Energy Materials, 8(23), pp.17431-17441.
2. Jena, L.K., Chahal, S., Sahoo, S., Boomishankar, R. and Asthana, S., 2025. Energy storage and harvesting potential of eco-friendly Ca-substituted Ba0. 8Sr0. 2TiO3/PVDF ferro-flexible composite films. ACS Applied Electronic Materials, 7(3), pp.1314-1328
3. Sahu, R.K. and Asthana, S., 2025. Enhanced Energy Storage and Thermal-Frequency Stability in Lead-Free Relaxor Ceramics through Single-Element Substitution: A Landau Perspective. ACS Applied Energy Materials, 8(22), pp.16974-16992.
4. Niu, J., Chourasia, A.K., Liu, X., Sharma, C.S. and Alwarappan, S., 2025. Unveiling Structure-Activity Relationship of Polyoxometallate-Confined Single Atom Electrocatalyst and Polyoxometallate-Modified Multifunctional Separator for Neutral Zn-Air Batteries. Small, 21(37), p.2504500.
5. Kandasamy, M., Sangabathula, O., Chakraborty, B. and Sharma, C.S., 2024. Candle soot carbon-Co3O4 nanofibers composite as a binder-free electrode for high-performance supercapacitor application: an experimental and theoretical investigation. Journal of Energy Storage, 81, p.110371.

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026035 Ti, Mo, V-based MXenes and Metal Oxides/Sulfides as Advanced Electrode Materials for Aqueous Zn-ion Batteries

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Abstract

This research investigates Ti-based and Mo/V-based MXenes and metal oxides/sulfides as electrode materials for aqueous Zn-ion batteries. The study focuses on correlating crystal structure, MXene surface termination chemistry, and Zn^{2+} storage mechanisms with electrochemical degradation behavior, aiming to develop high-performance, durable electrodes for safe and sustainable next-generation energy storage systems.

Keywords

Zn-ion batteries, MXenes, hybrid electrodes, Structural Engineering, Electrochemistry

Funding

MoE (Regular)

Background & Motivation

Aqueous Zn-ion batteries are promising alternatives to lithium-ion systems due to their safety, low cost, and environmental compatibility. However, their performance is limited by slow Zn^{2+} kinetics and electrode instability. MXenes and metal oxides/sulfides offer tunable structures and surface chemistry, providing opportunities to enhance Zn-ion storage and improve electrochemical stability.

Essential Qualifications

Zn-ion batteries, MXenes, hybrid electrodes, Structural Engineering, Electrochemistry

Desirable Qualifications

M.Tech/M.Sc. in Materials Science, Nanosciene or nanotechnology, Chemistry, Physics, or Chemical Engineering, with a preference for >70% marks and GATE qualification.

Key Publications (Last 3 Years)

1. Low-Temperature Synthesis of Battery Grade Graphite: Mechanistic Insights, Electrochemical Performance, and Techno-Economic Prospects, G. Kiran Kumar, S. Ghosh, J. Dutta, B. B. Panigrahi, S. K. Martha, Adv. Energy Mater. 2025, 2500501 https://doi.org/10.1002/aenm.202500501 (I.F. 26.5).
2. FeS2@Ti3C2Tx Pseudocapacitive Anode for Supercapacitors: Effect of Counter-Electrode Electrochemical Behavior on Supercapacitor Metrics. G. Kiran Kumar, S. Naskar, S. K. Martha*, and B. B. Panigrahi*. ACS Applied Energy Materials 7, no. 16 (2024): 6950-6960. (I.F.5.5) https://doi.org/10.1021/acsaem.4c00962
3. VOx anchored Ti3C2Tx MXene heterostructures for high-performance 2.2 V supercapacitors, Kiran Kumar Garlapati, S. K. Martha*, B. B. Panigrahi*, Journal of Energy Storage, 605 (2024): 234503. (I.F. 8.9). https://doi.org/10.1016/j.jpowsour.2024.234503
4. Correlative insights into the degradation pathways and direct regeneration healing mechanisms of spent lithium-ion battery active materials KK Garlapati, J Dutta, BB Panigrahi*, SK Martha*, J Power Sources 650 (2025) 237528. https://doi.org/10.1016/j.jpowsour.2025.237528.
5. Hydrofluoric acid-free synthesis of Ti3C2Tx-Fe3O4 composite anode coupled with high voltage NaxMn3O7 cathode for 2.2 V supercapacitors, KK Garlapati, S Sahoo, BB Panigrahi*, S. K. Martha*, J. Energy Storage 150 (2026) 120390. https://doi.org/10.1016/j.est.2026.120390

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026036 Micro–Macro Investigation of Failure of Mine Overburden Dumps and Associated Runout Hazards

Supervisor 1: **Prasanna R**
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Supervisor 2: **Krishan Kanhaiya**
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Abstract

High overburden dumps in open-cast coal mines pose significant stability challenges due to increasing dump heights and limited disposal space. This study proposes a multiscale investigation integrating advanced geotechnical testing, discrete element modelling, and AI-based analysis to understand failure mechanisms and predict potential runout hazards, supporting safer dump design and protection of nearby infrastructure.

Keywords

Coal Mining, Geotechnical Engineering, Discrete element modelling, hazard analysis

Funding

MoE (Regular)

Background & Motivation

High overburden dumps in open-cast coal mines are increasing in height due to limited dumping space, raising concerns about slope stability and potential runout hazards. Conventional analyses often rely on empirical approaches. Integrating advanced laboratory testing, discrete element modelling, and AI offers new opportunities to understand failure mechanisms and improve hazard prediction.

Essential Qualifications

M. Tech in relevant branches of civil and chemical engineering

Desirable Qualifications

CGPA 7.0 and above, knowledge in finite element modelling, mechanics and basic coding

Key Publications (Last 3 Years)

1. Prasanna, R and Sivathayalan, S. (2024). "Liquefaction characteristics of sand under complex seismic loading paths". Journal of Geotechnical and Geoenvironmental Engineering, ASCE, 150(10), 04024098 – 1-14
2. Premnath, S., Pouragha, M., Prasanna, R., and Sivathayalan, S. (2023). "Effects of Principal Strain Direction and Intermediate Principal Strain on Undrained Shear Behavior of Sand." Journal of Geotechnical and Geoenvironmental Engineering, ASCE, 149(7), 04023048 -1-13
3. Kanhaiya, K., Nathanson, M., Veld, P. J. I. '., Zhu, C., Nikiforov, I., Tadmor, E. B., Choi, Y. K., Im, W., Mishra, R. K., & Heinz, H. (2023). Accurate force fields for atomistic simulations of oxides, hydroxides, and organic hybrid materials up to the micrometer scale. Journal of Chemical Theory and Computation, 19(22), 8293–8322.
4. Winetrout, J. J., Kanhaiya, K., Kemppainen, J., Veld, P. J. I. '., Sachdeva, G., Pandey, R., Damirchi, B., Van Duin, A., Odegard, G. M., & Heinz, H. (2024). Implementing reactivity in molecular dynamics simulations with harmonic force fields. Nature Communications, 15(1), 7945.

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026037 HARVEST: Harnessing Agrivoltaics, Robotics, Virtual Systems and AI through Integrated Engineering and Design

Supervisor 1: **Dr. Pradeep Kumar Yemula**
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Supervisor 2: **Prof. Deepak Jhon Matthew**
Department: Design
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Abstract

HARVEST upgrades an existing 1 MW PV plant into an agrivoltaic–hydroponic living lab at IIT Hyderabad combining solar engineering, robotics, AI, and human-centered design. It integrates techno-economic modeling, digital twins, and interaction/experience design to create net-zero, climate-resilient agricultural systems that are efficient, understandable, and adoptable by farmers, operators, students, and policymakers.

Keywords

HARVEST develops a 1 MW agrivoltaic–hydroponic living lab at IIT Hyderabad combining solar engineering, robotics, AI, and human-centered design. It integrates techno-economic modeling, digital twins, and interaction/experience design to create net-zero, climate-resilient agricultural systems that are efficient, understandable, and adoptable by farmers, operators, students, and policymakers.

Funding

MoE (Regular)

Background & Motivation

Agrivoltaic systems often emphasize technology but overlook usability, local practices, and decision workflows, limiting real-world adoption. By combining electrical engineering with interaction and sustainability-focused design, HARVEST aims to deliver net-zero agrivoltaic solutions that are technically robust, explainable, and desirable to users, supporting wider uptake of sustainable food–energy–water systems.

Essential Qualifications

M.E./M.Tech in Power Systems/Renewable Energy/Control/Embedded Systems OR M.Des in Interaction/Communication/Product/Sustainability Design OR B.E./B.Tech/B.Des Electrical / Electronics / Communication / Design / Interaction Design / related branch with minimum 2 years relevant industry / research experience in energy, agritech, or design for sustainability

Desirable Qualifications

Agrivoltaics / PV systems; Sensor networks / IoT; Visualization / UI design; Human-centered / interaction design; Field experimentation / living labs / interaction/UX design

Joint Supervision History

Under the joint guidence of Dr. Pradeep and Prof. Deepak, Mr. Sushanta Banerjee's PhD work on Agrivoltaic Systems (AVS) and Energy Trading has evolved into a strong, structured collaboration with Kyoto University. Together, Dr. Pradeep and Prof. Deepak initiated and nurtured the AVS collaboration with Prof. Ogata, aligning Sushanta's thesis with Kyoto's expertise in agrivoltaics and energy markets. They have co-developed and advanced the AI-Engage proposal, coordinated joint research activities at IIT Hyderabad and Kyoto University, and actively engaged with international offices and faculty to expand the partnership. Their joint guidance has ensured that Sushanta's research is not only academically rigorous but also embedded in a broader India–Japan cooperation framework, including Quad-country seminar and proposal initiatives. Through co-teaching, joint meetings, proposal development, and sustained mentoring, Dr. Pradeep and Prof. Deepak have played a central role in building a long-term, multi-institutional collaboration around sustainable energy and agrivoltaic innovation.

Key Publications (Last 3 Years)

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Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026038 Sustainable Asphalt Mixtures: Evaluating Lignin as a Renewable Binder Extender

Supervisor 1: **Mullapudi Ramya Sri**
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Supervisor 2: **Avanthi Althuri**
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Abstract

Identification and characterization of lignin sources which are suitable will be done, also synthesis of lignin will be carried out at laboratory scale for a few sources. As a next step, binder preparation with adoption of various dosages of lignin will be carried out and characterized (both for physical and chemical characteristics). For mix level, mix designs, mechanical property and performance evaluation will be done. Parallelly benchmarking of the prepared mixes will be carried out using conventional asphalt mixes and best combination of lignin source and dosage will be identified.

Keywords

Lignin based bio bitumen, asphalt mixes, bio binder, road application

Funding

MoE (Regular)

Background & Motivation

Several research studies have studied lignin modified bitumen and mixes by using the lignin as modifier (curtailing the dosage to 20 % by weight of bitumen) owing to issues related to imparted high stiffness and fatigue performance. Current study will focus on improving the dosage of lignin to 50 % (by weight of bitumen) or beyond with the help of identification of lignin sources and employment of rejuvenators in parallel

Essential Qualifications

Mtech in Transportation Engineering or MTech in Biotechnology. Hands on experience in either asphalt mix or biomass extraction process

Desirable Qualifications

MTech in Transportation Engineering or MTech in Biotechnology

Key Publications (Last 3 Years)

1. Synergistic effect of nanoclay-modified binders and RAP material on performance and emission reduction in hot mix asphalt
2. Fatigue and Healing Characteristics of WMA–RA Blended Binders
3. Evaluation of fatigue damage and healing capability of RAP mixtures using time lag: an ITSM test parameter
4. Gelatin crosslinked novel lignin-pullulan dialdehyde biocomposite film for active food packaging
5. Tuning of chitosan with lignin-derived bioactive properties to develop a lignin-reinforced and sustainable food packaging biomaterial

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026039 **Dirt to Design: Engineering High-Tech Materials from Chromite Mining Waste by Sustainable Hydrometallurgical Route**

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Supervisor 2: **D V Sai Praneeth**
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Abstract

Chromite overburden contains low but recoverable nickel associated with iron oxides and silicates. This study proposes hydrometallurgical acid leaching followed by selective separation using liquid–liquid or solid liquid process. Process intensification will enhance leaching efficiency, while purified nickel will be recovered as nickel foam and nanoparticles for catalytic and energy storage applications.

Keywords

Critical minerals, Hydrometallurgy, Selective separation, Ni foam, Nanoparticles

Funding

MoE (Regular)

Background & Motivation

Chromite mining overburden contains recoverable Nickel, but is often discarded, causing environmental concerns. With rising nickel demand for energy technologies, recovering it from secondary resources is important. Hydrometallurgical extraction combined with process intensification and selective separation can enable efficient recovery and conversion into value-added materials such as nickel foam and nanoparticles.

Essential Qualifications

B.Tech./B.E. in Chemical Engineering, Metallurgical Engineering, Materials Science and Engineering, Civil Engineering, Environmental Engineering or any allied discipline

Desirable Qualifications

Prior experience in hydrometallurgy and metals chemistry

Key Publications (Last 3 Years)

1. V.V. Gande, S. Pushpavanam, Continuous synthesis of copper nanoparticles using a polyol process in a milli-channel reactor , J. Flow Chem. (2021). doi:10.1007/s41981-021-00169-y.
2. V.V. Gande, S. Vats, N. Bhatt, S. Pushpavanam, Sequential recovery of metals from waste printed circuit boards using a zero-discharge hydrometallurgical process , Clean. Eng. Technol. 4 (2021) 100143. doi:10.1016/j.clet.2021.100143.
3. Praneeth, S., Sakr, A. K., Dardona, M., Tummala, C. M., Roy, P. K., & Dittrich, T. M. (2024). Potential for Eco-Friendly Recovery of Rare Earth Elements from Fly Ash Using Carboxylic Acids: A Comparative Study with Mineral Acids and Environmental Risk Assessment for Sustainable Fly Ash Reuse. Chemical Engineering Journal, 158355
4. Praneeth, S., Sakr, A. K., Dardona, M., Tummala, C. M., Roy, P. K., & Dittrich, T. M. (2024). Selective separation and recovery of rare-earth elements (REEs) from acidic solutions and coal fly ash leachate by novel TODGA-Impregnated organosilica media. Chemical Engineering Journal, 156849
5. Sakr, A. K*., Praneeth, S*., Roy, P. K., Dittrich, T. M. (2026). CMPO-Functionalized Silica Sorbents for pH-Tunable Separation and Enrichment of Rare-Earth Elements from Environmental Matrices. ACS Sustainable Chemistry & Engineering

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026040 Versatile Wide Bandgap Perovskites for Tandem Solar Cells (VIP-TSCs)

Supervisor 1: **Dr. Ashish Kulkarni**
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Supervisor 2: **Prof. Suhash Ranjan Dey**
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Abstract

This project aims to develop versatile wide-bandgap perovskite materials for high-efficiency tandem solar cells. The project focuses on compositional engineering, charge transport analysis, and degradation studies to improve efficiency and stability. Advanced characterization will provide insights into recombination mechanisms, enabling the design of durable and high-performance tandem photovoltaic devices.

Keywords

Perovskite Solar Cells, Silicon–Perovskite Tandem Solar Cells, Wide Bandgap Perovskites, Charge Transport and Recombination, Device Stability and Degradation Mechanisms

Funding

MoE (Regular)

Background & Motivation

Metal–halide perovskites have emerged as promising photovoltaic materials due to their excellent optoelectronic properties and rapidly increasing efficiencies. Integrating wide-bandgap perovskites in tandem architectures offers a pathway to surpass single-junction efficiency limits. However, challenges related to material stability, interfacial recombination, and degradation must be addressed for fabricating reliable devices.

Essential Qualifications

1. MSc or M.Tech in Chemistry / Materials Science Engineering / Nanoscience / Energy Science and Engineering,
2. Background in Perovskite Solar Cells or Photovoltaic Materials,
3. Understanding of Semiconductor Physics or Optoelectronic Devices,
4. Experience in Thin Film Deposition and Device Fabrication,
5. Work in Interdisciplinary Project

Desirable Qualifications

1. Experience with Characterization Techniques (PL, SEM, XRD, Impedance Spectroscopy).
2. Knowledge of Charge Transport and Device Stability Analysis.
3. Experience with Tandem Solar Cells
4. Scientific writing and publication experience
5. Device Simulations

Key Publications (Last 3 Years)

1. Kulkarni, A.* et al., A Universal Strategy of Perovskite Ink - Substrate Interaction to Overcome the Poor Wettability of a Self-Assembled Monolayer for Reproducible Perovskite Solar Cells, Advanced Functional Materials, 2023, 33, 2305812.
2. Siekmann, J., Kulkarni, A.* et al., Characterizing the Influence of Charge Extraction Layers on the Performance of Triple-Cation Perovskite Solar Cells, Advanced Energy Materials, 2023, 13, 2300448.
3. Kumar, D., Bansal, N. K., Dixit, H., Kulkarni, A.,* et al., Numerical Study on the Effect of Dual Electron Transport Layer in Improving the Performance of Perovskite–Perovskite Tandem Solar Cells, Advanced Theory and Simulations, 2023, 2200800
4. Yadav, B. S., Dey, S. R., Dhage, S. R., Inkjet printed CuIn(1-X)GaXSe2 thin film by controlled Selenium distribution for improved power conversion efficiency in chalcopyrite solar cells, Applied Surface Science Advances, 2021, 100144
5. Yadav, B. S., Dey, S. R., Dhage, S. R., Microstructural investigation of inkjet printed Cu(In,Ga)Se2 thin film solar cell with improved efficiency, Journal of Alloys and Compounds, 2020, 827, 154295.

Broad Proposal Objectives View Broad Proposal Objectives (PDF)

VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026041 3D-printable photonic porous ceramics for passive cooling applications

Supervisor 1: **Shinde Satish Laxman**
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Supervisor 2: **Ranajit Mondal**
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Abstract

Rapid urbanization and increasing global temperatures demand energy-efficient cooling strategies. This project proposes the development of 3D-printable photonic porous ceramics capable of passive cooling through controlled interaction with thermal radiation. By integrating radiative heat transfer, photonic material design, and additive manufacturing, the research aims to create scalable materials for sustainable cooling applications.

Keywords

Passive cooling, Photonic materials, Porous ceramics, 3D printing, Thermal radiation engineering

Funding

MoE (Regular)

Background & Motivation

Rising global temperatures and urbanization increase the demand for energy-efficient cooling technologies. Conventional air-conditioning consumes significant energy and contributes to greenhouse gas emissions. Advances in photonic structures enable control of thermal radiation, allowing radiative cooling. This research proposes 3D-printable photonic porous ceramics with tailored microstructures that provide efficient passive cooling while maintaining desirable mechanical properties such as structural stability, strength, and durability for practical construction and infrastructure applications.

Essential Qualifications

M.E/M. Tech. (Chemical, Mechanical, Materials, Civil, Nanotechnology Engineering) OR BE/BTech Chemical, Mechanical, Materials, Civil, Nanotechnology Engineering) with a valid GATE score OR M.Sc. (Physics, Applied physics, Material Science, Nanotechnology) with a valid GATE score/CSIR/UGC-NET

Desirable Qualifications

Expertise in materials synthesis and their characterization, optical spectroscopy techniques, knowledge of thermal physics, additive manufacturing, and knowledge on heat transfer modelling are highly encouraged.

Key Publications (Last 3 Years)

1. Solar-active Titanium-based Oxide Photocatalysts Loaded on TiN Array Absorbers for Enhanced Broadband Photocurrent Generation. S. L Shinde, H. D. Ngo, S. Ishii, and T. Nagao. Journal of Applied Physics, 2020, 129, 2, 023103.
2. Direct observation of photoinduced charge separation at transition metal nitride-semiconductor interfaces. Y. Min-Wen, S. Ishii, S. L Shinde, N. K. Tanjaya, K. P. Chen, and T. Nagao. ACS Applied Materials & Interfaces, 2020, 12, 50, 56562-56567.
3. Narrow-band thermal emitter with titanium nitride thin film demonstrating high temperature stability, Z.-Y. Yang, S. Ishii, D. T. Anh, S. L. Shinde, T. D. Dao, Y.-P. Lo, K.-P. Chen, and T. Nagao, Advanced Optical Materials 2020, 1900982.
4. Instabilities in drying colloidal films: Role of surface charge and substrate wettability, A. M.S. Kumar, A. H. Govindha, R. Mondal, and K. C. Sahu, International Journal of Multiphase Flow, 2026, 197, 105631.
5. Physics of drying complex fluid drop: Flow field, pattern formation, and desiccation cracks, R. Mondal, H. Lama, and K. C. Sahu, Physics of Fluids, 2023, 35, 061301.

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026042 Discovery Through Play: Bringing Experimental Science to Schools via Interactive 3D Models

Supervisor 1: **Mohammad Shahid**
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Supervisor 2: **Saurabh Sandilya**
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Abstract

This research aims to make complex science experiments more accessible through tangible learning tools. By developing accurate 3D-printed models of scientific instruments and experiments, it enables students to engage with science through hands-on interaction. Accompanied by educational resources, the study will test and validate this pedagogical approach while fostering curiosity, improving scientific understanding, and inspiring interest in STEM fields.

Keywords

STEM Engagement, Experiential Learning, 3D printing and Education, Playful Learning

Funding

MoE (Regular)

Background & Motivation

Many scientific concepts remain abstract and difficult for students to grasp through conventional textbook-based learning. Limited access to advanced laboratories and scientific instruments further widens this gap, especially in under-resourced schools. This research is motivated by the need to create tangible, interactive tools that make science learning more engaging, accessible, and experiential for students.

Essential Qualifications

Knowledge of 3D software, Product design, 3D printing

Desirable Qualifications

BDes/BTech (8 CGPA and above), MDes/MTech with understanding of 3D software

Key Publications (Last 3 Years)

1. "GPU-based track-finding for the J-PARC muon g-2/EDM experiment," H. Chetri, D. Samuel, S. Sandilya, T. Yamanaka, T. Mibe and T. Suehara, JINST 21, no.01, P01006 (2026).
2. "The imaging Time-of-Propagation detector at Belle II," H. Atmacan, M. Belhorn, Y. Guan, L. Li, B. Pal, S. Sandilya, A. J. Schwartz, B. Wang, S. Watanuki and M. Andrew, et al., Nucl. Instrum. Meth. A 1080, 170627 (2025).
3. "Charged-hadron identification at Belle II," I. Adachi et al. [Belle II Collaboration (includes S. Sandilya)], Eur. Phys. J. C 85, no.11, 1237 (2025).
4. "Measurement of $B \to K*(892)\gamma$ decays at Belle II," I. Adachi et al. [Belle II Collaboration (includes S. Sandilya)], JHEP 09, 024 (2025).
5. "Measurement of branching fractions, CP asymmetry, and isospin asymmetry for $B \to \rho\gamma$ decays using Belle and Belle II data," I. Adachi et al. [Belle and Belle II Collaboration (includes S. Sandilya)], Phys. Rev. D 111, no.7, L071103 (2025).
6. Rajitha, S.,and Shahid, M.(2025) Bridging the Learning Gap in Inclusive Preschool Classrooms: Impact of Soft Teaching Materials on Behavioural Challenges, in Mahamuni, R., Onkar, P. (eds.), ServDes 2025: Empowering Diversity, Nurturing Lasting Impact, 6–10 October, Hyderabad, India. https://doi.org/10.21606/servdes2025.74
7. Bajaj, N., Shahid, M. (2025). RECO: Gamified Learning for Recognizing Shapes and Patterns. In: Chakrabarti, A., Singh, V., Onkar, P.S., Shahid, M. (eds) Responsible and Resilient Design for Society, Volume 4. ICoRD 2025. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-96-5495-6_27
8. Chourasia, D., Shahid, M. (2025). Customising Keyboard Accessibility for Data-Entry Intensive Workflows: A Case Study of the Automotive Retail Industry. In: Chakrabarti, A., Singh, V., Onkar, P.S., Shahid, M. (eds) Responsible and Resilient Design for Society,

Volume 3. ICoRD 2025. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-96-5491-8_15

9. Aalla, C., Shahid, M. (2025). Shape of Numbers: A Study on Origin and Evolution of Brahmi Numerals and Their Structural Relationship with Letterforms. In: Chakrabarti, A., Singh, V., Onkar, P.S., Shahid, M. (eds) Responsible and Resilient Design for Society, Volume 2. ICoRD 2025. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-96-6511-2_1
10. Ranjana, R., Monika, Shahid, M., Kamran, M. (2026). Exploring Adaptability of Miniature Painting to New Media. In: Brooks, A.L., Banakou, D., Ceperkovic, S. (eds) ArtsIT, Interactivity and Game Creation. ArtsIT 2024. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 651. Springer, Cham. https://doi.org/10.1007/978-3-031-97257-7_16

Broad Proposal Objectives	**View Broad Proposal Objectives (PDF)**

VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026043 Spatiotemporally Optimized Active Control of Thermoacoustic Instability using Nanosecond Repetitively Pulsed Plasma Discharge

Supervisor 1: **Vishnu Rajasekharan Unni**
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Supervisor 2: **Anupam Gupta**
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Abstract

Combustion systems are prone to thermoacoustic instability resulting from positive feedback between the unsteady flame and the acoustic field of the combustion chamber. In this project, using tools from complex systems theory, we will develop an optimized active control mechanism to suppress thermoacoustic instability and experimentally validate it.

Keywords

Complex Systems, Nonlinear Dynamics, Phase Transitions, Thermoacoustics, Active Control

Funding

Project-funded PhD position

Background & Motivation

Thermoacoustic instability arises from nonlinear interactions between the spatiotemporal patterns of the reaction and the acoustic field, leading to the emergence of spatiotemporal order in the system. Using a complex systems approach, we could identify the optimal location to introduce appropriate control action that would suppress the emerging order.

Essential Qualifications

M.Sc Physics with a valid GATE score or M.Tech Mechanical/Aerospace Engineering or B.Tech Mechanical/Aerospace Engineering with a valid GATE score

Desirable Qualifications

Experience in mathematical modeling, time series analysis, nonlinear dynamics, thermodynamics, and combustion

Key Publications (Last 3 Years)

1. Raghunathan M, George NB, Unni VR, Kurths J, Surovyatkina E, Sujith RI. Inhibiting the onset of thermoacoustic instability through targeted control of critical regions. International Journal of Spray and Combustion Dynamics. 2023;15(1):3-15. doi:10.1177/17568277221149507
2. George, N.B., Raghunathan, M., Unni, V.R. et al. Preventing a global transition to thermoacoustic instability by targeting local dynamics. Sci Rep 12, 9305 (2022). https://doi.org/10.1038/s41598-022-12951-6
3. Weng, Y., Unni, V.R., Sujith, R.I. et al. Synchronization-based model for turbulent thermoacoustic systems. Nonlinear Dyn 111, 12113–12126 (2023). https://doi.org/10.1007/s11071-023-08368-z
4. Kiran, K. V., Kumar, K., Gupta, A., Pandit, R. & Ray, S. S. Onset of Intermittency and Multiscaling in Active Turbulence. Phys. Rev. Lett. 134, 088302 (2025).
5. Kashyap, K., Kiran, K. V. & Gupta, A. Emergence of Local Ordering and Mesoscale Giant Number Fluctuations in Active Turbulence. Phys. Rev. Lett. 136, 108301 (2026).

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026044 Understanding sheared turbulent flows: from boundary-layers and wind-turbines to tokamaks

Supervisor 1: **Niranjan S. Ghaisas**
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Supervisor 2: **Kiritkumar Makwana**
Department: Physics
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Abstract

This project aims to understand the structure of sheared turbulent flows using computational fluid dynamics (CFD), focused on the universal features that are common across boundary-layers, wind-turbines and tokamaks. The student will gain experience in conducting CFD simulations, performing critical physics-/data-driven analyses, handling large datasets, and CPU/GPU parallel computing.

Keywords

Computational Fluid Dynamics, Turbulence, Machine Learning, High-Performance Computing

Funding

MoE (Regular)

Background & Motivation

Turbulent flows are ubiquitous in natural/engineered systems. Applications range from atmospheric boundary-layer, the flow over wind-turbines to fusion reactions in tokamaks. Several features of turbulence are common, irrespective of the system, e.g. energy cascade, broadband spectrum and nonlocal/multiscale interactions. High-fidelity simulations and data-driven techniques will be used to understand/model turbulent flows.

Essential Qualifications

BE/BTech/ME/MTech/MSc in Mechanical Engineering, Physics, or affiliated areas. Experience or interest in programming.

Desirable Qualifications

Experience in one or more of computational fluid dynamics and/or turbulence.

Key Publications (Last 3 Years)

1. K. Mondal, N. N. Kethavath, N. S. Ghaisas, "Large-eddy simulation study of the atmospheric boundary layer flow over smooth-to-rough surface roughness transitions", Boundary-Layer Meteorology, 191, 2025. doi: 10.1007/s10546-025-00906-z
2. N. N. Kethavath, N. S. Ghaisas, "Effect of an abrupt rough-to-smooth surface roughness transition on wind farm wakes: An LES and analytical modelling study", Journal of Renewable and Sustainable Energy, 16, 033302, 2024. doi: 10.1063/5.0202733
3. K. Mondal, N. N. Kethavath, N. S. Ghaisas, "Large-eddy simulation study of atmospheric boundary-layer flow over an abrupt rough-to-smooth surface roughness transition", Boundary-Layer Meteorology, 188, 229 - 257, 2023. doi: 10.1007/s10546-023-00811-3
4. H. Pradhan, K. D. Makwana, B. Ripperda, “Energy conversion and scaling analysis of relativistic magnetic reconnection in the Sweet-Parker regime”, Physics of Plasmas, 32, 112904, 2025. doi: 10.1063/5.0281465
5. J. Sharma, K. D. Makwana, “Kinetic Alfvén wave cascade in sub-ion range plasma turbulence”, Frontiers in Astronomy and Space Sciences, 11, 1423642, 2024. doi: 10.3389/fspas.2024.1423642

Broad Proposal Objectives

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VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026045 Development of a Laser-Based Wireless Power Transfer System for UAV

Supervisor 1: **Dr. Nithyanandan Kanagaraj**
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Supervisor 2: **Dr. Vishnu R Unni**
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Abstract

Wireless power transfer using laser beams is emerging as a transformative technology for powering drones, UAVs, and remote autonomous systems where conventional energy delivery is impractical. Recent advances in fiber lasers and coherent beam combining enable scalable high-power optical sources, yet atmospheric turbulence and inefficient energy remain key challenges. This project seeks to address these limitations by integrating adaptive photonic control, machine learning, and optimized photovoltaic receivers, enabling reliable and efficient laser-based power delivery for next-generation aerospace and defence applications.

Keywords

Wireless Power Transfer, Power Beaming, Laser Technology

Funding

MoE (Regular)

Background & Motivation

The increasing demand for remote, uninterrupted, and cable-free energy delivery has motivated research in wireless power transfer. Laser-based power beaming provides a highly directional and flexible solution for long-distance transmission. Advancing this technology can support emerging systems requiring lightweight, continuous, and targeted power delivery in inaccessible or mobile environments. The proposed work will establish a compact, scalable, and efficient platform for remote power transfer, supporting future applications in autonomous systems, sensors, defence, and space technologies. The research addresses a strategic technology of national importance for defence, aerospace, and autonomous systems.

Essential Qualifications

UG/PG in Mechanical Engineering, Electrical Engineering, Engineering Physics, Instrumentations, mechtronics, and related areas

Desirable Qualifications

Experience in Control Systems, Power electronics, Photonics, Laser Technology, AI/ML, Instrumentation

Key Publications (Last 3 Years)

1. B Jacob, JR Jegaraj, N Kanagaraj, An all-optical passive device based on wavelength-adaptive diffractive neural network for dynamic beam shaping, "Optics and Lasers in Engineering 201, 109703 (2025)
2. Yashwanth Mohan Kumar, Harishankar Manoharan, Vishnu Unni, Nithyanandan Kanagaraj, "A System And Method For Controlling State Of Array Of Coherent Sources Of Electromagnetic Waves", Indian Patent Granted (202441040191).
3. M Kumar, N Kanagaraj, "Effects on beam quality due to misalignment errors in beam combination systems, " Optics & Laser Technology 194, 114415 (2025).
4. B Jacob, JR Jegaraj, N Kanagaraj, "Dynamic Beam Shaping Using a Wavelength-Adaptive Diffractive Neural Network for Laser-Assisted Manufacturing" arXiv preprint arXiv:2509.13849 (2025).
5. DK Murugan, R Joseph, N Kanagaraj, "Transformer Encoder–Decoder Framework for Nonlinear Pulse Evolution and Inverse Modeling" Advanced Photonics Research 6 (11), 2500149 (2025).

Broad Proposal Objectives — View Broad Proposal Objectives (PDF)

VERTICAL: ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

IDPHD2026046 Extraction of rare earth elements from secondary sources (coal ash, overburden, red mud etc)

Supervisor 1: **Ashok Kamaraj**
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Supervisor 2: **Gande Vamsi Vikram**
Department: Chemical Engineering
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Abstract
Given the increasing demand for critical minerals, it is essential to recover rare earth elements in an ecologically friendly manner from sources like metal-rich soil, coal topsoil, overburden, red mud, and coal fly ash for commercial metal recovery. Various combinations of physical separation, pyrometallurgy, and hydrometallurgy are being explored to extract REEs from various sources.

Keywords
Rare earth elements, extractive metallurgy, metal recycling, circular economy

Funding
Project-funded PhD position

Background & Motivation

The concentration of rare earth elements (REEs) and critical minerals is notably higher in coal fly ash compared to coal itself. The overburden, often considered waste material, can have higher concentrations of critical minerals than the primary coal seam itself, presenting another potential secondary resource for recovery. With the right techniques, overburden could be processed to extract valuable metals, reducing the need for new mining operations. Additionally, red mud, a byproduct of bauxite refining, is rich in various minerals, including iron oxide, titanium, and trace amounts of REEs. Though traditionally viewed as an environmental challenge due to its caustic nature, red mud holds promise as a secondary source of critical minerals.

Essential Qualifications
M.Tech in Metallurgy / Chemical Engineering / Material Science (or) B.Tech in Metallurgy / Chemical Engineering / Material Science from CFTI with CGPA more than 8 (or) B.Tech in Metallurgy / Chemical Engineering / Materials Science with valid gate score

Desirable Qualifications
-nil-

Key Publications (Last 3 Years)

1. A novel approach for the efficient recovery of lead from End-of-Life Silicon Photovoltaic modules: D.S. Prasad, P.P. Srinivasa Kumar, B. Sanjana, D. Sai Kiran, Ashok Kamaraj, R. Ratheesh: Solar Energy Materials and Solar Cells (2024) Vol. 266 112672.
1. comparative study on environmental impact analysis of synthetic and ESR flux used for refining of steel: Ashok Kamaraj, Rohit B Meshram#: Procedia CIRP (2021) Vol. 98, p. 448-451
2. V.V. Gande, S. Vats, N. Bhatt, S. Pushpavanam, Sequential recovery of metals from waste printed circuit boards using a zero-discharge hydrometallurgical process , Clean. Eng. Technol. 4 (2021) 100143. doi:10.1016/j.clet.2021.100143.
5. V.V. Gande, S. Pushpavanam, Continuous synthesis of copper nanoparticles using a polyol process in a milli-channel reactor , J. Flow Chem. (2021). doi:10.1007/s41981-021-00169-y.

Broad Proposal Objectives

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VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026047 Smart Sensors for Lung and Breast Cancer Therapy

Supervisor 1: **Prof.Ranjith Ramadurai**
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Supervisor 2: **Avinash Eranki**
Department: Biomedical Engineering
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Abstract

Breast and Lung cancer, together, are the largest cumulative cause of mortality in India. The role of tumor treating fields (TTF) built with novel lead-free materials in treating malignant breast tumors and lung tumor is unclear. Developing novel TTF for these tumors could significantly help survival outcomes.

Keywords

Breat Cancer, Lung Cancer, Smart Materials, TTF, Clinical Trials

Funding

MoE (Regular)

Background & Motivation

Breast and Lung cancer, together, are the largest cumulative cause of mortality in India. Tumor Treating Fields (TTF) or low-intensity electric fields represent a novel, non- invasive cancer treatment modality. This approach leverages alternating electric fields to disrupt cancer cell division and impede tumor growth. The mechanistic role of tumor treating fields (TTF) built with novel materials in treating malignant breast tumors (hormone-positive or triple-negative) is unclear.

Essential Qualifications

Master's in Electrical, Material Science or Biomedical Engineering

Desirable Qualifications

Has experience in building devices, working with materials and characterizing materials

Key Publications (Last 3 Years)

1. Sabale, A., Rizvi, M. S., Chinthapenta, V., & Eranki, A. (2025). Effect of focused ultrasound on shearwave production in a hyperelastic media: A. Sabale, et al. Biomechanics and Modeling in Mechanobiology, 24(4), 1279-1294.
2. Chowdhury, S., Eranki, A., & Garlapati, S. K. (2024). Low-Cost Desktop Printed Sensors for Therapeutic Ultrasound Applications. IEEE Sensors Journal, 24(23), 39719-39726.
3. Prabahar, K., Ranjith, R., Srinivas, A., Kamat, S. V., Mallesham, B., Niranjani, V. L., ... & Das, D. (2017). Effect of deposition temperature on the microstructure, ferroelectric and mechanical properties of lead free BCZT ceramic thin films. Ceramics International, 43(6), 5356-5361.
4. Ranjith, R., Mangalam, R. V. K., Boullay, P., David, A., Lepetit, M. B., Lüders, U., ... & Aruta, C. (2010). Constrained ferroelectric domain orientation in (BiFeO3) m (SrTiO3) n superlattice. Applied Physics Letters, 96(2).
6. 5. Bhat, A. P., Joshi, M. C., M, H., Ummethala, G., P, S., Kibkalo, L., ... & Ramadurai, R. (2022). Ba0. 85Ca0. 15Zr0. 1Ti0. 90O3/CoFe2O4/Ba0. 85Ca0. 15Zr0. 1Ti0. 90O3 Nanoscale Composite Films with 2–2 Connectivity for Magnetoelectric Actuation. ACS Applied Nano Materials, 5(12), 17652-17663.

Broad Proposal Objectives

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VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026048 Fluorescence-based Detection and Analysis of DNA Methylation

Supervisor 1: **Krishna Gavvala**
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Supervisor 2: **Rajkumara Eerappa**
Department: Biotechnology
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Abstract

The present thesis proposal aims to develop a fluorescence-based platform for detecting methylation status on genome that could be used for screening small molecules particularly targeting the CpG methylation (mCpG:aka DNA methylation) reader or writer proteins and diagnosing the methylation status on genes or genome.

Keywords

Fluorescence spectroscopy, DNA methylation, DNA-protein interactions

Funding

MoE (Regular)

Background & Motivation

mCpG is an epigenetic modification of covalent addition of methyl group to cytosine (5mC) residue of DNA that is essential for normal function, and growth and differentiation of the cell, and dysregulation linked to various disorders including cancer and neurological. Hence, establishing a fluorescence-based method that detects methylation on DNA could find potential biomedical applications in diagnosis.

Essential Qualifications

MSc (Chemistry) or MSc (Biochemistry) or MTech (Biotechnology) with valid CSIR or GATE

Desirable Qualifications

MSc (Chemistry) or MSc (Biochemistry) or MTech (Biotechnology) with valid CSIR or GATE Prior experience in biophysics or fluorescence spectroscopy

Key Publications (Last 3 Years)

Dr Krishna Gavvala:

1. Dineshbabu Takkella, Javier Cerezo, Lara Martinez-Fernandez, Krishna Gavvala New insights into the structure and dynamics of the epigenetic modifications on DNA RSC Chemical Biology, 2025, 6, 1927.
2. Thor van Heesch, Sudhanshu Sharma, Bert van Erp, Alberto Perez de Alba Ortiz, Remus T Dame, Jocelyne Vreede, Krishna Gavvala. Adaptation of DNA to Protein Binding Revealed by Spectroscopy and Molecular Simulation J. Phys. Che. B, 2025, 129, 5653.
3. Dineshbabu Takkella, Mayur Suryawanshi, Meghna Mani, Satheesh Ellipilli, Krishna Gavvala. Carbazole-rhodanine conjugate acts as an effective fluorescence biomarker for protein structural dynamics studies. Int. J. Biol. Macromol., 2025, 147156.
4. Dineshbabu Takkella, Jyoti Vishwakarma, Krishna Gavvala. Effect of PEG-Induced Liquid–Liquid Phase Separation on DNA–Topotecan Interactions. J. Phys. Che. B, 2025, 129, 11636.
5. Dineshbabu Takkella, Krishna Gavvala. Deciphering Structural Dynamics of DNA-Surfactant Interactions Using the Isomorphic Nucleobase Analogue. Langmuir, 2025, 41, 30880.

Prof Rajakumara Eerappa:

1. Dagur Singh Hanuman, Singh Neeharika, Eerappa Rajakumara. PARP2 Catalytic Activity Is Allosterically Stimulated by Binding to the c-KIT1 G-Quadruplex. ACS omega, 2025, 10, 8767.

2. Dagur Hanuman Singh, Waghela Deeksha, Eerappa Rajakumara. Characterization of PARP1 binding to c-KIT1 G-quadruplex DNA: Insights into domain-specific interactions. Biophys. Chem. 2024, 315, 107330.
3. Rajakumara E, Nakarakanti NK, Nivya MA and Satish, M. Waghela Deeksha, Eerappa Rajakumara. DNA repair. 2024, 133, 103593.
4. Suman Abhishek, Waghela Deeksha, Eerappa Rajakumara. Mechanistic insights into allosteric regulation of methylated DNA and histone H3 recognition by SRA and SET domains of SUVH5 and the basis for di-methylation of lysine residue. FEBS J. 2023, 290, 1060.
5. Waghela Deeksha, Suman Abhishek, Eerappa Rajakumara. PAR recognition by multiplereader domains ofPARP1 allosterically regulates the DNA-dependent activities and independently stimulatesthe catalytic activity of PARP1. FEBS J. 2023, 290, 5098.

Broad Proposal Objectives	**View Broad Proposal Objectives (PDF)**

VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026049 **Human Heat Strain and Survivability under Extremely Hot Conditions: Integrated Thermoregulation and Climate Modelling**

Supervisor 1: **Ankush Kumar Jaiswal**
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Supervisor 2: **Chetankumar Jalihal**
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Abstract

Human beings are experiencing high heat exposure due to rise in the planetary temperature, which will get severely worse by 2050 (~ 4°C). Such extreme exposure can lead to heat stroke and even death. Thus, a detailed analysis of human heat strain under such extreme conditions will be performed to predict and reduce adverse effects of extreme heat exposure. Various mitigation strategies will also be investigated.

Keywords

Human Heat Stress, Human Thermoregulation Modelling, Climate Change, Heat Strain, and Heat Waves

Funding

MoE (Regular)

Background & Motivation

The rising temperature on the planet and frequent heat waves are creating unliveable conditions for survival of human beings and other animals. Our body maintains constant core body temperature through thermoregulation mechanism. When the body cannot release excess heat, it leads to heat storage and a rise in core temperature, which can result in heat exhaustion and, ultimately, heat stroke.

Essential Qualifications

B.E/B.Tech: Mechanical Engineering/ Chemical Engineering/ Energy Engineering/ Climate Science/Aerospace Engineering Or M.E./M.Tech: Mechanical Engineering/Thermal Engineering/Chemical Engineering/Energy Engineering/Climate Science/Biomedical Engineering or related disciplines with background in Thermal Sciences or M.Sc. (Applied Mathematics, Physics) or related disciplines with background in Thermal Sciences

Desirable Qualifications

Heat Transfer / Thermal Engineering, Thermodynamics and Fluid Mechanics, Human Thermoregulation, Computational Modelling (MATLAB/ CFD), / Climate Modelling

Key Publications (Last 3 Years)

1. A. K. Jaiswal, C. T. Jose, R. Ramesh, V. K. Nanani, K. Sadeghi, A. Joshi, K. Kompally, G. Pahikonda, H. N. Emady, B. Bheda, S. A. Kavouras, and K. Rykaczewski, 2024 "Microscale Imaging and Sweat Evaporation Rate Measurement using Wind Tunnel inspired Ventilated Capsule" iScience https://doi.org/10.1016/j.isci.2024.110304
2. A. Joshi, S. H. Viswanathan, A. K. Jaiswal, K. Sadeghi, L. Bartels, R. M. Jain, G. Pathikonda, J. K. Vanos, A. Middel, and K. Rykaczewski, 2024 "Characterization of human extreme heat exposure using an outdoor thermal manikin" Science of The Total Environment https://doi.org/10.1016/j.scitotenv.2024.171525
3. K. Rykaczewski, A. Joshi, S. H. Viswanathan, S. S. Guddanti, K. Sadeghi, M. Gupta, A. K. Jaiswal, K. Kompally, G. Pahikonda, R. Barlett, J. K. Vanos, A. Middel, 2024 "A frugal three-cylinder radiometer and low-speed anemometer for biometeorological characterization of human exposure to extreme heat" International Journal of Biometeorology https://doi.org/10.1007/s00484-024-02646-0
4. A. Joshi, L. Bartels, S. Viswanathan, D. Martinez, K. Sadeghi, A. K. Jaiswal, D. Collins, and K. Rykaczewski, 2023 "Evaluation of thermal properties and thermoregulatory impacts of lower back exosuit using thermal manikin" International Journal of Industrial Ergonomics https://doi.org/10.1016/j.ergon.2023.103517
5. C. Jalihal, U. Mikolajewicz 2025, “Energetics of monsoons and deserts: role of water vapor vs surface albedo feedbck” Earth System Dynamics preprint https://egusphere.copernicus.org/preprints/2025/egusphere-2025-1734/egusphere-2025-1734.pdf

Broad Proposal Objectives

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VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026050 A robust, control-theoretic framework for optimal enzyme allocation in genome-scale metabolic networks

Supervisor 1: **Dr. Abhishek Subramanian**
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Supervisor 2: **Dr. Vishal Sawant**
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Abstract

We propose a robust, control-theoretic framework for metabolic networks that - (i) computes optimal enzyme levels to obtain steady-state fluxes maximizing biomass and maintaining desired product; (ii) uses observer-based controller maintaining the network at optimal steady state under disturbances; (iii) ML clustering of stable steady states to obtain biologically feasibility.

Keywords

Metabolic engineering, optimal enzyme allocation, steady-state optimization, Luenberger observer, strain design

Funding

MoE (Regular)

Background & Motivation

Metabolic engineering relies largely on precise enzyme control for product optimization. However, protein overexpression may lead to growth defects, toxicity, impaired protein synthesis which may not be economically viable. Popular computational approaches for strain optimization neglect kinetics, partial enzyme controllability, robust enzyme identification or toxic accumulation identifying unrealistic flux states.

Essential Qualifications

UG or PG candidates in - Bioinformatics / Biotechnology / Bioengineering / Chemical engineering / Mathematics or Allied areas

Desirable Qualifications

Computational biology / Metabolic engineering / Control Systems / Non-linear dynamics

Key Publications (Last 3 Years)

1. Manjunatha Beduru Krishnamurthy, Harish P S, Abhishek Subramanian (2026), "NAViFluX: a visualization centric platform for interactive analysis, refinement and design of genome scale metabolic networks", bioRxiv, https://doi.org/10.64898/2026.01.03.697453 (under minor revision in Oxford Bioinformatics – IF: 5.4)
2. Mohite S, Devkate T, Kalaskar P, Singh P, Abhishek Subramanian, Joshi RJ (2025), "Trehalose metabolism regulates transcriptional control of muscle development in lepidopteran insects", eLife 15:RP109485, https://elifesciences.org/reviewed-preprints/109485
3. Abhishek Subramanian, Kurthkoti K, Mattioni Marchetti V and Vijay S (2025) Editorial: Bacterial population heterogeneity, stress response and antibiotic tolerance. Front. Cell. Infect. Microbiol. 15:1754314. https://doi.org/10.3389/fcimb.2025.1754314 (IF: 4.6)
4. Declercq M, Treps L, Geldhof V, Conchinha NV, Rooij LD, Abhishek Subramanian, Feyeux M, Cotinat M, Boeckx B, Vinckier S, Dupont L, Vermeulen F, Boon M, Proesmans M, Libbrecht L, Pirenne J, Monbaliu D, Jochmans I, Dewerchin M, Eelen G, Roskams T, Verleden S, Lambrechts D, Carmeliet P, Witters P (2024), "Single cell RNA sequencing of cystic fibrosis liver disease explants revealed alternative complement activation", Liver International, 44 (9), 2382-2395, https://doi.org/10.1111/liv.15963 (IF: 5.2)
5. Vishal Sawant and Rafal Wisniewski, “Evaluating the criticality of nodes in consensus networks under false data injection attack”, IEEE Control Systems Letters, https://doi.org/10.1109/LCSYS.2023.3257265, 2023 (Scopus Index, Impact Factor: 3.698)
6. Vishal Sawant and Rafal Wisniewski, “On the average controllability centrality of laplacian dynamics”, Indian Control Conference (ICC), Bhopal, India, https://doi.org/10.1109/ICC64753.2024.10883686, 2024.

Broad Proposal Objectives

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VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026051 **Hybrid Nanotheranostic Platforms for Precision Targeting and Image-Guided Therapy of Metastatic Abdominal Tumors**

Supervisor 1: **Dr. Aravind Kumar Rengan**
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Supervisor 2: **Prof. Prabusankar Ganesan**
Department: Chemistry
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Abstract

Metastatic abdominal tumors remain difficult to detect and treat due to poor targeting and therapeutic resistance. This project proposes the development of hybrid nanotheranostic platforms integrating diagnostic imaging and targeted therapy. By combining advanced nanomaterial engineering with molecular targeting strategies, the study aims to enhance tumor localization, therapeutic efficacy, and real-time treatment monitoring.

Keywords

Hybrid Nanotheranostics; Metastatic Tumors; Targeted Drug Delivery; Cancer Imaging; Nanomedicine;

Funding

MoE (Regular)

Background & Motivation

Metastatic abdominal cancers often exhibit poor prognosis due to delayed detection and limited therapeutic targeting. Hybrid nanotheranostic systems offer the potential to integrate imaging and therapy within a single platform, enabling precise tumor targeting and monitoring. Developing such multifunctional nanosystems could significantly improve treatment outcomes and advance translational cancer nanomedicine.

Essential Qualifications

M.Tech- Nanomedicine, Molecular Medicine, Biotechnology, M.Pharm or any other equivalent stream

Desirable Qualifications

Nanoparticle synthesis, Cell culture, animal handling, In-vivo studies

Key Publications (Last 3 Years)

1. Ravichandran, G.; Harijan, D.; Ganapathy, N.; Prabusankar, G.; De, A.;* Rengan, A. K.* The multifaceted role of degradable cobalt nanoparticles: Dual-target starvation and intracellular acidification engendering LC3-associated whole-cell autophagy. ACS Mater. Lett. 2023, 5 (10), 2726-2738.
2. Rai, R. K.; Putta, C. L.; Lahkar, B.; Rawat, A.; Sahu, A.; Matsumoto, K.; Tsutsumi, O.; Rengan, A. K.;* Prabusankar, G.* Selective Sensing of the Fluoride Ion in Water and B16F10 Cells by Naphthoimidazolium Salts. ACS Appl. Bio Mater. 2025, 8 (8), 6999-7010.
3. Thanekar, A. M.; Rai, R. K.; Putta, C. L.; Buddhiraju, H. S.; Prabusankar, G.;* Rengan, A. K.* Iohexol-Conjugated Polydopamine for Cancer Theranostics. ACS Appl. Polym. Mater. 2025, 7 (21), 14531-14540.
4. Dokkari Nagalaxmi Yadav, Sri Amrutha, ……..A.K.Rengan*, Bioinspired Gold coated Phage Nanosomes for Anti-Microbial and Anti-CancerTheranostics Material Today Nano 23(2023)2518. .
5. Revi, N.; Nandeshwar, M.; Harijan, D.; Sankaranarayanan, S. A.; Joshi, M.; Prabusankar, G.;* Rengan, A. K.* Acridine Benzimidazolium Derivatives Induced Protective Microglia Polarization and In Silico TDP-43 Interaction Potential Implications for Amyotrophic Lateral Sclerosis. ACS Chem. Neurosci. 2025, 16 (6), 1103-1116.

Broad Proposal Objectives

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VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026052 **Development of AI-based prognostic risk models and biomarker discovery for neurodegenerative disorders using radiomics, neurophysiological and multi-omics data**

Supervisor 1: **Neeraj Kumar**
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Supervisor 2: **Rahul Kumar**
Department: Biotechnology
Email: rahulk@bt.iith.ac.in

Abstract

Neurological disorders are one of the major disease burdens worldwide and need immediate theranostics interventions. Advancement in various technologies pertaining to brain pathophysiology provided a significant opportunity to delineate the disease mechanism. This project is based on leveraging these techniques to propel theranostics advancement for neurodegenerative disorders.

Keywords

AI, MRI, EEG, Neurodegeneration, Multi-omics

Funding

MoE (Regular)

Background & Motivation

Neurodegenerative disorders are complex and poorly understood in the Indian context and need a multimodal approach to develop theranostics. We aim to develop a catalogue based on the MRI and EEG dataset for AD and PD. Our goal is to develop AI tools to early prognosis, disease progression and delineating disease mechanisms.

Essential Qualifications

First class MTech/MSc in Bioinformatics, Computational Biology, Neuroscience, Cognitive Science, Data Science, AI/Computer Science, Mathematics

Desirable Qualifications

Bioinformatics, Neuroscience, Cognitive Science, Data Science, AI/Computer Science

Key Publications (Last 3 Years)

1. Kavita Kundal, Divya K Rani, Vinodini D., Neeraj Kumar, Rahul Kumar (2025). RadGLO: an interactive platform for radiomic feature analysis and prognostic modeling in glioma, npj Precision Oncology, 19, 323.
2. Kavita Kundal, K Venkateswara Rao, Sandeep Kumar Dhanda, Neeraj Kumar, Rahul Kumar (2025). Tumor location, genomic alterations, and radiomic features as predictors of survival in glioblastoma: a Multi-Modal analysis, Neuroradiology, 1432-1920.
3. Kavita Kundal, K Venkateswara Rao, Arunabha Majumdar, Neeraj Kumar, Rahul Kumar (2024). Comprehensive Benchmarking of CNN-Based Tumor Segmentation Methods Using Multimodal MRI Data, Computers in Biology and Medicine, 178, 108799.
4. Simran Sharma, Kavita Kundal, Ishsirjan Kaur Chandok, Neeraj Kumar, Rahul Kumar (2024). Radiomic based investigation of a potential link between precuneus and fusiform gyrus with Alzheimer's disease. medRxiv doi:https://doi.org/10.1101/2024.05.15.24307.
5. Avik Sengupta, Sushree Sangita Kar, Rahul Kumar (2025). Non-apoptotic regulated cell death based prognostic risk model for colorectal cancer using machine learning guided two-step framework, Briefings in Bioinformatics, 6, 26, bbaf639.

Broad Proposal Objectives

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VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026053 Uptake, translocation and bioaccumulation of microplastics in biological systems: In vitro and in vivo studies

Supervisor 1: **Prof. Renu John**
Department: Biomedical Engineering
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Supervisor 2: **Dr. Seetha N.**
Department: Civil Engineering
Email: seetha@ce.iith.ac.in

Abstract

Microplastics have been detected in water, air, soil, and food. This leads to their ingestion and bioaccumulation in humans. This study envisages to provide a comprehensive understanding of absorption, translocation, and quantitative accumulation of microplastics in biological systems through in vitro and in vivo experimental studies and toxicokinetic modeling.

Keywords

Microplastics, biosensing, toxicity, modeling

Funding

MoE (Regular)

Background & Motivation

Microplastics are ubiquitous in environment and have serious health consequences to humans and the ecosystem. Microplastics are detected in human organs and bloodstream, which induces oxidative stress, metabolic disruption, and neurotoxicity. Understanding the bioaccumulation and toxicity of microplastics in biological systems is essential to assess their impact on human health.

Essential Qualifications

BE/BTech in Biomedical/Chemical/Civil/Environmental/Mechanical/Materials engineering Or MSc in Physics/Chemistry/Biology or MSc/MTech in Nanoscience and Technology or ME/MTech in Biomedical/Chemical/Environmental/Water Resources/Mechanical/Materials Engineering

Desirable Qualifications

Previous experience in working with microplastics, biological systems, or fish/ imaging using light or electron microscopy/ developing physics-based models or numerical simulations

Key Publications (Last 3 Years)

1. Vijay, A., Mohandas, J.L., Dutta-Gupta, S. and John, R., 2024. Label-free detection and characterization of secondary microplastics from tea bags. Optical Engineering, 63(1), pp.013101-013101.
2. Vijay, A., Galande, A.S. and John, R., 2023, June. Low-cost portable lens less digital holographic microscope for studying anemic RBCs. In European Conference on Biomedical Optics (p. 1263016). Optica Publishing Group.
3. Galande, A.S., Gurram, H.P.R., Kamireddy, A.P., Venkatapuram, V.S., Hasan, Q. and John, R., 2022. Quantitative phase imaging of biological cells using lensless inline holographic microscopy through sparsity-assisted iterative phase retrieval algorithm. Journal of Applied Physics, 132(24).
4. Thattaramppilly, R.M., Seetha, N., 2026. Modeling pharmaceutical removal in membrane bioreactors using a novel inhibition kinetics-based biokinetic model. Journal of Water Process Engineering, 83, 109662.
5. Manik, R., Seetha, N., Deeksha, W. and Rajakumara, E., 2025. Cotransport of zinc oxide and titanium dioxide nanoparticle aggregates with bacteria in saturated porous media: A coupled experimental and modeling approach. Journal of Hazardous Materials, 139941.
6. Horta, M.J., Seetha, N., 2024. Experimental and mathematical investigation of cotransport of clay and microplastics in saturated porous media. Science of the Total Environment, 954.

Broad Proposal Objectives

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VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026054 Integrating Machine Learning and Multiscale Modeling to Advance Drug Targeting of Opioid Receptors

Supervisor 1: **Debasish Koner**
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Supervisor 2: **Himanshu Joshi**
Department: Biotechnology
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Abstract

This project integrates machine learning and multiscale molecular modeling to accelerate the discovery of peptide ligands targeting the μ-opioid receptor. By combining AI/ML, and QM/MM and molecular simulations, the study aims to design selective peptide therapeutics with improved safety, reducing adverse effects associated with conventional opioid analgesics.

Keywords

μ-opioid receptor, Molecular Modelling, Machine Learning, Drug Design

Funding

MoE (Regular)

Background & Motivation

Opioid receptors regulate pain signaling, yet current μ-opioid drugs cause severe side effects such as addiction and respiratory depression. Advances in cryo-EM, structural databases, and artificial intelligence enable new strategies for rational drug discovery. Integrating machine learning with multiscale simulations can reveal peptide-receptor interactions and guide the development of safer opioid therapeutics.

Essential Qualifications

MSc in Physics/Chemistry/Life Sciences or BTech/MTech in any Engineering Discipline

Desirable Qualifications

Experiences in computer programming, computational physics or computational chemistry

Key Publications (Last 3 Years)

1. Pandey, U.; Behara, S. M.; Sharma, S.; Patil, R. S.; Nambiar, S.; Koner, D.; Bhukya, H. DeePNAP: A Deep Learning Method to Predict Protein-Nucleic Acid Binding Affinity from Their Sequences J. Chem. Inf. Model. 64, 1806-1815 (2024)
2. Käser, S.; Koner, D.; Meuwly, M. Compact Kernel/Neural Network Representation for Accurate, Fast, and Global Reactive Molecular Potential Energy Surfaces PrecisionChem accepted, https://doi.org/10.1021/prechem.5c00074
3. Tuti, N , Khatua R. R., Yadav, S , Rathnam SSV, Jangra, J , Rath SN, Joshi, H , Khan FA, Roy, Targeting DNA termini with a small-molecule natural product analogue: a DNA end-binder (DEB) to augment DNA double-strand breaks, NAR, 53, 19, gkaf1027, (2025)
4. Raj, R; Jiang, Y; Jha, RK, Moresco, EMY, Joshi, H; Zhang, H; Beutler, B; Structural insights into GM4951 as a lipid droplet GTPase regulating hepatic lipid metabolism, Nat. Commun., 16, 11458 (2025)
5. Banerjee, A; Yadav, S; Vidwath, VS, Kalita, S; Agasti, SS; Joshi, H, Ganji, M; Proximity-Based Super-Resolution Imaging Enabled by DNA Base-Stacking Interactions, Small, 22, 3, e07139 (2026)

Broad Proposal Objectives

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VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026055 Designing bioinspired flavin-based module for specific cellular colocalization, sensing and bioimaging applications

Supervisor 1: **Dr. Ashutosh Kumar Mishra**
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Supervisor 2: **Prof. Anamika Bhargava**
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Abstract

A prerequisite for future advances in diagnostic tools is the development of novel chemical entities for the timely detection of biomarkers in subcellular spaces. Bioinspired design around flavin has scarcely been explored despite its intense emissive properties, biocompatibility etc. This project intends to harness its inherent properties for biomedical applications.

Keywords

Flavin, Bioimaging, cellular colocalization

Funding

MoE (Regular)

Background & Motivation

Specific Cellular colocalization and sensing of bioactive entities within cells remain challenging and require continuous effort to design and develop newer chemical entities that address the shortcomings of current probes. Naturally occurring "Flavin" inherit intense photophysical behaviour along with possibilities to fine tune the properties through subtle chemical modification, which this project intend to investigate.

Essential Qualifications

Master's in chemistry/pharmaceutical/biology

Desirable Qualifications

Synthetic skill with bio-background

Key Publications (Last 3 Years)

1. Flavin-based Probe for Real-Time Monitoring of Hypochlorous Acid Dynamics in Live Cells, Agrawal HG, Giri PS, Sahoo T, Rath S N*, Mishra, A. K.*; J. Mater. Chem. B. 2025, 13, 5109
2. Tuning the Flavin Core via Donor Appendage for Selective Subcellular Bioimaging and PDT Application, Agrawal HG, Khatun S, Rengan AK*, Mishra A. K. *; Chem. Eur. J., 2024;30(46):e202401483.
3. A Neutral Flavin–Triphenylamine Probe for Mitochondrial Bioimaging under Different Microenvironments. Agrawal HG, Giri PS, Meena P, Rath SN*, Mishra A. K*.; ACS Med. Chem. Lett., 2023; 14(12):1857-1862.
4. Rahman, G., Pramanik, A., Das, S., Anindya, R., Bhargava, A*. An LC-MS/MS Method for the Quantification of Doxorubicin Uptake in Zebrafish Larvae Breast Cancer Xenografts. J. Pharm. Biomed. Anal, 2026, 117230.
5. Neema Kumari, A. Bhargava*, S. N. Rath*, T-type calcium channel antagonist, TTA-A2 exhibits anti-cancer properties in 3D spheroids of A549, a lung adenocarcinoma cell line. Life Sci. 2020, 260:118291.

Broad Proposal Objectives View Broad Proposal Objectives (PDF)

VERTICAL: BIOENGINEERING & HEALTHCARE

IDPHD2026056 Quantitative Magnetic Resonance Imaging and Artificial-Intelligence-enabled radiotherapy planning

Supervisor 1: **Jaladhar Neelavalli**
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Supervisor 2: **Konda Reddy Mopuri**
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Abstract

MRI to CT image generation can play an important role in reducing radiation burden and shorten treatment times for cancer patients receiving radiotherapy. Optimal MR input image sets and deep neural network designs for accurate MRI CT image generation and dose planning are the key research topics in this project.

Keywords

MRI to CT prediction, radiotherapy planning, quantitative MRI, Deep Learning, Artificial intelligence, Generative Models, Image-to-Image translation

Funding

MoE (Regular)

Background & Motivation

Cancer burden in the subcontinent has been steadily increasing. Today, about 1 in 9 people in India are expected to face a cancer diagnosis within their lifetime. Radiotherapy treatment for cancer requires additional imaging investigations (MRI and CT) for planning treatment delivery. The goal of this project is to remove CT from this using AI.

Essential Qualifications

MSC or MTech in Biomedical Engineering or Medical Physics or Medical Electronics or AI

Desirable Qualifications

Exposure to radiation physics in biological tissue Exposure to Computed tomography (CT) and or Magnetic resonance imaging (MRI) Strong mathematical foundations (linear algebra, probability, optimization) and programming experience (Python preferably) Strong enthusiasm for applying AI to critical problems in healthcare

Key Publications (Last 3 Years)

1. Yadav BK, Buch S, Krishnamurthy U, Jella P, Hernandez-Andrade E, Trifan A, Yeo L, Hassan SS, Mark Haacke E, Romero R, Neelavalli J*. Quantitative susceptibility mapping in the human fetus to measure blood oxygenation in the superior sagittal sinus. Eur Radiol. 2019 Apr;29(4):2017-2026.
2. Krishnamurthy U, Yadav BK, Jella PK, Haacke EM, Hernandez-Andrade E, Mody S, Yeo L, Hassan SS, Romero R, Neelavalli J*. Quantitative Flow Imaging in Human Umbilical Vessels In Utero Using Nongated 2D Phase Contrast MRI. J Magn Reson Imaging. 2018 Jul;48(1):283-289.
3. Krishnamurthy U, Szalai G, Shen Y, Xu Z, Brijesh K Yadav, Tarca A.L., Chaiworapongsa T, Hernandez-Andrade E, Than N.G, Haacke E.M, Romero R, Neelavalli J*. Longitudinal changes in placental MRI relaxation parameter in murine pregnancy: compartmental analysis. Gynecol Obstet Invest. 2016;81(3):193-201. PMID: 26336923
4. Buch S, Liu S, Ye Y, Cheng YC, Neelavalli J, Haacke EM. Susceptibility mapping of air, bone, and calcium in the head. Magn Reson Med. 2015 Jun;73(6):2185-94. PMID: 25046134.
5. Liu S, Neelavalli J*, Cheng YC, Tang J, Mark Haacke E. Quantitative susceptibility mapping of small objects using volume constraints. Magn Reson Med. 2013 Mar 1;69(3):716-23. PMID: 22570268.
6. Naveen George, Karthik D., Rutheesh Ch., Konda Reddy Mopuri, "The Illusion of Unlearning: The Unstable Nature of Machine Unlearning in Text-to-Image Diffusion Models", IEEE CVF Conference on Computer Vision and Pattern Recognition (CVPR) 2025.
7. Harsh Rangwani, Konda Reddy Mopuri, R. Venkatesh Babu, Class Balancing GAN with a Classifier in the Loop, Uncertainty in Artificial Intelligence (UAI), 2021.

Broad Proposal Objectives

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VERTICAL: AI, COMPUTING, COMMUNICATIONS & NETWORKS

IDPHD2026057

Development of a Comprehensive Machine Learning Based Platform for Optimization, Reduction and Integration of Chemical Kinetic Mechanisms into LES and RANS based Turbulent CFD Codes

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Supervisor 2: **Dr. Kishalay Mitra**
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Abstract

Development of reduced chemical kinetic mechanisms is essential for integrating detailed fuel oxidation chemistry into CFD simulations of engines and combustors. This work explores machine learning–assisted mechanism reduction and optimization to efficiently model novel zero-carbon fuels, enabling accurate prediction of combustion behavior, emissions, and operational limits within RANS and LES turbulent combustion frameworks.

Keywords

Chemical kinetic mechanism reduction, Machine learning in combustion modeling, Surrogate modeling for combustion chemistry, Turbulent combustion CFD (RANS/LES), Zero-carbon fuel combustion modeling

Funding

MoE (Regular)

Background & Motivation

Accurate modeling of novel zero-carbon fuels in combustion systems requires integrating detailed chemical kinetic mechanisms into CFD simulations. However, large mechanisms impose prohibitive computational costs for turbulent combustion modeling. This motivates the development of efficient reduction and optimization strategies, where machine learning approaches offer scalable alternatives to classical methods for enabling practical high-fidelity simulations.

Essential Qualifications

1. B Tech/M Tech in Chem Engg / MAE Engg 2. Knowledge of Chem Reactions 3. Computational Background

Desirable Qualifications

1. Machine Learning 2. Chemical Kinetics of Combustion 3. Computational Fluid Dynamics

Key Publications (Last 3 Years)

1. Roy, S., Pal, R.K., Mathew, R.S., Banerjee, R., Mitra, K. and Banerjee, S., 2026. Reduction of detailed CH4/NH3/H2 combustion mechanism using ANN-based global sensitivity analysis. Fuel, 405, p.136644.

Broad Proposal Objectives

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VERTICAL: AI, COMPUTING, COMMUNICATIONS & NETWORKS

IDPHD2026058 Physics-Informed Neural Networks for solving Inhomogeneous wave equations

Supervisor 1: **Dr. P. K. Srijith**
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Abstract

Solving inhomogeneous wave equations (second-order partial differential equations) is a fundamental field of study with applications ranging from mobility to industrial and environmental sciences, for instance aircraft engine noise, car side mirror noise, valve noise. Traditional numerical solvers, such as Computational Fluid Dynamics (CFD) methods, including Finite Element Methods (FEM), Boundary Element Methods (BEM), and Finite Volume Methods (FVM), often require significant computational resources and struggle with high-dimensional or complex domains. Recent advancements in deep learning, particularly Physics-Informed Neural Networks (PINNs), provide an alternative approach to solving inhomogeneous wave equation problems by embedding physical laws associated with multi-domain systems directly into the learning process. This proposal outlines the development and application of PINNs for solving acoustic wave equations with source estimations from fluid and structural dynamics efficiently and accurately.

Keywords

Deep Learning, Physics-Informed Neural Networks (PINNs), Partial differential equations, Inhomogeneous wave equation.

Funding

MoE (Regular)

Background & Motivation

Physics-informed neural networks leverage both data and governing physical laws, such as the continuity equation and Navier-Stokes equations for aerodynamic sources and the equation of motion for structure-borne noise, to ensure physically consistent solutions. Unlike purely data-driven models, PINNs require fewer data points as they rely on differential equations to guide learning, making them advantageous in scenarios where data collection is expensive or limited. This helps to develop low-fidelity models into high-fidelity ones. Traditional CFD and FEM/BEM methods suffer from dimensionality and high computational costs, particularly for turbulent flows and unsteady simulations. PINNs offer a promising solution by using neural networks to approximate solutions to partial differential equations (PDEs) efficiently while incorporating physics-based constraints to improve generalizability and robustness. Solving the acoustic wave equation due to airborne noise sources creates a major challenge in scaling and order of magnitude while solving the equations simultaneously. This challenge needs to be addressed by leveraging transfer learning techniques as part of this research work.

Essential Qualifications

BE/B.Tech with valid GATE score in any discipline, ME/M.Tech with valid GATE score in any discipline

Desirable Qualifications

Programing in PyTorch, Tensorflow Deep learning models, Fluid Mechanics, Finite element modelling (FEM)

Key Publications (Last 3 Years)

1. A Majumdar, A Krishna, P. K. Srijith, Neural Wave Equations, International Conference on Learning Representations (ICLR), 2025.
2. S Anumasa, G Gunapati, P. K. Srijith, Continuous Depth Recurrent Neural Differential Equations, European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECML-PKDD), 2023.

3. Srinivas Anumasa and P. K. Srijith, Latent Time Neural Ordinary Differential Equations, Proceedings of the Association for the Advancement of Artificial Intelligence (AAAI), 2022.
4. Golla ST, Venkatesham B. Prediction of splash noise in a rectangular tank under longitudinal periodic excitation. Proceedings of the Institution of Mechanical Engineers, Part D. 2024;0(0). doi:10.1177/09544070241292853
5. Sree, N K Vijaya; Venkatesham, B. Optimization methods for acoustic material selection in interior spaces, INTER-NOISE and NOISE-CON Congress and Conference Proceedings, InterNoise23, Chiba, Japan, pages 1995-2994, pp. 2846-2856(11). Doi: 10.3397/IN_2023_0414

Broad Proposal Objectives	**View Broad Proposal Objectives (PDF)**

VERTICAL: AI, COMPUTING, COMMUNICATIONS & NETWORKS

IDPHD2026059 Unrolled deep learning based sparse solvers: Analysis and application to inverse problems in Tomography

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Supervisor 2: **Phanindra Varma Jampana**
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Abstract

The learned (or unrolled) algorithms map each step of an iterative method of an algorithm into a network layer. Combining a finite number of such layers creates a deep learned network. Unlike 'black-box' type neural networks, unrolled networks offer interpretability. Notwithstanding their applicability, the unrolled algorithms largely lack analytical justification. This proposal aims at designing and analyzing unrolled networks that are applicable to the inverse problems in X-ray CT and Impedance tomography.

Keywords

Unrolled neural networks, deep learning, Inverse problems

Funding

MoE (Regular)

Background & Motivation

Of late, viewing the steps of certain iterative processes as layers in neural networks has gained popularity. One reason for this popularity is due to their functioning as 'white boxes.' The inverse problems in X-ray CT and Electrical Impedance Tomography (EIT) often lead to large-scale systems possessing certain numerical instabilities. Unrolled deep learning techniques appear to offer some promises in designing stable inversion operators. Our preliminary work gave us some promising results. Motivated by this, the current proposal aims to delve deeper into analytical as well as application of deep learning.

Essential Qualifications

M.Sc (Mathematics or Computer Science)/M.Tech (Computer Science or AI or Chemical Engg with decent math background). B.Tech (ECE or Maths and Computing or Comp.Sc)

Desirable Qualifications

Candidate are expected to have done some advanced math courses, Good understanding of Machine Learning, Good coding skills.

Key Publications (Last 3 Years)

1. Akash Sen and C. S. Sastry, "Deep unrolled networks for nonnegative least squares problem: Analysis and application," To appear in IEEE Signal Processing Letters, 2026.
2. Koteswara Rao Kandukuri, Satya Someswara Sarma Velamuri, Mahesh M. Sucheendran, and Phanindra Jampana, Automated Estimation of Air Entrainment in Plunging Jet Flows Below Onset Velocity, To appear in Physics of Fluids.
3. S. Gulati and P.V. Jampana and C. S. Sastry, "Series solution and sensitivity analysis of central disc-shaped objects in electrical impedance tomography," Physica Scripta, IoP, Vol. 99, No. 11, 2024.
4. K. Z. Najiya and C. S. Sastry, "AdaTL1: An adaptive non-convex sparse solver with applications to CT reconstruction and image denoising, Inverse Problems, IoP, Vol. 40, No. 11, 2024.
5. K. Z. Najiya and C. S. Sastry, "Analysis of general weights in weighted l1-2- minimization through applications," Digital Signal Processing, Vol. 133, 3, 2023.

Broad Proposal Objectives

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VERTICAL: AI, COMPUTING, COMMUNICATIONS & NETWORKS

IDPHD2026060 Developing Neurosymbolic Framework for Interatomic Potentials: Bridging Machine Learning and Materials Physics for Interpretable Atomistic Models

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Abstract

Interatomic potentials enable large-scale atomistic simulations but are traditionally derived by manual analytical modeling or learned using opaque machine learning approaches. This project proposes a neurosymbolic framework that integrates neural representation learning with symbolic program synthesis to discover interpretable interatomic potentials directly from a material's atomic structure and first-principles potential-energy-surface data. The approach aims to augment the predictive accuracy of modern machine-learned potentials by adding interpretable analytical interaction models. The aim of the proposal is to develop a hierarchical, learnable, and practical neurosymbolic framework that can discover transferable interatomic potentials for complex systems.

Keywords

Machine learning Interatomic Potentials, Graph Neural Networks, Neurosymbolic Programming, Program Synthesis, First-principles Density Functional Theory Calculations

Funding

MoE (Regular)

Background & Motivation

Recent advances in machine learning interatomic potentials (MLIPs) have significantly improved predictive accuracy by learning potential energy surfaces directly from first-principles data. Graph neural networks and equivariant architectures can reproduce DFT energies and forces with high fidelity. Despite this progress, most MLIPs behave as black-box models with limited interpretability and inability to extrapolate to new elements. Physics-informed neural networks (PINN) incorporate known constraints, but generally require governing equations that are not explicitly known for complex many-body atomic interactions. In parallel, the Computer Science and AI community has developed Neurosymbolic programming (or Neurosymbolic learning), a paradigm that integrates neural learning with symbolic reasoning and program synthesis to discover structured models and analytical equations directly from data while incorporating domain knowledge and logical constraints. The advantages are multifold: it yields inherently interpretable representations, enables scalable learning in resource- and data-constrained domains, and provides critical guardrails that constrain the otherwise imprecise predictions (or "hallucinations") of purely neural approaches, ensuring physically meaningful outputs even during extrapolation. Despite rapid progress in both MLIPs and neurosymbolic learning, these research directions have largely evolved independently. A systematic framework for applying neurosymbolic programming to atomistic materials modeling is missing. Interatomic potentials are hierarchical, involving multiple steps or nested operations rather than a single mathematical expression. Therefore, symbolic reasoning and program synthesis is necessary for developing meaningful interpretable interaction models. Bridging this gap could enable automated discovery of interpretable interatomic potentials for various multi-component systems widely used in advanced engineering applications.

Essential Qualifications

(BSc + MSc) in Math/Physics or (BTech/MTech) in relevant any of the engineering disciplines (Computer Science/AI/DataScience/Electrical Engineering/MaterialsScience/Mechanical)

Desirable Qualifications

Linear algebra, Numerical computational methods, Probability and statistics, Programming and coding skills

Key Publications (Last 3 Years)	1. Patrick LaFontaine, Zhe Zhou, Ashish Mishra, Suresh Jagannathan, and Benjamin Delaware. We've got you covered: Type-guided repair of incomplete input generators. Proc. ACM Program. Lang., 9(OOPSLA2), October 2025. 2. Zhe Zhou, Ashish Mishra, Benjamin Delaware, and Suresh Jagannathan. Covering all the bases: Type-based verification of test input generators. Proc. ACM Program. Lang., 7(PLDI), June 2023. 3. Matthew D Witman, Anuj Goyal, Tadashi Ogitsu, Anthony H McDaniel, and Stephan Lany. Defect graph neural networks for materials discovery in high-temperature clean-energy applications. Nature Computational Science, 3(8):675–686, 2023. 4. Ashish Mishra. Cs 5770: Topics in neurosymbolic programming. Course Webpage, 2025. Indian Institute of Technology Hyderabad. 5. Saswata Bhattacharya and Anuj Goyal. Ms 5480: Machine learning and data analytics in materials science, Course Webpage 2026. Indian Institute of Technology Hyderabad.
Broad Proposal Objectives	**View Broad Proposal Objectives (PDF)**

VERTICAL: AI, COMPUTING, COMMUNICATIONS & NETWORKS

IDPHD2026061 Artificial Intelligence Assisted Smart Systems for Next-Generation Photonic Technologies

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Supervisor 2: **Dr. Nithyanandan Kanagaraj**
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Abstract
Artificial intelligence and machine learning are transforming the design, control, and optimization of complex photonic systems. This project aims to integrate AI/ML techniques with advanced laser and fiber-optic platforms to model nonlinear light–matter interactions, enable intelligent control of laser dynamics, and develop adaptive photonic technologies for next-generation communication, sensing, and high-power laser applications.

Keywords
Artificial Intelligence, Machine Learning, Photonic Technologies,

Funding
Project-funded PhD position

Background & Motivation

Modern photonic and laser systems exhibit complex nonlinear and spatio-temporal dynamics that are difficult to model and control using conventional approaches. Recent advances in artificial intelligence and machine learning provide powerful tools to learn underlying physical behavior from data, enabling predictive modeling, intelligent control, and optimized design of next-generation photonic technologies.

Essential Qualifications
Background in Computer Science, Electrical Engineering, Engineering Physics, Physics, Applied Physics, Instrumentation. Experience in AI/ML and photonics is desirable but not essential.

Desirable Qualifications
UG/PG in Computer Science, Electrical Engineering, Engineering Physics. M.Scs/M.Tech in pure and applied Physics

Key Publications (Last 3 Years)

1. KalmanNet-Based Single-Shot Phase Estimation and Control for Coherent Beam Combination, Dinesh Kumar, Khsuhboo Soni, Srijith P K, Nithyanandan, Under Review (Machine Intelligence)
2. Bidirectional Fourier-Enhanced Deep Operator Network for Spatio-Temporal Propagation in Multi-Mode Fibers (arXiv preprint arXiv:2512.15474)
3. Transformer Encoder–Decoder Framework for Nonlinear Pulse Evolution and Inverse Modeling DK Murugan, R Joseph, N Kanagaraj, Advanced Photonics Research 6 (11), 2500149

Broad Proposal Objectives — View Broad Proposal Objectives (PDF)

VERTICAL: AI, COMPUTING, COMMUNICATIONS & NETWORKS

IDPHD2026062 Decentralized Federated Learning for Health Care Management

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Supervisor 2: **Sumohana Channappayya**
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Abstract
The objective of this work is to design a decentralized federated learning framework that can operate efficiently in realistic distributed environments which can enable learning for health care management involving multiple hospitals. Some of the issues that we have to tackle in this setting are client heterogeneity, communication delays etc.

Keywords
Decentralized Federated Learning, Fault Tolerance, Distributed Machine Learning

Funding
MoE (Regular)

Background & Motivation

Machine learning is a subfield of artificial intelligence that focuses on developing algorithms, enabling computer systems to: (a) Learn knowledge and representations from data. (b) Make predictions or decisions based on the learned information. The motivation here is extend ML to federated setup for healthcare management by hospitals.

Essential Qualifications
Machine Learning, Good Programming and Debugging Skills

Desirable Qualifications
Programming Knowledge in C++, Knowledge of Distributed Systems

Key Publications (Last 3 Years)

1. "Fault-Tolerant Decentralized Distributed Asynchronous Federated Learning with Adaptive Termination Detection". Phani Sahasra Akkinepally, Manaswini Piduguralla, Sushant Joshi, Sathya Peri, Sandeep Kulkarni. International Conference on Distributed Computing and Intelligent Technology (ICDCIT) 2026.
2. "Efficient Scheduling of Smart Contract Transactions via Conflict Graph Coloring". Ankit Ravish, Yaron Hay, Manaswini Piduguralla, Rishabh Jain, Roy Friedman, Sathya Peri. PRDC 2025: 91-101
3. "Improving the Hu-Toueg Construction of a Byzantine Linearizable SWMR Register". Ajay D. Kshemkalyani, Manaswini Piduguralla, Sathya Peri, Anshuman Misra. SSS 2025: 359-375
4. "Fed-SMTDA: A Novel Framework for Federated Source-Free Multi-Target Domain Adaptation Using Feature Clustering and Adaptive Aggregation." CP Revanth, SS Channappayya, CK Mohan. 2025 International Joint Conference on Neural Networks (IJCNN), 1-8
5. "Training-free Adapter for Multi-Modal Image Matching for All-Day Visual Place Recognition." Anuradha Uggi, Sumohana Channappayya. ICASSP 2025-2025 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)

Broad Proposal Objectives

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