2024
INTERDISCIPLINARY DOCTORAL PROGRAM
PROJECT PROPOSALS

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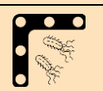
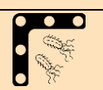
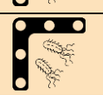
IDPHD2024043	Modeling and Experimental Studies on Warpage and Spring-in Behaviour of Hybrid Composite Structures	 
IDPHD2024044	Production of polymeric nanofibers from liquid jets using electric fields	 
IDPHD2024045	High Strain Rate Behaviour of Ultra High Performance Concrete under Tensile Loading	

PROPOSAL No. - IDPHD2024001

Title of the Proposal	**Artificial Intelligence and Machine Learning for HydroMeteorology**
Supervisor-1	Shruti Upadhyaya, *Civil Engineering*
Supervisor-2	Srijith P.K., *Computer Science and Engineering*
Email IDs	shrutiau@ce.iith.ac.in srijith@cse.iith.ac.in
Abstract	This proposal aims to utilize Artificial Intelligence (AI) techniques for enhancing hydrometeorological forecasting and modeling. It seeks to address challenges in prediction accuracy and uncertainty quantification in hydrometeorology through innovative AI algorithms.
Keywords	Artificial Intelligence, Machine Learning, Deep Learning, Computer Vision, HydroMeteorology, Forecasting, Uncertainty Quantification, Climate Modeling
Background and Motivation	HydroMeteorology plays a crucial role in managing water resources and mitigating natural disasters. However, traditional methods often struggle to accurately predict complex hydrological and meteorological phenomena. This proposal seeks to leverage AI to improve prediction accuracy and enhance resilience in water resource management and disaster preparedness.
Relevant publications	1. Sai Harsha Yelleni, Deepshikha Kumari, P.K. Srijith, Krishna Mohan C., Monte Carlo DropBlock for modeling uncertainty in object detection, Pattern Recognition, Volume 146, pp 110003, 2024. 2. M. Dubey, R. Palakkadavath, P.K. Srijith, Bayesian neural Hawkes process for event uncertainty prediction. International Journal of Data Science and Analytics, pp 1-15, 2023. 3. 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), pp 223-238, 2023. 4. Upadhyaya, S. A., Kirstetter, P. E., Kuligowski, R. J., & Searls, M. (2022). Exploring the Temporal Information from GEO Satellites for Estimating Precipitation with Convolutional Neural Networks. IEEE Geoscience and Remote Sensing Letters. 5. Upadhyaya, S.A., Kirstetter, P.-E., Kuligowski, R.J., Searls, M. (2021) Classifying precipitation from GEO Satellite Observations: Diagnostic Model. Quarterly Journal of the Royal Meteorological Society,1–17. 6. Upadhyaya, S.A., Kirstetter, P.-E., Kuligowski, R.J., Gourley, J.J. and Grams, H. (2021) Classifying precipitation from GEO Satellite Observations: Prognostic Model. Quarterly Journal of the Royal Meteorological Society.
Essential qualifications	NA
Desirable qualifications	Background in Data Analysis and Python programming, Basic AI/ML/DL tools such as Scikit-Learn//PyTorch, basic Hydrometeorology, and working experience with gridded/image datasets.
Broad proposal objectives	https://drive.google.com/open?id=16ihbMUfRzvhVV9lXt5w5TPHGIB968qki

PROPOSAL No. - IDPHD2024002

Title of the Proposal	**Development of Integrated Circuits for MEMS based IMUs**
Supervisor-1	Ashok Kumar Pandey, *Mechanical & Aerospace Engineering*
Supervisor-2	Gajendranath Chowdary, *Electrical Engineering*
Email IDs	ashok@mae.iith.ac.in gajendranath@ee.iith.ac.in
Abstract	Inertial Measurement Units (IMUs) are vital in navigation, robotics, and virtual reality, offering precise orientation, acceleration, and magnetic field measurements. This research aims to develop integrated circuits (ICs) for MEMS-based IMUs, focusing on miniaturization, power efficiency, and performance. The ICs will be designed, simulated, fabricated, and tested for accuracy, sensitivity, noise, and power consumption, with integration into a single IMU module evaluated for real-world applications, advancing IMU technology.
Keywords	Control Circuit, Closed Loop, IMU, MEMS
Background and Motivation	MEMS-based IMUs [1-3] have become increasingly popular due to their small size, low cost, and high reliability. Previous research has focused on individual sensor design and integration techniques. However, there is a need for further research in the development of integrated circuits that can improve the overall performance and integration of these sensors into compact IMU modules.
Relevant publications	None
Essential qualifications	Masters in Electrical Engineering/Mechanical Engineering with focus on controls and circuit designs.
Desirable qualifications	Masters in Electrical Engineering/Mechanical Engineering with focus on controls and circuit designs. Direct PhD for BTech (IIT) in Mechanical or Electrical Engineering
Broad proposal objectives	https://drive.google.com/open?id=1EOVYW5ZLugsw70P5N8Eiy0NLebhOEcIx

PROPOSAL No. - IDPHD2024003

Title of the Proposal	**Flexible Robotic Manipulation Planning for Grasping**
Supervisor-1	Rekha Raja, *Artificial Intelligence*
Supervisor-2	R Prasanth Kumar, *Mechanical & Aerospace Engineering*
Email IDs	rekha.raja@ai.iith.ac.in rpkumar@mae.iith.ac.in
Abstract	We propose cognitive robots with compliant mechanism-based grippers and sensors for real-time feedback, enhancing versatility in handling diverse object properties such as shape, size, weight, etc. Using machine learning for object recognition and adaptive grasp strategies to improve manipulation in complex environments, expanding applications in processing and packaging.
Keywords	Robot grasping, semantic knowledge, adaptive manipulation, pick and place.
Background and Motivation	Current robotic gripping technology excels with rigid objects but struggles in cluttered, dynamic environments. To improve this, we propose developing cognitive robots with compliant grippers and sensors for real-time feedback. By integrating machine learning, robots can adapt their grasp strategies, enhancing versatility for industries like processing and packaging.
Relevant publications	1. R. Raja*, A. K. Burusa, G. Kootstra, E. V. Henten, “Advanced Robotic System for Efficient Pick-and-Place of Deformable Poultry in Cluttered Bin: A Comprehensive Evaluation Approach”, IEEE Transactions on AgriFood Electronics, Feb 2024. [accepted] 2. R. Raja*, DC Slaughter, S Fennimore, MC Siemens, “Real-time control of high-resolution micro-jet sprayer integrated with machine vision for precision weed control”, Biosystems engineering, 2022. https://doi.org/10.1016/j.biosystemseng.2023.02.006 3. A P Hima Vamsi, Mangesh D Ratolikar and R Prasanth Kumar "Swinging Up and Balancing a Pendulum on a Vertically Moving Cart Using Reinforcement Learning," IEEE Robotics and Biomimetics 2021 4. 4. S. Bharadwaj, K. Gonabattula, S. Saha, C. Sarkar, & R. Raja, “Concurrent Transmission for Multi-Robot Coordination”, Robocom 2022 in conjunction with IEEE CCNC 2022. 5. R. Raja*, DC Slaughter, S Fennimore, MC Siemens, “Real-time control of high-resolution micro-jet sprayer integrated with machine vision for precision weed control”, Biosystems engineering, 2022. https://doi.org/10.1016/j.biosystemseng.2023.02.006
Essential qualifications	1. System thinking 2. Programming skills 3. Active learning 4. Mathematics 5. Complex problem solving
Desirable qualifications	1. Basic Robotics 2. Machine Learning 3. Computer Vision 4. Mechatronics 5. Automation
Broad proposal objectives	https://drive.google.com/open?id=1PoUpSHRGF-fHxfgU05o5LQ5OB0fqtSaV

PROPOSAL No. - IDPHD2024004

Title of the Proposal	**Integrative Density Functional Theory and Machine Learning Approach for Designing Two Dimensional Layered Materials in Therapeutics**
Supervisor-1	Arup Mahata, *Chemistry*
Supervisor-2	G. Narahari Sastry, *Biotechnology*
Email IDs	arup@chy.iith.ac.in gnsastry@bt.iith.ac.in
Abstract	The emergence of 2D layered materials has emerged as a promising but poorly explored for innovative applications in biomedicine, particularly in targeted drug delivery and bioimaging. This proposal aims to explore the potential of ML algorithms combined with DFT methods to enhance the therapeutic efficacy of 2D layered materials.
Keywords	2D layered materials, Density Functional Theory, Machine Learning, Therapeutics
Background and Motivation	The emergence of the fourth scientific discovery paradigm marks a transformative shift propelled by advancements in technology, data-intensive methodologies, and interdisciplinary collaboration. The emergence of 2D materials in the therapeutic area is driven by their unique properties which offer promising applications in biomedical fields such as drug delivery, bioimaging, and tissue engineering.
Relevant publications	1. Nandan Kumar, Himakshi Sarma, G Narahari Sastry, Repurposing of approved drug molecules for viral infectious diseases: a molecular modelling approach, Journal of Biomolecular Structure and Dynamics, 40, 2022, 8056-8072. 2. Bitopan Mazumdar, Pankaj Kumar Deva Sarma, Hridoy Jyoti Mahanta, G. Narahari Sastry, Machine learning based dynamic consensus model for predicting blood-brain barrier permeability, Computers in Biology and Medicine, 160, 2023, 106984 3. Lijo John, Hridoy Jyoti Mahanta, Y. Soujanya, G. Narahari Sastry, Assessing machine learning approaches for predicting failures of investigational drug candidates during clinical trials, Computers in Biology and Medicine, 153, 2023, 106494 4. C. Coccia, M. Morana, Arup Mahata,* W. Kaiser, M. Moroni, B. Albini, P. Galinetto, G. Folpini, C. Milanese, A. Porta, E. Mosconi, A. Petrozza, F. De Angelis, L. Malavasi, Ligand-Induced Chirality in ClMBA2SnI4 2D Perovskite, Angew. Chem. Int. Ed., 63, 2024, e202318557. 5. Arup Mahata,* E. Mosconi, D. Meggiolaro, S. Fantacci, F. De Angelis, Rationalizing Electron–Phonon Interactions and HotCarriers Cooling in 2D to 3D Metal Halide Perovskites, Adv. Energy Mater., 2024, DOI: 10.1002/aenm.202303405.
Essential qualifications	MSc in Chemistry/Biotechnology
Desirable qualifications	Background in basic programming languages (e.g. Python)
Broad proposal objectives	https://drive.google.com/open?id=1GtTHrLBwFChd8-YNnEd_I_dZzfE2z3Dz

PROPOSAL No. - IDPHD2024005

Title of the Proposal	**Learn to Fly: Developing a test platform that aids an ornithopter to learn fly.**
Supervisor-1	Vishnu R Unni, *Mechanical & Aerospace Engineering*
Supervisor-2	Nithyanandan Kanagaraj , *Physics*
Email IDs	vishnu.runni@mae.iith.ac.in nithyan@phy.iith.ac.in
Abstract	Ornithopters have better flight performance at small length scales (~1-15 cm) than drones of multi-rotor configuration. Furthermore, they have vertical takeoff and landing capabilities and high maneuverability. In this project, we will develop experimental and theoretical machinery to develop control strategies to enable the autonomous fight of ornithopters (scale: 1 cm to 15 cm wing span, 1-20 g weight).
Keywords	Flight Control, Machine Learning, Fluid-structure Interaction,
Background and Motivation	A flapping wing flier is highly maneuverable. However, this also means the flight lacks stability and warrants a comprehensive control system. We propose to develop a testing platform and a machine learning algorithm that would help develop an autonomous control system for an ornithopter that enables different modes of control under different flight conditions.
Relevant publications	1. Bagchi, S., Unni, V. R., & Saha, A. (2023). Transition to Limit-Cycle Oscillation in Fluid-Structure Interactions: Mutual Correlations and Causal Dependencies. AIAA Journal, 61(4), 1475-1484. 2. Liu, Z., Unni, V. R., Chaudhuri, S., Sui, R., Law, C. K., & Saha, A. (2021). Self-turbulization in cellularly unstable laminar flames. Journal of Fluid Mechanics, 917, A53. 3. Saha, A., Unni, V. R., Ruiz, E. A., Sujith, R. I., & Dhadphale, J. (2021): “Device and method to predict onset of oscillatory instability in systems with turbulent flows”, United States Provisional Patent Application Number: 63052867 4. Triki, H., Jose, A. & Nithyanandan, K. (2022). Chirped self-similar localized pulses on a continuous wave background in presence of cubic–quintic nonlinearity and self-frequency shift, Optik 270, 169876 5. Tchepemen N., Balasubramanian S., Kanagaraj N. & Kengne E., Modulational instability in a coupled nonlocal media with cubic, quintic and septimal nonlinearities, Nonlinear Dynamics 111 (21), 20311-20329
Essential qualifications	Masters or Bachelors in Aerospace Engineering, Mechanical Engineering, or Physics. Comfortable with mathematics.
Desirable qualifications	Background in Fluid Dynamics, Machine Learning, and Image Analysis. Have experience performing experiments.
Broad proposal objectives	https://drive.google.com/open?id=1TnqMh1XAGjIoFgO-uZG2LCZThh9ODWRh

PROPOSAL No. - IDPHD2024006

Title of the Proposal	**Synthesizing Computational Fluid Dynamics, High-Performance Computing and Machine-Learning for Wind Power Forecasting on Complex Terrain**
Supervisor-1	Niranjan S Ghaisas, *Mechanical & Aerospace Engineering*
Supervisor-2	Sathya Peri, *Computer Science and Engineering*
Email IDs	nghaisas@mae.iith.ac.in sathya_p@cse.iith.ac.in
Abstract	This project combines computational fluid dynamics (CFD) simulations of wind-farms, high-performance computing (HPC), and machine-learning techniques to develop wind-power forecasting tools that are of immense use to the wind industry. The student will gain experience in CPU/GPU parallel computing, turbulence simulations, handling large datasets, and developing machine-learning algorithms.
Keywords	Computational Fluid Dynamics, Wind Energy, High-Performance Computing, Machine Learning
Background and Motivation	Accurately forecasting the power generated by wind-farms over a 48-hour (day-ahead) window is critical for the growth of the wind energy sector. This is challenging because the time-frame is too large for statistical methods and too small for physics-based simulations. A synergistic combination of CFD/HPC/ML will be explored.
Relevant publications	1. 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 2. N. N. Kethavath, K. Mondal, N. S. Ghaisas, "Large-eddy simulation and analytical modelling study of the wake of a wind turbine behind an abrupt rough-to-smooth surface roughness transition", Physics of Fluids, 34, 125117, 2022, doi: 10.1063/5.0129022 3. N. S. Ghaisas, A. S. Ghate, S. K. Lele, "Effect of tip spacing, thrust coefficient and turbine spacing in multi-rotor wind turbines and farms", Wind Energy Science, 5, 51 - 72, 2020, doi: 10.5194/wes-5-51-2020 4. H. Eedi, S. Karra, S. Peri, N. Ranabothu, R. Utkoor, “An Improved/Optimized Practical Non-Blocking PageRank Algorithm for Massive Graphs”, International Journal of Parallel Programming 50 (3-4), 381-404, 2022. 5. Manaswini P, Saheli C, Anjana PS, and S Peri. “DAG-based Efficient Parallel Scheduler for Blockchains: Hyperledger Sawtooth as a Case Study”. In the 29th International European Conference on Parallel and Distributed Computing (Europar) 2023, Limassol, Cyprus.
Essential qualifications	BE/BTech/ME/MTech in Mechanical Engineering, Computer Science & Engineering, or affiliated areas. Experience or interest in C/Fortran/Matlab/Python programming.
Desirable qualifications	Experience in one or more of Computational Fluid Dynamics, Turbulence Simulations, Distributed-memory Parallel Computing, Machine Learning
Broad proposal objectives	https://drive.google.com/open?id=1SZL9Y43drcVDPJmELr-RUiifxyKCviR_

PROPOSAL No. - IDPHD2024007

Title of the Proposal	**Machine learning informed uncertainty-aware optimization for crashworthiness**
Supervisor-1	Biswarup Bhattacharyya, *Civil Engineering*
Supervisor-2	Prabhat Kumar, *Mechanical & Aerospace Engineering*
Email IDs	biswarup@ce.iith.ac.in pkumar@mae.iith.ac.in
Abstract	The main objective is design optimization, which considers uncertainty for crashworthiness. The uncertainty in the system will be propagated using advanced machine learning technology. The optimization will include different safety aspects of a vehicle for crash scenarios. A sensitivity analysis will also be conducted on the design variables.
Keywords	Machine learning, uncertainty, optimization, crashworthiness, sensitivity analysis
Background and Motivation	The socioeconomic load has attracted our attention to road and vehicle safety. The crashworthiness design of automobiles/vehicles has shown efficacy, which can avoid fatalities by up to 43%. To enhance safety criteria, the uncertainty associated with a crash should be considered. The proposed work is motivated by all these aspects.
Relevant publications	1. Bhattacharyya, B., Jacquelin, E. and Brizard, D. (2022), “Stochastic analysis of a crash box under impact loading by an adaptive POD-PCE model", Structural and Multidisciplinary Optimization, 65: 229, pp. 1-26. 2. Bhattacharyya, B., Jacquelin, E. and Brizard, D. (2020), “Uncertainty quantification of stochastic impact dynamic oscillator using a proper orthogonal decomposition-polynomial chaos expansion technique”, Journal of Vibration and Acoustics, Vol. 142, No. 6, pp. 1-13. 3. Bhattacharyya, B. (2020), “Global sensitivity analysis: A Bayesian learning based polynomial chaos approach”, Journal of Computational Physics, Vol. 415, 109539, pp. 1-22. 4. Kumar, P. and Langelaar, M. (2021), "On topology optimization of design-dependent pressure-loaded three-dimensional structures and compliant mechanisms", International Journal for Numerical Methods in Engineering 122 (9), 2205-2220. 5. Kumar, P. (2022), "Topology optimization of stiff structures under self-weight for given volume using a smooth Heaviside function", Structural and Multidisciplinary Optimization 65 (4), 128.
Essential qualifications	M.Tech in Civil Engineering (Structural Engineering) or Mechanical Engineering or Applied Mechanics or Aerospace Engineering, Knowledge of finite element methods and computing.
Desirable qualifications	Matlab/Python, ANSYS/Abaqus, Machine learning.
Broad proposal objectives	https://drive.google.com/open?id=1cit-G41TPkAm_0gmFfD22JlsFEbf4fBN

PROPOSAL No. - IDPHD2024008

Title of the Proposal	**Beyond the Screen: Assessing Extended Reality Content and User Experience**
Supervisor-1	Abhinav Kumar, *Electrical Engineering*
Supervisor-2	Prasad Onkar, *Design*
Email IDs	abhinavkumar@ee.iith.ac.in psonkar@des.iith.ac.in
Abstract	Extended Reality (XR) demands robust quality assessment methods and user-centric studies for advancement. This research aims to develop such methods by collecting diverse content, exploring design aspects, and analysing user feedback, with the goal of enhancing XR technology using data-driven approaches.
Keywords	Deep Learning (DL), Extended Reality (XR), Machine Learning (ML), Quality Assessment (QA)
Background and Motivation	Extended Reality (XR) offers immersive experiences through Head Mounted Displays, utilized in medicine and entertainment. Assessing content quality and user experience is crucial for smooth technology operation. Quality assessment methods from Image and Video domains are being extended to XR, necessitating novel methodologies. Latency and user experience metrics pose additional challenges, urging further research for display and content quality enhancement.
Relevant publications	1. N. Eswara, S. Chakraborty, H. P. Sethuram, K. Kuchi, A. Kumar, and S. S. Channappayya, "Perceptual QoE-optimal Resource Allocation for Adaptive Video Streaming," IEEE Transactions on Broadcasting, vol. 66, no. 2, pp. 346-358, June 2020, doi: 10.1109/TBC.2019.2954064. 2. N. Eswara, Manasa K., A. Kommineni, S. Chakraborty, H. P. Sethuram, K. Kuchi, A. Kumar, and S. S. Channappayya, "A Continuous QoE Evaluation Framework for Video Streaming over HTTP," IEEE Transactions on Circuits and Systems for Video Technology, vol. 28, no. 11, pp. 3236-3250, Nov. 2018, doi: 10.1109/TCSVT.2017.2742601. 3. N. Eswara, Manasa K., A. Kommineni, S. Chakraborty, H. P. Sethuram, K. Kuchi, A. Kumar, and S. S. Channappayya, "A Continuous QoE Evaluation Framework for Video Streaming over HTTP," IEEE Transactions on Circuits and Systems for Video Technology, vol. 28, no. 11, pp. 3236-3250, Nov. 2018, doi: 10.1109/TCSVT.2017.2742601.
Essential qualifications	Machine Learning, Computer Science, Electronics and Communication, Signal Processing
Desirable qualifications	BTech in Electronics and communication, Computer Science and Engineering, artificial intelligence or equivalent with or without MTech in artificial intelligence, signal processing, networking, or communication and signal processing
Broad proposal objectives	https://drive.google.com/open?id=19yrOQ002-Fg0OQdVQrDty6nPql5-MEDf

PROPOSAL No. - IDPHD2024009

Title of the Proposal	**Development of 2D material heterostructures based Magnetic Random Access Memory**
Supervisor-1	Shubhadeep Bhattacharjee, *Electrical Engineering*
Supervisor-2	Chandrasekhar Murapaka, *Materials Science and Metallurgical Engineering*
Email IDs	shubhadeep@ee.iith.ac.in mchandrasekhar@msme.iith.ac.in
Abstract	Despite two decades of development, material research has yielded limited optimal combinations, notably CoFeB/MgO, with no viable alternatives identified thus far. In recent years, a wide array of novel emerging two-dimensional materials (2DMs) and heterostructures have shown promise in addressing these challenges. This Ph.D. project aims to investigate the fundamental properties of atomically smooth interfaces, reduced material intermixing, crystal symmetries, and proximity effects to achieve disruptive enhancements in MRAM technology. The student will develop a transfer stage to facilitate the deterministic fabrication of 2D heterostructures. Subsequently, by assembling various 2D material heterostructures, we will assess their effectiveness in constructing synthetic antiferromagnetic (SAFs) layers to achieve high perpendicular magnetic anisotropy (PMA). Finally, we will fabricate devices in our cleanroom using the screened heterostructures to realize STT/SOT MRAM devices and quantify the tunnel magnetoresistance (TMR) ratios.
Keywords	2D heterostructures, Magnetic Random Access Memory, ferromagnetism, tunnel magnetoresistance
Background and Motivation	The rising power consumption in modern-day CMOS von-Neumann computing is a serious issue for environmental sustainability. Therefore there is an urgent need to explore novel CMOS-compatible electronic devices to support beyond von Neumann architectures such as neuromorphic and quantum computing. Non-volatile magnetic random-access memories, such as current-driven spin-transfer torque (STT) MRAMs and next-generation spin-orbit torque (SOT) MRAMs, play a crucial role in enabling low-power technologies not only for conventional memory but also for beyond von Neumann computing architectures. Though MRAM is already in production for niche applications, full-scale commercialization is hindered by several significant device and materials challenges, including scalability, thermal stability (endurance/reliability), and write speed/power consumption.
Relevant publications	1. Effect of seed layer thickness on the Ta crystalline phase and spin Hall angle K Sriram, J Pala, B Paikaray, A Haldar, C Murapaka Nanoscale 13 (47), 19985-19992 2. Analog and digital phase modulation and signal transmission with spin-torque nano-oscillators A Litvinenko, P Sethi, C Murapaka, A Jenkins, V Cros, P Bortolotti, ... Physical Review Applied 16 (2), 024048 3. Voltage-controlled magnetic anisotropy gradient-driven skyrmion-based half-adder and full-adder S Sara, C Murapaka, A Haldar Nanoscale 16 (4), 1843-1852 4. Interfacial ferroelectricity in marginally twisted 2D semiconductors A Weston, EG Castanon, V Enaldiev, F Ferreira, S Bhattacharjee, S Xu, ... Nature nanotechnology 17 (4), 390-395 5. Insights into Multilevel Resistive Switching in Monolayer MoS2 S Bhattacharjee, E Caruso, N McEvoy, C Ó Coileáin, K O'Neill, L Ansari, ... ACS applied materials & interfaces 12 (5), 6022-6029 6. Emulating synaptic response in n- and p-channel MoS2 transistors by utilizing charge trapping dynamics S Bhattacharjee, R Wigchering, HG Manning, JJ Boland, PK Hurley Scientific reports 10 (1), 12178
Essential qualifications	Mtech/MSc./BTech in ECE, Materials, Physics, Nanotechnology
Desirable qualifications	Hands on experience with device materials growth synthesis or device fabrication
Broad proposal objectives	https://drive.google.com/open?id=1js61cIIe1YblC7seSwkl8MQ4WOnPBPIq

PROPOSAL No. - IDPHD2024010

Title of the Proposal	**Investigation of Disruptions in Biological Clock, Sleep, and Cognitive Functions in Alzheimer's Disease for Novel Theranostic Implications**
Supervisor-1	Sandipan Ray, *Biotechnology*
Supervisor-2	Neeraj Kumar, *Liberal Arts*
Email IDs	sandipan.ray@bt.iith.ac.in neeraj.kumar@la.iith.ac.in
Abstract	Here we aim to understand whether our body clocks and sleep patterns are disrupted in Alzheimer's Disease (AD) and if such alterations can be used for early diagnosis, prognosis, and therapeutic interventions. We will also evaluate if the impairment of cognitive functions in AD patients matches well with clock dysfunctions.
Keywords	Alzheimer's Disease, Circadian rhythms, Sleep, Cognition, Neuropharmacology
Background and Motivation	AD is the most frequent cause of dementia and is a rising global health concern with devastating societal impacts. The central motivation of this project is to develop a novel theranostic approach for AD through understanding the alterations in daily rhythms, sleep, and cognitive functions in AD patients.
Relevant publications	1. Bhatnagar A, Murray G, Ray S*. Circadian biology to advance therapeutics for mood disorders. Trends Pharmacol Sci. 2023, 44(10), 689-704. [Impact Factor: 13.8] 2. Ray S, Valekunja UK, Stangherlin A, Howell SA, et al., Reddy AB*. Circadian rhythms in the absence of the clock gene Bmal1. Science 2020, 367(6479), 800-806 [Featured in Science. 2020, 367(6479), 740-741]. [Impact Factor: 63.71] 3. Ch R, Rey G, Ray S, Jha P, et al., Reddy AB*. Rhythmic glucose metabolism regulates the redox circadian clockwork in human red blood cells. Nature Communication 2021, 12, 377. [Impact Factor: 17.69] 4. Kumar N, Sidarta A, Smith C, Ostry DJ*. Ventrolateral Prefrontal Cortex Contributes to Human Motor Learning. Eneuro 2022, 9(5). [Impact Factor: 4.36] 5. Kumar N, van Vugt FT, Ostry DJ*. Recognition memory for human motor learning. Current Biology 2021, 31(8), 1678-1686. [Impact Factor: 10.9]
Essential qualifications	MSc/MTech in any area of Life Sciences or Biology
Desirable qualifications	Molecular biology techniques, Neurobiology, Programming languages (R or Python)
Broad proposal objectives	https://drive.google.com/open?id=1zLOqjaabCFp778aOePejsFB8o53VstY9

PROPOSAL No. - IDPHD2024011

Title of the Proposal	**A covalent-ligand binding approach for targeting the 'undruggable' oncoprotein Myc with metallodrugs**
Supervisor-1	Anindya Roy, *Biotechnology*
Supervisor-2	Somnath Maji, *Chemistry*
Email IDs	anindya@bt.iith.ac.in smaji@chy.iith.ac.in
Abstract	The oncogene Myc, frequently amplified in human cancers, poses challenges for direct targeting due to its intrinsically disordered structure. This study proposes a strategy utilizing covalent ligands, specifically targeting a Myc-specific cysteine residue, synthesis and in vitro screening of cysteine-reactive ligands with an aim to identify a novel potentially Myc-inactivating DNA cleaving compound.
Keywords	Cancer, metallodrug, Myc, DNA cleavage
Background and Motivation	The oncogene myc, highly amplified in human cancers, encodes a transcription factor critical for cell proliferation, anabolic pathways, and survival. Despite its significance, the intrinsically disordered nature of Myc has hindered direct targeting, rendering it 'undruggable,'. The proposal aims to disrupt Myc-Max complex formation, yielding a Myc-inactivating compound capable of DNA cleavage.
Relevant publications	1. Chromophore appended DPA-based copper(ii) complexes with a diimine motif towards DNA binding and fragmentation studies. S. Mathur, K. S. Karumban, A. Muley, N. Tuti, U. P. Shaji, I. Roy, A. Verma, M. K. Kumawat, A. Roy, S. Maji Dalton Trans., 2024, 53, 1163-1177. 2. Mononuclear cobalt(II) complexes with Polypyridyl Ligands: Synthesis, Characterization, DNA interactions and in vitro cytotoxicity towards human cancer cells K. S. Karumban, R. Raut, P. Gupta, A. Muley, B. Giri, S. Kumbhakar, A. Misra, S. Maji J. Inorg. Biochem., 2022, 233, 111866 3. Symmetrical and un-symmetrical curcumin analogues as selective COX-1 and COX-2 inhibitor. Mohan M, Hussain MA, Khan FA, Anindya R., Eur J Pharm Sci. (2021);160:105743. 4. Oxidative demethylase ALKBH5 repairs DNA alkylation damage and protects against alkylation-induced toxicity. Akula D, O'Connor TR, Anindya R. Biochem Biophys Res Commun. (2021) 534:114-120. 5. Synthesis and antibacterial activities of marine natural product Ianthelliformisamines and subereamine synthetic analogues. Narayan Khadake S, Karamathulla S, Kumar Jena T, Monisha M, Kumar Tuti N, Ahmed Khan F, Anindya R. Bioorg Med Chem Lett. (2021) 39:127883.
Essential qualifications	Biochemistry, Pharmacology, Molecular Biology, Organic chemistry
Desirable qualifications	Bioinformatics, structural biology
Broad proposal objectives	https://drive.google.com/open?id=1r8Mjypf_rkTGWaAUJisTXe3zvaRBocmk

PROPOSAL No. - IDPHD2024012

Title of the Proposal	**Multiphyics & Multiphase Fluid Flow in Biomechanics: Slurry flow in a Complex Geometry with an Application in GUT-Motility**
Supervisor-1	Saptarshi Majumdar, *Chemical Engineering*
Supervisor-2	Raja Banerjee, *Mechanical & Aerospace Engineering*
Email IDs	saptarshi@che.iith.ac.in rajabanerjee@mae.iith.ac.in
Abstract	This research work aims to numerically solve multiphase slurry flow in a complex geometry. The immediate application is in the GUT-motility, where food residues will pass through the large intestine through varying boundary conditions before taking exit from the body. This has tremendous implications for understanding of the digestion process and subsequent pathological consequences.
Keywords	CFD, Multiphase, Complex Geometry, Non-Newtonian Fluid Mechanics, Biomechanics
Background and Motivation	GUT movement/motility is not only linked with the issues of contractions or expansions of related muscles, but also with the slurry conditions. The fluid (precisely slurry) dynamics is mostly uncharted area of research in a realistic environment. This effort tries to frame a CFD problem, where the passage & muscles will act as a soft geometry tubing carrying slurry.
Relevant publications	1. Goel H., Chandran P. R., Mitra K., Majumdar S., Ray P. (2014), Estimation of Interfacial Tension for Miscible and Partially Miscible Liquid Systems by Dissipative Particle Dynamics, Chemical Physics Letters, Vol. 600, Page 62-67. 2. Mitra S., Pasupalak A., Majumdar S., Bandyopadhyay D. (2020) A computational study on osmotic chemotaxis of a reactive Janusbot, Physics of Fluids, 32, Page 112018 3. Kant, K. & Banerjee, R. Effect of density ratios on droplet breakup for Newtonian and power-law fluids. Int. J. Multiphase Flow 167, 104561 (2023) 4. Kant, K. & Banerjee, R. Study of the secondary droplet breakup mechanism and regime map of Newtonian and power law fluids at high liquid–gas density ratio. Phys. Fluids 34, 43108 (2022) 5. M. Kumar, R. Reddy, R. Banerjee, and N. Mangadoddy, Effect of particle concentration on turbulent modulation inside hydrocyclone using coupled MPPIC-VOF method, Sep. Purif. Technol. 266, 118206 (2021)
Essential qualifications	M.Tech in Mechanical/Chemical/Biomedical Engineering with the basic background of CFD.
Desirable qualifications	With thesis topic in CFD/Multiphase Flow
Broad proposal objectives	https://drive.google.com/open?id=1tRdIABBUWU9l78jO3Lgb13C-IVTSj1DL

PROPOSAL No. - IDPHD2024013

Title of the Proposal	**Hypoxia in Cancer-on-a-chip: Transcriptomic variations with various hypoxia levels in breast cancer stem cells for drug resistance**
Supervisor-1	Gunjan Mehta, *Biotechnology*
Supervisor-2	Subha Narayan Rath, *Biomedical Engineering*
Email IDs	gunjanmehta@bt.iith.ac.in subharath@bme.iith.ac.in
Abstract	Cancer breast is very common in India and lead to high morbidity and mortality rates. The cancer stem cells associated with the cancer lead to this high recurrent rate. Hypoxic cores lead to highly resistant cells and the gene expression and pathways associated with hypoxia make the cancer cells highly resistant to chemotherapy. All the detailed factors are not completely understood as scientists culture cells in normal oxygen levels and test the drugs while cancer tissue have variegated levels of necrosis and hypoxic cores. To understand this factor we try to make a cancer-on-a-chip device with varied hypoxic levels. They will be tested with drugs with RNA collection at different hypoxic levels. This might make us understand the chemotherapy regimens or other agents to make the cancer tissue susceptible for remission.
Keywords	Hypoxia, cancer-on-a-chip, breast cancer, personalized medicine, transcriptomic analysis
Background and Motivation	Hypoxia plays a crucial role in cancer biology which is not easy to replicate in the in vitro models. A microfluidic device with cancer stem cells can be used to make a hypoxic cancer-on-a-chip device. With proper imaging and transcriptomic analysis, the cancer biology can be understood with respect to cancer cell proliferation and metastasis. We have developed a patented cancer-on-a-chip device to understand the sequential hypoxic levels and the effect of chemotherapeutic agents on survival and apoptosis of the cancer stem cells.
Relevant publications	1. Das A, Kapoor A, Mehta GD, Ghosh SK, Sen S. Extracellular Matrix Density Regulates Extracellular Proteolysis via Modulation of Cellular Contractility. Journal of Carcinogenesis and Mutagenesis 2013; S13:003. doi: 10.4172/2157-2518.S13-003. https://www.omicsonline.org/extracellular-matrix-density-regulates-extracellular-proteolysis-via-modulation-of-cellular-contractility-2157-2518.S13-003.php?aid=14010 2. Podh NK, Paliwal S, Dey P, Das A, Morjaria S, Mehta GD*. In-vivo Single-Molecule Imaging in Yeast: Applications and Challenges. Journal of Molecular Biology 2021; 433(22):167250. 3. Mehta, V., Vilikkathala Sudhakaran, S., & Rath, S. N. (2021). Facile Route for 3D Printing of Transparent PETg-Based Hybrid Biomicrofluidic Devices Promoting Cell Adhesion. ACS Biomaterials Science & Engineering, 7(8), 3947-3963. 4. Sankar, S., Mehta, V., Ravi, S., Sharma, C. S., & Rath, S. N. (2021). A novel design of microfluidic platform for metronomic combinatorial chemotherapy drug screening based on 3D tumor spheroid model. Biomedical Microdevices, 23(4), 1-10. 5. Dhiman, N., Shagaghi, N., Bhave, M., Sumer, H., Kingshott, P., & Rath, S. N. (2021). Indirect co-culture of lung carcinoma cells with hyperthermia-treated mesenchymal stem cells influences tumor spheroid growth in a collagen-based 3-dimensional microfluidic model. Cytotherapy, 23(1), 25-36. 6. Dhiman, N., Shagaghi, N., Bhave, M., Sumer, H., Kingshott, P., & Rath, S. N. (2020). Selective Cytotoxicity of a Novel Trp-Rich Peptide against Lung Tumor Spheroids Encapsulated inside a 3D Microfluidic Device. Advanced biosystems, 4(4), 1900285.
Essential qualifications	The Biomedical engineering, Biotechnology, Microfluidic device fabrication experience, Molecular and cell biology, Life sciences background.
Desirable qualifications	Expert in cell biology or microfluidic device fabrication
Broad proposal objectives	https://drive.google.com/open?id=1csFTg8pOrJ19kkp8-Xju2GOCOobdCEwC

PROPOSAL No. - IDPHD2024014

Title of the Proposal	**Ultrasound-triggered Active Drug Delivery (uADD) System for Triple Negative Breast Cancer Therapy**
Supervisor-1	Avinash Eranki, *Biomedical Engineering*
Supervisor-2	Ranabir Dey, *Mechanical & Aerospace Engineering*
Email IDs	aeranki@bme.iith.ac.in ranabir@mae.iith.ac.in
Abstract	In this project we will study how focused ultrasound (FUS) combined with self-propelled, drug-loaded microswimmers can help to mechanically disrupt tumor tissues in specific locations of the tumor, and deliver a drug autonomously. We will develop a novel FUS aided active drug delivery system for cancer therapy.
Keywords	active microswimmers, drug delivery, focused ultrasound, breast cancer
Background and Motivation	Presently, targeted anti-cancer drug delivery is primarily based on passive micro/nano-vehicles with target specific biochemical modifications or external stimulation. These suffer from poor uptake of drugs or therapeutic antibodies into the tumor resulting in lower bioavailability of anti-cancer agents. Hopefully, our FUS aided active drug delivery system is going to change this status quo.
Relevant publications	1. Eranki A, et al. High-Intensity Focused Ultrasound (HIFU) Triggers Immune Sensitization of Refractory Murine Neuroblastoma to Checkpoint Inhibitor Therapy. Clinical Cancer Research. 2020 Mar 1;26(5):1152-61. 2. Eranki A, Mikhail AS, et al. Tissue-mimicking thermochromic phantom for characterization of HIFU devices and applications. International Journal of Hyperthermia. 2019 Jan 1;36(1):517-28. 3. Eranki A, et al. Mechanical fractionation of tissues using microsecond-long HIFU pulses on a clinical MR-HIFU system. International Journal of Hyperthermia. 2018 Nov 17;34(8):1213-24. 4. Dey, R. *, Buness, C. M., Hokmabad, B. V., Jin, C., & Maass, C. C. * (2022), Nature Communications, 13(1), 1-10. (Selected as Editor's highlight under Applied Physics and Mathematics). 5. Hokmabad, B. V., Dey, R. et al. (2021). Emergence of bimodal motility in active droplets. Physical Review X, 11(1), 011043.
Essential qualifications	Mechanical engineering; Biomedical engineering; Biotechnology
Desirable qualifications	Microfluidics; microscopy; image processing; statistical analysis
Broad proposal objectives	https://drive.google.com/open?id=1E9jRV8mHtEiDJC5ICxLSdcwa353iqNy7

Please Note that this proposal is for a Project-funded position from the research funds of the supervisors. For more information, please contact the supervisors directly.

PROPOSAL No. - IDPHD2024015

Title of the Proposal	**Design and development of fluorescence-based assay for detecting the CpG methylation epigenetic mark on DNA for potential biomedical applications.**
Supervisor-1	Krishna Gavvala, *Chemistry*
Supervisor-2	Rajakumara Eerappa, *Biotechnology*
Email IDs	kgavvala@chy.iith.ac.in eraj@bt.iith.ac.in
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-based assay, DNA methylation, DNA-protein interactions
Background and 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.
Relevant publications	1. **Dr Krishna Gavvala:** 1. D. Takkella, S. Sharma, J. Vishwakarma, J. Cerezo, L. M.-Fernandez, K. Gavvala. Unveilingthe Interaction Modes of Imiquimod with DNA: Biophysical and Computational Studies. J.Photochem. Photobiol. A., 2024, 115190. 2. S. Sharma, D. Takkella, J. Vishwakarma, K. Gavvala. Spectroscopy and dynamics of beta-lactoglobulin complexed with rifampicin J. Biomol. Struct. Dyn., 2023, 1-14. 3. D. Takkella, S. Sharma, R. Krzemieniecki, A. Pabbathi, S. Sappati, K. Gavvala. TargetingSpike-ACE2 Interface of SARS-CoV-2?and its Omicron Variant: A Comparative Screeningof Potential Inhibitors for Existing and Anticipating Variants Using Molecular ModellingApproach. ChemistrySelect, 2023, 8 (32), e202302687. 4. S. Sharma, D. Takkella, P. Kumar, K. Gavvala. Spectroscopic Analysis to Identify the BindingSite for Rifampicin on Bovine Serum Albumin. Spectrochim. Acta A, 2022, 283, 121721. 5. D. Takkella, S. Sharma, L. M. Fernandez, K. Gavvala. Excited-State Dynamics of Imiquimodin Aqueous Solutions. J. Photochem. Photobiol. A, 2022, 113998. 2. **Prof Rajakumara Eerappa:** 1. Abhishek S, Nakarakanti NK, Deeksha W,Rajakumara E. Mechanistic insights intorecognition of symmetric methylated cytosines in CpG and non-CpG DNA by UHRF1 SRA.Int J Biol Macromol. 170:514-522 (2021). 2. Abhishek S, Deeksha W, Rajakumara E. Mechanistic insights into allosteric regulation ofmethylated DNA and histone H3 recognition by SRA and SET domains of SUVH5 and thebasis for di-methylation of lysine residue. FEBS J. 290(4):1060-1077 (2023). 3. Rajakumara E, Nakarakanti NK, Nivya MA and Satish, M. Mechanistic insights into therecognition of 5-methylcytosine oxidation derivatives by the SUVH5 SRA domain.Scientific Reports. 6: 2016 (2016). 4. Rajakumara E, Satish M, Abhishek S. In vitro studies on non-canonical DNA bindingspecificities of KAP6 and HMO1 and mechanistic insights into DNA bound and unbindingdynamics of KAP6. Int J Biol Macromol. 160: 925-933 (2020). 5. Deeksha W, Abhishek S, Rajakumara E. PAR recognition by multiplereader domains ofPARP1 allosterically regulates the DNA-dependent activities andindependently stimulatesthe catalytic activity of PARP1. FEBS J. doi:10.1111/febs.16907). (2023).
Essential qualifications	MSc (Biochemistry), MSc (Chemistry), MTech (Biotechnology) with valid CSIR or GATE
Desirable qualifications	MSc (Biochemistry), MSc (Chemistry), MTech (Biotechnology) with valid CSIR or GATE Prior experience in biophysics or fluorescence spectroscopy
Broad proposal objectives	https://drive.google.com/open?id=1UXdT1Z1reFUKr4Kc6VLhpVGKCwfwZtnm

PROPOSAL No. - IDPHD2024016

Title of the Proposal	**Organo-Inorganic Degradable Nanoclusters for Biomedical Applications**
Supervisor-1	Aravind Kumar Rengan, *Biomedical Engineering*
Supervisor-2	Prabusankar Ganesan, *Chemistry*
Email IDs	aravind@bme.iith.ac.in prabu@chy.iith.ac.in
Abstract	Nanoclusters measuring less than 2 nm in diameter, offer exceptional physico-chemical properties compared to nanoparticles, attributing to their quantum confinement effect. Leveraging this, we aim to develop hybrid nanoclusters for cancer and antimicrobial theranostics, facilitating real-time treatment monitoring via X-ray CT or optical imaging.
Keywords	Nanoclusters, Biomaterials, Anti-cancer, Anti-microbial, Theranostics,
Background and Motivation	Conventional treatment modalities such as chemotherapy and radiotherapy render the host sensitive to various microbial infections. These observations point towards the unmet need of developing formulations that can tackle both the rapidly proliferating & invading cancer cells and subsequent infections, thus, necessitating the need to research and develop affordable and indigenous theranostic technologies
Relevant publications	1. Ravichandran, G., Harijan, D., Ganapathy, N., Prabusankar, G., De, A., and Rengan A. K@. The Multifaceted Role of Degradable Cobalt Nanoparticles: Dual-Target Starvation and Intracellular Acidification Engendering LC3-Associated Whole-Cell Autophagy. ACS Materials Letters, 2023, 5(10), pp.2726–38. 2. Yadav, D. N., Sankaranarayanan, S. A., Thanekar, A. M., and Rengan, A. K@. Bioinspired Gold-coated Phage Nanosomes for Anti-microbial and Anti-cancer Theranostics. Mater Today Nano, 2023, 23. 3. Tejaswini Appidi, PS Rajalakshmi, Shubham A Chinchulkar, Arpan Pradhan, Hajera Begum, Veeresh Bantal, Rohit Srivastava, Ganesan Prabusankar, A.K.Rengan@, Plasmon-enhanced fluorescent gold coated novel lipo-polymeric hybrid nanosystem: Synthesis, characterization and application for imaging and photothermal therapy of breast cancer, Nanoscale (2022) 4. Syed Baseeruddin Alvi, PS Rajalakshmi,...,A.K.Rengan@. In Situ Nanotransformable Hydrogel for Chemo-Photothermal Therapy of Localized Tumors and Targeted Therapy of Highly Metastatic Tumors. Applied Materials & Interfaces. 2021, 13 (47), 55862-55878. 5. Moulali Vaddamanu, Arruri Sathyanarayana, Yamane Masaya, Shohei Sugiyama, Ozaki Kazuhisa, Kavitha Velappan, Muneshwar Nandeshwar, Kyohei Hisano, Osamu Tsutsumi and Ganesan Prabusankar, Acridine N-Heterocyclic Carbene Gold(I) Compounds: Tuning from Yellow to Blue Luminescence, Chemistry An Asian Journal, 2021, 16(5), 521-529. [IF: 4.83]
Essential qualifications	Master's degree in Biotech/ Nanomedical sciences/ Pharma/ Bio-chemistry or equivalent
Desirable qualifications	M.Tech/M.Pharm preferred or Qualified CSIR/UGC/DBT-JRF/INSPIRE would be desirable
Broad proposal objectives	https://drive.google.com/open?id=12SrBUzxsUwtcGf-BwGWLnYEZhQ_H1Yk8

PROPOSAL No. - IDPHD2024017

Title of the Proposal	**Development of novel mRNA vaccine platform for infectious and chronic diseases by highly interdisciplinary approach of mRNA engineering and nanoengineering of delivery system**
Supervisor-1	Jyotsnendu Giri, *Biomedical Engineering*
Supervisor-2	Indranil Malik, *Biotechnology*
Email IDs	jgiri@bme.iith.ac.in indranil@bt.iith.ac.in
Abstract	Traditional DNA or inactivated pathogen-based vaccines are often inefficient. Although mRNA vaccines with advanced delivery systems hold the promise to overcome many issues of traditional vaccines, there are still many unmet challenges. Objective of this project is to develop a novel platform by mRNA engineering and nanoengineering of novel deliver system for affordable and efficient mRNA vaccines.
Keywords	mRNA vaccine, mRNA engineering, mRAN delivery system, mRNA vaccine storage and transport, cold-chain free vaccine,
Background and Motivation	Despite the pressing need of mRNA vaccines against many diseases, vaccine development faces many challenges related to the synthetic mRNA expression and stability, and the delivery system. Using existing mRNA vaccine candidates against SARS-CoV as a model, this project will address major concerns related to mRNA engineering and delivery system
Relevant publications	1. Jyotsnendu Giri, Nanostructure-hybrid lipid capsule system for delivery/co-delivery of nucleic-acid and active-pharmaceutical ingredient and its fabrication method, Patent Application No.: 202241054829 2. Jyotsnendu Giri, Sunil K Yadava, A system and method for fabricating dual pH/temperature-responsive nanostructure hybrid-lipid capsule for theragnostic application, Patent Application No.: 202341015865 3. Basu, S. M., Chauhan, M., & Giri, J. (2023). pH-Responsive Polypropylene Sulfide Magnetic Nanocarrier-Mediated Chemo-Hyperthermia Kills Breast Cancer Stem Cells by Long-Term Reversal of Multidrug Resistance and Chemotherapy Resensitization. ACS Applied Materials & Interfaces, 15(50), 58151-58165. 4. Malik, I., Tseng, Y.-J., Wright, S. E., Zheng, K., Ramaiyer, P., Green, K. M., & Todd, P. K. (2021). SRSF protein kinase 1 modulates RAN translation and suppresses CGG repeat toxicity. EMBO Molecular Medicine, 13(11), e14163. 5. Qiu, C., Arora, P., Malik, I., Laperuta, A. J., Pavlovic E. M., Ugochukwu. S., Naik. M., Kaplan, C. D. (2024 Thiolutin has complex effects in vivo but is a direct inhibitor of RNA polymerase II in vitro. Nucleic Acids Res, 2024 Jan 12:gkad1258. doi: 10.1093/nar/gkad1258. Online ahead of print.
Essential qualifications	M Tech in Pharmaceutics, Nanobiotechnology with interdisciplinary work experience in materials and biology
Desirable qualifications	MTech, MPharma with interdisciplinary working experience materials and biology
Broad proposal objectives	https://drive.google.com/open?id=1XchdVbWFKODhbtHg3yraVw7vwgf3a2_r

PROPOSAL No. - IDPHD2024018

Title of the Proposal	**Bacterial Cellulose based Microfluidic Point-of-Care Device for Antibiotic Susceptibility Testing**
Supervisor-1	Mudrika Khandelwal, *Materials Science and Metallurgical Engineering*
Supervisor-2	Suhanya Duraiswamy, *Chemical Engineering*
Email IDs	mudrika@msme.iith.ac.in suhanya@che.iith.ac.in
Abstract	Antimicrobial resistance (AMR) is a global public health challenge, which has accelerated due to the over and indiscriminate use of broad-spectrum antibiotics worldwide. We propose to fabricate a lateral flow based microfluidic device using bacterial cellulose, which can hold the bacterial growth solution, antibiotic and a halo-chromic dye. This device will be capable of detecting antibiotic susceptibility by allowing the bacteria in the sample solution to grow if resistant and by preventing growth at the minimum inhibitory concentration (MIC), if susceptible. This growth can be detected by the change in color of the halo-chromic dye in the device.
Keywords	Antimicrobial resistance, Antibiotic Susceptibility Testing, Bacterial cellulose, Minimum Inhibitory Concentration, Point-of-Care
Background and Motivation	The extensive and indiscriminate use of broad-spectrum antibiotics has led to a rise in antimicrobial resistant (AMR) strains of bacteria. This has led to several known antibiotics being ineffective to the pathogen causing the infection, thus once-preventable diseases have become infectious again. The current gold standards for Antibiotic Susceptibility Testing (AST) are culture based, and typically take 8 hours or more, depending on the bacterial strain causing the infection and its resistance profile. It is hence imperative now to develop quick and efficient tests to identify antibiotic resistance profile.
Relevant publications	1. Provisional patent filed: 'BACTERIAL CELLULOSE BASED MICROFLUIDIC POC DEVICE FOR AST',Application Ref Number-202241030646, Filing Date-27/05/2022 -Indian Patent Office 2. S. J. Eichhorn, A. Etale, J. Wang, L. A. Berglund, Y. Li, Y. Cai, C. Chen, E. D. Cranston, M. A. Johns, Z. Fang, G. Li, L. Hu, M. Khandelwal, K.-Y. Lee, K. Oksman, S. Pinitsoontorn, F. Quero, A. Sebastian, M. M. Titirici, Z. Xu, S. Vignolini & B. Frka-Petesic. Current international research into cellulose as a functional nanomaterial for advanced applications. J Mater Sci. 2022; 57, 5697-5767. 3. Duraiswamy S, Agarwalla S, Lok KS, Tse YY, Wu R, et al. (2023) A multiplex Taqman PCR assay for MRSA detection from whole blood, PLOS ONE 18(11): e0294782. 4. Weidong Zhou, Ruige Wu, Suhanya Duraiswamy, Wei Wang, Liang Zhu, Zhiping Wang, Development of Microfluidic Cartridge for Culture-Free Detection of Staphylococcus aureus in Blood, Journal of Micromechanics and Microengineering, 2021, 31(5), 055012.
Essential qualifications	MTech in Chemical or Biotechnology or Materials Engg.
Desirable qualifications	Knowledge of Microbiology
Broad proposal objectives	https://drive.google.com/open?id=1lAka9sN66JO-d7gAuT_DIgyQDYJSkrfK

Please Note that this proposal is for a Project-funded position from the research funds of the supervisors. For more information, please contact the supervisors directly.

PROPOSAL No. - IDPHD2024019

Title of the Proposal	**Examining the effects of climate change crisis on health (in)equity**
Supervisor-1	Asif Qureshi, *Civil Engineering*
Supervisor-2	Anindita Majumdar, *Liberal Arts*
Email IDs	asif@ce.iith.ac.in anindita@la.iith.ac.in
Abstract	This work will document and project the increasing health-related vulnerability of such groups from a variety of exposure endpoints that have been, elsewhere, know to disproportionately impact such communities: (i) environmental pollution exposure, (ii) water and other climate related stress, (iii) health accessibility and affordability, at present and due to climate change related impacts.
Keywords	crisis, climate change, health equity, exposure and stress
Background and Motivation	The disproportionate impact of environmental pollution and environmental hazards on vulnerable communities has rarely been systematically studied in India. While climate change as a phrase gets attention, projections of vulnerabilities within these communities as a result of climate change are absent. By identifying health inequity-equity through the identification and classification of environmental crisis, we hope to contribute to related policy intervention
Relevant publications	1. **A Qureshi** 1. Majumdar, A. Qureshi, A. (2022) Thinking about infertility from a mixed methods perspective: the need to look at toxicity in rural India. Sexual and Reproductive Health Matters, doi: 10.1080/26410397.2021.1999565. 2. Muthalagu, A., Lian, Y., Ravindran, R.M., Qureshi, A. (2024) Impacts of Floods on the Indoor Air Microbial Burden. Aerosol and Air Quality Research, doi: 10.4209/aaqr.230191. 3. Shende, P., Qureshi, A. (2022) Burden of diseases in fifty-three urban agglomerations of India due to particulate matter (PM2.5) exposure. Environmental Engineering Research, 22(3), 210042, doi: 10.4491/eer.2021.042. 4. Qureshi, A. (2022) Mercury in the environment around industrially impacted Locations in India: a mini-review. Bulletin of Environmental Contamination & Toxicology, doi: 10.1007/s00128-022-03548-w. 5. Pramanik, S., Shalini, M., Qureshi, A. (2021) Mercury in soil around a 2600 MW coal-fired super thermal power plant in India and human health risk assessment. Journal of Hazardous, Toxic, and Radioactive Waste, doi: 10.1061/(ASCE)HZ.2153-5515.0000613.

2. **A Majumdar**

6. Jacobson, H., König, A. Majumdar, A. (2023): Im/ mobility in the transnational surrogacy market: disruptions and vulnerabilities in and beyond pandemic times. Applied Mobilities, DOI: 10.1080/23800127.2023.2274238

7. Majumdar, A. Qureshi, A. (2022) Thinking about infertility from a mixed methods perspective: the need to look at toxicity in rural India. Sexual and Reproductive Health Matters, doi: 10.1080/26410397.2021.1999565.

8. Thapar-Björkert, S., Majumdar, A., Gondouin, J. (2023). "There are two sides to everything": Re (locating) vulnerability in the surrogacy industry in India. Feminism & Psychology. https://doi.org/10.1177/09593535231172592

9. Majumdar, A. (2023). Infertility as inevitable: Chronic lifestyles, temporal inevitability and the making of abnormal bodies in India. Anthropology and Medicine, 30(2): 120-134.

10. Majumdar, A. (2019). Beyond essentialism: Ecofeminism and the "friction" between gender and ecology. in Anu Aneja (Ed.), Women and Gender Studies in India: Crossings. New Delhi: Routledge.

Essential qualifications	BSc-MA, BTech-MA, MSc-MA, MSc-MPhil, BTech-MSc
Desirable qualifications	Mixed Methods; Laboratory Testing; Social Sciences; Data Sciences; fieldwork
Broad proposal objectives	https://drive.google.com/open?id=1RSgsqBy0X6HiSN4RawFGKwco9rQLwji4

PROPOSAL No. - IDPHD2024020

Title of the Proposal	**Dynamic uptake and transport of micro and nanoparticles in living systems: In vitro and in vivo studies**
Supervisor-1	Prof. Renu John, *Biomedical Engineering*
Supervisor-2	Dr. Seetha N., *Civil Engineering*
Email IDs	renujohn@bme.iith.ac.in seetha@ce.iith.ac.in
Abstract	This study envisages to provide a comprehensive understanding of micro and nanoparticle uptake, transformation, accumulation, and toxicity in edible plants and fishes due to irrigation with nanoparticle-containing water and nanoparticle application in aquaculture, respectively. The project involves both in vitro and in vivo experimental and modeling studies. The outcomes of this project include estimates of the rates of micro and nanoparticle uptake, transformation, and accumulation in plants and fishes, and the optimal safe dose of nanoparticles that can be used in agriculture and aquaculture.
Keywords	Nano and microparticles, uptake, accumulation, plants, aquaculture
Background and Motivation	Nanotechnology has a wide range of applications in agriculture and aquaculture. Nanofertilizers and nanopesticides increase crop yield and plant resilience against diseases. Nanoparticles are used in aquaculture for faster fish growth, drug administration, and disease management. Moreover, microplastics are ubiquitous in many environmental waters. The micro and nanoparticles uptaken by plants and fishes may get metabolized and accumulate inside their system. Hence, it is important to understand nanoparticle uptake, transport, and transformation in plants and fishes to minimize the impacts on ecology and human health.
Relevant publications	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. Seetha, N., Dibyanshu, Raychoudhury, T., 2024. Modeling the transport behavior of zinc oxide nanoparticles in soil under various environmental conditions. Water, Air, & Soil Pollution, 235 (55). 5. Jayaraj, J., Seetha, N., Hassanizadeh, S.M., 2023. Modeling the transport and retention of nanoparticles in a single partially-saturated pore in soil. Water Resources Research, 59, e2022WR034302.
Essential qualifications	BTech in Agricultural/Chemical/Civil/Environmental/Mechanical engineering from a recognized university with more than 8.5 CGPA and qualified in GATE in the last two years Or BTech in Agricultural/Chemical/Civil/Environmental/Mechanical engineering from NITs/IITs with 7.5 CGPA or above. GATE qualification is not mandatory for NIT/IIT graduates. Or MSc in Physics or MSc/MTech in Nanoscience and Technology or ME/MTech in Chemical/Environmental/Water Resources/Agricultural/Mechanical Engineering with a CGPA of 7.5 or above
Desirable qualifications	Previous experience in working with nanoparticles, plants, or fish/ imaging using light or electron microscopy/ developing physics-based models/ numerical simulations
Broad proposal objectives	https://drive.google.com/open?id=15DaTKdbq8gIkqtQ9sLKMWQuwG9Ah8HAW

PROPOSAL No. - IDPHD2024021

Title of the Proposal	**Porous and Layered MXene materials for Advanced Hybrid Energy Storage Devices**
Supervisor-1	Narendra Kurra, *Chemistry*
Supervisor-2	Atul S. Deshpande, *Materials Science and Metallurgical Engineering*
Email IDs	narendra@chy.iith.ac.in atuldeshpande@msme.iith.ac.in
Abstract	A new class of 2D materials is proposed for use as electrodes for hybrid energy storage applications. These materials are popularly known as MXenes – 2D form of metal carbides, nitrides and carbonitrides. Given their metallic conductivity and redox active gallery sites, MXenes are candidate materials for high-rate high energy storage applications.
Keywords	2D materials, surface chemistry, MXenes, energy storage, carbon, redox chemistry, sustainability
Background and Motivation	The design of advanced energy storage devices demands for the development of electrode materials with high capacity and electrochemically stable electrode|electrolyte interfaces. For instance, the state-of-the-art commercial electrical double layer capacitors (EDLCs) suffer from mediocre capacitance and energy density (~10 Wh/kg) due to physical charge storage mechanism across porous carbon materials. On contrary, Li-ion batteries offer superior energy density over EDLCs due to Faradaic reactions throughout the bulk of the electrode materials but suffer from poor power density based on sluggish solid state diffusion kinetics. The trade-off between the energy and power can be circumvented through the exploration of new types of materials which are capable of storing high amount of charge at high rates simultaneously.
Relevant publications	1. **Dr. Narendra Kurra** 1. Suman Yadav and Narendra Kurra,* Energy Storage Materials (I.F. 20.3), 2024, 65, 103094. 2. Soujanya H. Goudar, Shubham Bhoi, Saroj Kumar Sahoo, Venkata Rao Kotagiri and Narendra Kurra,* Small (I.F. 13.3), 2024, 10.1002/smll.202309905 3. S. Yadav, D. S. Ingle, K. V. Rao, Narendra Kurra, Organic Materials as Charge Hosts for Pseudocapacitive Energy Storage, Sustainable Energy & Fuels (I.f. 5.062), 2023, 7, 2802 - 2818 4. Rohit Choudhury, Narendra Kurra, Praveen Meduri, "Doped micro-silicon and vanadium carbide MXene composite as anode for high stability and high capacity Li-ion batteries" , Results in Engineering (I.f. 5.5), 2023, 19, 101338 5. Geetha Valurouthu, Rachita Panigrahi, Mohit Saraf, Christopher E. Shuck, Bhabani S. Mallik, Narendra Kurra*, Yury Gogotsi, "Ambipolar Electrochemistry of Pre-Intercalated Ti3C2Tx MXene in Ionic Liquid Electrolyte" Batteries & Supercaps (I. F. 6.023), 2023, doi.org/10.1002/batt.202300009 2. **Dr. Atul Deshpande** 1.High temperature elemental segregation induced structure degradation in high entropy fluorite oxide.Hu Y, Anandkumar M, Zhang Y, et al. Journal of Advanced Ceramics. Published online 2024 (2024). doi:10.26599/JAC.2024.9220854 2. Improved chemiresistor gas sensing response by optimizing the applied electric field and interdigitated electrode geometry.Naganaboina VR, Bonam S, Anandkumar M, Deshpande AS, Singh SG. Materials Chemistry and Physics. 305 (2023). doi:10.1016/j.matchemphys.2023.127975 3. PEDOT:PSS-bacterial cellulose bilayer actuators: From the movement of ions to deflection.Najathulla BC, Kumar S, Deshpande AS, Khandelwal M. Polymers for Advanced Technologies. Published online 2023 (2023). doi:10.1002/pat.6040 4. Effective band gap engineering in multi-principal oxides (CeGdLa-Zr/Hf)Ox by temperature-induced oxygen vacancies.Hu Y, Anandkumar M, Joardar J, Wang X, Deshpande AS, Reddy KM. Scientific Reports. 13(1):2362, (2023). doi:10.1038/s41598-023-29477-0 5. TiO2 Decorated SiO2 Nanoparticles as Efficient Antibacterial Materials: Enhanced Activity under Low Power UV Light.Mahanta U, Deshpande AS, Khandelwal M. ChemistrySelect. 8(4):e202203724, (2023). doi:https://doi.org/10.1002/slct.202203724
Essential qualifications	MSc degree in Chemistry/Nano or M.Tech in Materials/At least one (Bachelors or Masters) Degrees in Materials Science, Mechanical Engg or Chemical Engg
Desirable qualifications	Materials synthesis and electrochemistry skills
Broad proposal objectives	https://drive.google.com/open?id=1Zh0xaY_MqYgvUPafyDywUadj7vIopUbJ

PROPOSAL No. - IDPHD2024022	
Title of the Proposal	**AI/ML-Enabled Life Cycle Sustainability Analysis of Climate Smart Agrifood Systems and Air Pollution Forecasting, with a Focus on Environmental, Health, and Resources Assessment (EHRA)**
Supervisor-1	Ambika S, *Civil Engineering*
Supervisor-2	C Krishna Mohan, *Computer Science and Engineering*
Email IDs	ambika@ce.iith.ac.in ckm@cse.iith.ac.in
Abstract	This research delves into the utilization of AI/ML applications to bolster the sustainability of climate-smart agriculture by employing life cycle analysis encompassing mass and energy balance considerations. It also specifically focuses on the implementation of AI/ML for predicting air pollution and measuring the impacts concerning environmental, health, and resource assessment (EHRA) focusing sustainability. Leveraging AI/ML techniques alongside geo-spatiotemporal image analysis can facilitate sustainable practices, resource efficiency, climate-smart agricultural approaches, and the anticipation of air pollution impacts for effective mitigation measures.
Keywords	AI/ML, geo-spatiotemporal image analysis, agri-food systems, forecasting pollution, life cycle sustainability analysis
Background and Motivation	Cutting-edge research advocate for the optimal utilization of water, energy, and chemical-free agricultural methods, acknowledging their link to sustainability and climate change. Additionally, air pollution from agriculture and other sectors poses challenges to environmental, health, and resource sustainability. In pursuit of sustainability, this research emphasizes employing AI/ML and geo-spatiotemporal image analysis to assess and forecast the impacts on EHRA and thus sustainability through life cycle analysis.
Relevant publications	• Ambika S, Jagratti, Shikar, Gaurav, Sustainability Assessment of Crops in India, Current Research in Environmental Sustainability, 2021 https://doi.org/10.1016/j.crsust.2021.100074 (IF:4.4) • Ambika S, Ananya, Rajeveer, Vijaya, Impact of COVID-19 on Health-Risk and Environmental Sustainability in India, Environmental Research, 26;196:110932, 2021 https://doi.org/10.1016/j.envres.2021.110932 (IF-8.3) • Ambika S, Sustainability Assessment of Trickling Filters, Risk, Reliability and Sustainable Remediation in the Field of Civil and Environmental Engineering, 2022, 93-109 https://doi.org/10.1016/B978-0-323-85698-0.00003-4 (Book Chapter, Elsevier) • Yashaswi M, Ambika S, Life Cycle-based Environmental, Health, and Resources Sustainability Assessment (EHRA) of Agrifood Systems, Revision submitted, Journal of Cleaner Production (IF:11.1) • Vaishnavi G, Sravanthi L, Ambika S, AI/ML based analysis and forecasting of air pollution and Sustainability Assessment in India (working paper) • G Swetha, Rajeshreddy Datla, C Vishnu, C Krishna Mohan, “M2-APNet: A multimodal deep learning network to predict major air pollutants from temporal satellite images”, SPIE Journal of Applied Remote Sensing, 2023. (Impact Factor = 1.7)
Essential qualifications	BTech/MTech/MS/MSc in Environment / Agriculture / RS-GIS / Computer Science / AI/ML / Applied Mathematics / Climate Change / Sustainability / Relevant Fields
Desirable qualifications	Strong mathematical background with good coding skills (Python, C/C++) • Prior experience/knowledge on the project’s theme is a plus • Knowledge on LCA and GIS packages is preferred
Broad proposal objectives	https://drive.google.com/open?id=1-MvSELb5-3mg7GHnk14U9ITy4jfl3ThG

PROPOSAL No. - IDPHD2024023

Title of the Proposal	**Transforming carbon dioxide into value-added hydrocarbons**
Supervisor-1	Sayak Banerjee, *Mechanical & Aerospace Engineering*
Supervisor-2	Debaprasad Shee, *Chemical Engineering*
Email IDs	Sayakb@mae.iith.ac.in dshee@che.iith.ac.in
Abstract	The proposed investigation focused on sustainable transformation of CO2 into value added hydrocarbons such as olefins, gasoline, aviation fuels etc. A highly efficient multifunctional nanostructured iron-based catalyst will be developed for the direct conversion of CO2 to value added hydrocarbons including gasoline and jet fuels range hydrocarbons.
Keywords	Carbondioxide, Multifunctional catalyst, gasoline, aviation fuel
Background and Motivation	CO2 capture from air or industrial emissions and transforming into value-added hydrocarbons address the challenge of climate change. It is now imperative to develop clean, energy-efficient technologies for producing sustainable hydrocarbons. The key to advancing this process is to search for a highly efficient inexpensive catalyst, that can preferentially produce the target hydrocarbons in the gasoline or jet fuel range.
Relevant publications	1. D Prabhakaran, S Banerjee, Development of a Reduced Combustion Kinetic Mechanism for Lemon Peel Waste Oil as a Jet-Fuel, Lecture Notes in Mechanical Engineering (2023), Pages 337 – 342 2. Wakale A. B., Banerjee S. and Banerjee R., Estimation of NOx and Soot Emission from a Constant Volume n-Butanol/n-Dodecane Blended Spray Using Unsteady Flamelet Model Based on n-Dodecane/n-Butanol/NOx/PAH Chemistry, Journal of the Energy Institute, 93 (2020) 1868 – 1882 3. T Kella, D Shee, Enhanced selectivity of benzene-toluene-ethyl benzene and xylene (BTEX) in direct conversion of n-butanol to aromatics over Zn modified HZSM5 catalysts, Microporous and Mesoporous Materials 323 (2021) 111216 4. VCS Palla, D Shee, SK Maity, S Dinda, One-step conversion of n-butanol to aromatics-free gasoline over HZSM-5 catalyst: Effect of pressure, catalyst deactivation and fuel properties as a gasoline, ACS Omega 46 (2023) 43739–43750 5. T Kella, D Shee, Production of aromatics from butanol over Ga-promoted HZSM5 catalysts: Tuning of benzene-toluene-xylene and ethylbenzene (BTEX) selectivity, Reaction Chemistry & Engineering, 7 (2022) 1096-1114
Essential qualifications	Btech in Chemical Engg or Mechanical Engg with GATE; MTech in Mechnical or Chemical Engg
Desirable qualifications	Catalysis, Kinetic modelling, chemical reactors modelling, Fuel combustion, fuels and thermal and reactive systems
Broad proposal objectives	https://drive.google.com/open?id=1xZVAZkj3c1H7fq4_DBq0b4bDXvoEDXIL

PROPOSAL No. - IDPHD2024024

Title of the Proposal	**To design an operational system for Urban Air Mobility (UAM)**
Supervisor-1	Deepak John Mathew, *Design*
Supervisor-2	Mahesh M. S., *Mechanical & Aerospace Engineering*
Email IDs	djm@des.iith.ac.in mahesh@mae.iith.ac.in
Abstract	The global issue of traffic congestion has sparked renewed interest in aerial taxis, particularly within the framework of Urban Air Mobility (UAM). UAM seeks to offer a cost-effective alternative to ground transportation in congested urban areas, utilizing on-demand or scheduled operations. Indian cities are seeing rapid urbanization and the present transportation system cannot meet the growing commuting needs, which is an opportunity to look for an alternative mode of public transportation. The primary objective of this proposal is to design a set of guidelines and systems for the implementation of operational spaces and supporting infrastructure specifically designed for the future of UAM aircraft service in India.
Keywords	Urban Air Mobility, Air-Taxi, Unmanned Aerial Vehiclec
Background and Motivation	Unmanned aerial vehicles (UAVs) are autonomous or self-flying aerial vehicles that are being used in a variety of fields, including surveillance and agriculture. The autonomous UAM aircraft is one such application of UAVs that is currently under development. Globally, there is a race for improved UAM design, testing, and commercial release. However, the expansion of urban air travel faces a major challenge due to the current inadequacy of the air traffic management (ATM) system to regulate urban airspace effectively. Thus, with this transportation industry progressing rapidly towards UAM vehicle technology, it becomes imperative to establish guidelines and infrastructure that guarantee the secure and effective incorporation of these aerial vehicles. Implementing UAM activities within the existing system requires expanding its capacity, presenting a more complex challenge than the ICAO's current airspace classifications. Addressing the complexity of segregating aerial vehicles in tight urban airspace calls for carefully designing new airspace structures to enhance safety and efficiency while minimizing complexity.
Relevant publications	1. A Visual Design Analysis of Urban Air Mobility for Indian Users KM Chaturmutha, DJ Mathew International Conference on Research into Design, 209-223, 2023 2. Understanding Working Scenarios of Urban Air MobilityP Rautray, DJ Mathew, B Eisenbart, J Kuys Proceedings of the Design Society 2, 563-572, 2022
Essential qualifications	Candidates with a Design or Aerospace Engineering background will be given preference.
Desirable qualifications	The candidate needs to work on the interdisciplinary topic related to the design of infrastructure related to Urban Air Mobility.
Broad proposal objectives	https://drive.google.com/open?id=1T5IM93Q_ArqW78OIsbBpJaKUmSpVLB7j

PROPOSAL No. - IDPHD2024025

Title of the Proposal	**Seawater Desalination and Recovery of Value-added Products using Novel Technologies**
Supervisor-1	Debraj Bhattacharyya, *Civil Engineering*
Supervisor-2	Tarun K Panda, *Chemistry*
Email IDs	debrajb@ce.iith.ac.in tpanda@chy.iith.ac.in
Abstract	It is an industry-funded project where we are trying to develop novel seawater desalination technologies while simultaneously recovering valuable minerals from the salt stream. While salt removal from seawater has been tested and verified on a bench scale using our proposed technology, recovering valuable minerals from the salt stream has proved challenging. The successful applicant needs to work on methods to overcome these technical challenges. The project must be completed within four years, and a minimum of one year must be spent in a laboratory in Japan. In addition to satisfying the academic and technical requirements for applying for this position, the applicant must have a passport with a minimum of five years validity when applying.
Keywords	Desalination, resource recovery, water treatment
Background and Motivation	Due to the rapid increase in human population, we must look beyond conventional water resources to satisfy our ever-increasing water demand. Oceans and seas represent unlimited sources of water. However, this water is non-potable due to its high salt content. Removing excess salt from seawater to make it fit for potable uses is expensive. Therefore, developing techno-economically feasible desalination technologies is a need of the hour. Apart from salt separation, economically recovering valuable minerals from the brine stream can significantly improve the economics of the overall process.
Relevant publications	1. Oruganti, R.K., Pal, D., Panda, T.K., Shee, D., Bhattacharyya, D. (2023). Green synthesis of calcium oxide nanoparticles impregnated activated carbon from algal–bacterial activated sludge: its application in ciprofloxacin removal. International Journal of Environmental Science and Technology. Springer, 20(11), pp. 12379-12396. DOI: 10.1007/s13762-022-04662-2 2. Oruganti, R.K., Sunar, S.L., Panda, T.K., Shee, D., Bhattacharyya, D. (2023). Kraft lignin recovery from de-oiled Jatropha curcas seed by potassium hydroxide pretreatment and optimization using response surface methodology. Bioresource Technology Reports, 23,101572. DOI: 10.1016/j.biteb.2023.101572 3. Gundupalli, M.P., Bano, K., Panda, T.K., Sriariyanun, M., and Bhattacharyya, D. (2022). Understanding the effect of low-concentrated protic ionic liquids (PILs) on coconut (Cocos nucifera) residues. Biomass Conversion and Biorefinery, Springer. DOI: 10.1007/s13399-022- 02572-4 4. Damaraju, M., Gupta, V.K., Bhattacharyya, D., Panda, T.K., and Kurilla, K.K. (2021). Improving the performance of a continuous bipolar-mode electrocoagulation (CBME) system, treating a marigold flower processing wastewater, through process modifications. Separation Science and Technology, Taylor & Francis, 56(3), 604-616 DOI: https://doi.org/10.1080/01496395.2020.1725572
Essential qualifications	Essential & minimum qualifications: The candidate interested in applying for this project must satisfy both Criterion A and Criterion B. Criterion A: First Class/Div. in M.Tech./M.E. in any of the following engineering disciplines: Civil Engineering (with specialization in Environmental Engineering), Environmental Engineering, Chemical Engineering; OR, First Class in M.Sc. in Chemistry. Criterion B: First Class/Div. in B.Tech./B.E. in any of the following engineering disciplines: Civil Engineering, Environmental Engineering, Chemical Engineering; OR, First Class in B.Sc. in Chemistry.
Desirable qualifications	Same as above.
Broad proposal objectives	https://drive.google.com/open?id=1eDFwbSLAPh2QtiCFkJE6k6hvpV66t9E2

Please Note that this proposal is for a Project-funded position from the research funds of the supervisors. For more information, please contact the supervisors directly.

This project has a duration of 4 Years only.

PROPOSAL No. - IDPHD2024026

Title of the Proposal	**Quantum computing for Climate Change through Carbon Capture**
Supervisor-1	Bhabani Shankar Mallik, *Chemistry*
Supervisor-2	Narendra Kumar Sahu, *Physics*
Email IDs	bhabani@chy.iith.ac.in nsahu@phy.iith.ac.in
Abstract	The climate variance is affected by global warming, which is primarily caused by increased levels of CO2. The process of the transformations of CO2 to other products is energy and time consuming. Quantum algorithm and computers are exponentially faster than classical computers to find a solution for the development of capture technology.
Keywords	Quantum computing, Climate change, CO2 capture, Utilization, Technology development
Background and Motivation	The unacceptable level of emissions could turn out to be potentially catastrophic for life on the planet. Developing low-carbon or zero-carbon emission techniques are encouraged to mitigate this effect. The relevant quantum algorithms can be developed to study the most basic reaction of CO2 with the relevant complexes and one can find appropriate material faster that the classical computers.
Relevant publications	1. Reaction Mechanism and Free Energy Barriers for the Chemisorption of CO2 by Ionic Entities, (https://pubs.acs.org/doi/10.1021/acs.jpca.9b06817) (PI from physics has expertise in eigen solver and PI from chemistry has expertise in CO2 capture process. The combined expertise will be essential to solve the proposed problem)
Essential qualifications	Master's degree in Chemistry or Physics, Quantum mechanics knowledge
Desirable qualifications	Programming knowledge
Broad proposal objectives	https://drive.google.com/open?id=1IXP42APWIXZt_lpRF0wVP-J8h7-EtLqJ

PROPOSAL No. - IDPHD2024027

Title of the Proposal	**Eco-friendly relaxor ferroelectrics materials' design strategy for energy storage applications**
Supervisor-1	Saket Asthana, *Physics*
Supervisor-2	Bharat Panigrahi, *Materials Science and Metallurgical Engineering*
Email IDs	asthanas@phy.iith.ac.in bharat@msme.iith.ac.in
Abstract	Ferroelectric materials are useful for energy storage applications. However, achieving the optimum parameters, materials design aspects can be explored through various approaches such as high entropy cation engineering and processing innovations. The project aims to tailor properties to achieve the reasonable energy storage parameters for possible energy harvesting experiments.
Keywords	Relaxor ferroelectrics, High entropy cation engineering, Processing innovations, energy storage
Background and Motivation	Prof. Saket Asthana's group has expertise in assessing the piezoelectric and ferroelectric properties of bulk materials and composites using various techniques. Prof. Bharat' has expertise in processing innovation field. Our joint efforts may achieve the optimum energy storage parameters through materials designs and processing innovations.
Relevant publications	1. **Relevant Publications of Prof Saket Asthana:** 1. Ranjan Kumar Sahu, Saket Asthana, "Effect of K-ion-rich substitution on structural, thermally assisted relaxation processes in Na0. 5Bi0. 5TiO3 relaxor ferroelectric" Materials Science and Engineering: B, 299, (2024) 117038 2. Ranjan Kumar Sahu, Krishnarjun Banerjee & Saket Asthana, "Ergodic-nonergodic relaxor behavior, recoverable energy storage density, and dynamic hysteresis scaling in NKBT ferroelectrics" J. Mater. Sci.: Materials in Electronics 34, (2023) 972 3. Banerjee, K., Saket Asthana, "Scaling behavior of different shapes of hysteresis loops and recoverable energy storage density in Na0.5Bi0.5TiO3, K0.5Bi0.5TiO3, and Na0.25K0.25Bi0.5TiO3ferroelectrics"J of Materiomics, 8 (2022) 918. 4. Cilaveni GouthamKinjarapu Venkata Ashok Kumar Sai Santosh Kumar Raavi Challapalli Subrahmanyam and Saket Asthana, "Enhanced electrical and photocatalytic activities in Na0.5Bi0.5TiO3 through structural modulation by using anatase and rutile phases of TiO2, J of Materiomics 8(1) (2022) 18. 5. Krishnarjun Banerjee and Saket Asthana, "Role of polar nanoregions in the enhancement of the recoverable energy storage density and electrostrictive coefficient in the lead free Na0.25K0.25Bi0.5TiO3" (Featured Article) Mater. Lett. 304 (2021) 130577. 2. **Relevant Publications of Prof Bharat:** 1. S.N. Priyanka S.N., A.K. Yadav, S. Naskar, Durgaraju G., Sheela Singh, B.B. Panigrahi, Low-Temperature Sintering of WC Powder Using CoCrFeMnNi High Entropy Alloy Binder, Transactions of the Indian National Academy of Engineering, (2023) DOI: 10.1007/s41403-023-00443-6 2. S.S.N. Murthy, Manish Patel, T. Sreekantha Reddy, V.V. Bhanu Prasad, Bharat B.Panigrahi, Processing and characterization of carbon fibres reinforced ZrB2 ultra high temperature ceramic matrix composite, Ceramics International, (2021) https://doi.org/10.1016/j.ceramint.2021.08.145. 3. Chandrakant, N.S. Reddy, B. B.Panigrahi, Electro spark coating of AlCoCrFeNi high entropy alloy on AISI410 stainless steel, Materials Letters, 304 (2021) 130580, https://doi.org/10.1016/j.matlet.2021.130580 . 4. Subhendu Naskar, S. Rohila, S. Suryakumar, B. B. Panigrahi, Influence of Heat treatments on Microstructure and Mechanical Properties of Additive Manufactured Inconel 718 Superalloy, Trans. INAE (2021). https://doi.org/10.1007/s41403-021-00247-6 5. R.B. Mane, R. Sahoo, B.K.S. Reddy, V. Ravula, B. B. Panigrahi , P. H. Borse, D. Chakravarty, Doping-induced coloration in titania, J. American Ceramic Society, 104, (2021), 2932-2936 https://doi.org/10.1111/jace.17790.
Essential qualifications	Masters in Physics/Chemistry/ Materials Science OR MTech 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 mathematics skills). Student should have suitable theoretical background to learn and perform research on these topics.
Broad proposal objectives	https://drive.google.com/open?id=1bzFkvRyPqZaiFYBDZOCcBK0O-BqejvR1

PROPOSAL No. - IDPHD2024028

Title of the Proposal	**Synthesis of Novel Organic Relaxor Ferroelectric Polymers for Energy Storage**
Supervisor-1	Abhijit Sau, *Chemistry*
Supervisor-2	Peddigari Mahesh, *Physics*
Email IDs	asau@chy.iith.ac.in mahesh.p@phy.iith.ac.in
Abstract	New chiral triazole difluoride and amide difluoride based organic polymers will be synthesized for relaxor ferroelectric materials. The chiral monomer difluoride azido alkyne and difluoride amino carboxylic acid will be introduced to cause local structural distortions and induce the relaxor behavior in ferroelectric polymers for use in energy storage applications.
Keywords	Organic Synthesis, Relaxor ferroelectric, Polymer, Energy storage, Polar nano regions
Background and Motivation	Relaxor ferroelectric (RFE) polymers exhibit exceptional properties such as high permittivity, high breakdown strength, slim hysteresis loops, and excellent mechanical flexibility, making them ideal for energy storage. With limited availability, a novel synthesis route becomes crucial for fabricating high-performance RFE polymers and enhancing their potential in energy storage technology.
Relevant publications	1. Mahesh Peddigari, Bo Wang, Rui Wang, Woon-Ha Yoon, Jongmoon Jang, et al., Giant Energy Density via Mechanically Tailored Relaxor Ferroelectric Behavior of PZT Thick Film, Advanced Materials, 2023, 35, 2302554. (I.F. factor 32.086). 2. R. Kumar, R. Meher, J. Sharma, A. Sau,* T. K. Panda*, Amidophosphine Boranes as Hydroboration Reagents for Nitriles, Alkynes, and Carboxylic Acids, Org. Lett., 2023, 25, 7923-7927 3. Seonhwa Park, Hyunsu Choi, Geon-Tae Hwang, Mahesh Peddigari, Cheol-Woo Ahn, et al., Molten-Salt Processed Potassium Sodium Niobate Single-Crystal Microcuboids with Dislocation-Induced Nanodomain Structures and Relaxor Ferroelectric Behavior, ACS Nano, 2022, 16, 9, 15328-15338. (I.F. factor: 18.03) 4. Mahesh Peddigari, Jung Hwan Park, Jae Hyun Han, Chang KyuJeong, Jongmoon Jang, et. al., Flexible Self-Charging, Ultrafast, High-Power-Density Ceramic Capacitor System, ACS Energy Letters, 2021, 6, 1383–1391. (I.F. factor: 23.99). 5. P. Chatelain 6. C. Muller, A. Sau, D. Brykczynska; M. Bahadori, C. Rowley, J. Moran “Desulfonative Suzuki-Miyaura Coupling of Sulfonyl Fluorides” Angew. Chem. Int. Ed., 2021, 60, 25307-25312.
Essential qualifications	M.Sc in Chemistry or Physics
Desirable qualifications	Experience of working in organic synthesis
Broad proposal objectives	https://drive.google.com/open?id=1LsXOOSeYJWi0Y9RkPOVA-8nzmt-iDm7X

PROPOSAL No. - IDPHD2024029

Title of the Proposal	**Selective and sequential recovery of critical valuables from silicon solar module wastes and their electronic components as potential materials for circular economy**
Supervisor-1	Suhash Ranjan Dey, *Materials Science and Metallurgical Engineering*
Supervisor-2	Sunil Kumar Maity, *Chemical Engineering*
Email IDs	suhash@msme.iith.ac.in sunil_maity@che.iith.ac.in
Abstract	This study proposes the recycling and recovery of useful materials sequentially such as starting from silicon, silver and aluminium from the panel to copper, tin and lead from the PV ribbon interconnects using various extractive metallurgical techniques which includes hydrometallurgical, pyrometallurgical and electrometallurgical routes. The recovery processing technology at lab scale shall be further developed into the industrial scale.
Keywords	Solar Panels, Recovery, Recycling, Circular Economy
Background and Motivation	With increasing generation of solar panel wastes in several metric tons, handling of the end of life/damaged solar wastes have become a major challenge. Few attempts are being adopted internationally and nationally and are still in their nascent stage. On the other hand, research on recycling of these PV modules is progressing in terms of technological improvements but is not being significant. Therefore, the need for recycling these PV modules has become extremely important to address the challenges in managing and handling the solar wastes globally.
Relevant publications	1. **Suhash Ranjan Dey** 1. Single step electrochemical synthesis of nanocrystalline multicomponent alloy thin films/coatings in an aqueous medium. Chokkakula L.P. Pavithra, Kunda Siri Kiran Janardhana Reddy and Suhash Ranjan Dey, Indian Patent, Patent No. 451603 (Granted). 2. Compositional modulation through galvanic displacement in electrochemically deposited FeCoNiCuZn high entropy alloy thin films. Reddy Kunda Siri Kiran Janardhana, Chokkakula L. P. Pavithra*, and Suhash Ranjan Dey*, Materials Letters, 350, 2023, 134941. (IF 3.574) 3. Strategies to Engineer FeCoNiCuZn High Entropy Alloy Composition Through Aqueous Electrochemical Deposition. Reddy Kunda Siri Kiran Janardhana, Chokkakula L. P. Pavithra*, and Suhash Ranjan Dey*, Electrochimica Acta, 453, 2023, 142350. (IF 7.336) 4. Graphene Oxide Reinforced Magnetic FeCoNiCuZn High Entropy Alloy through Electrodeposition. Chokkakula L. P. Pavithra, Reddy Kunda Siri Kiran Janardhana, Kolan Madhav Reddy, Chandrasekhar Murapaka, Uta Klement and Suhash Ranjan Dey, Journal of the Electrochemical Society, 169, 2022, 022501. (doi: https://doi.org/10.1149/1945-7111/ac4e56) (IF 4.386) 5. An advancement in the synthesis of unique soft magnetic CoCuFeNiZn high entropy alloy thin films. Chokkakula L. P. Pavithra, Reddy Kunda Siri Kiran Janardhana, Kolan Madhav Reddy, Chandrasekhar Murapaka, Joydip Joardar, Bulusu V. Sarada, Rameez R. Tamboli, Yixuan Hu, Yumeng Zhang, Xiaodong Wang and Suhash Ranjan Dey, Scientific Reports, 11, 2021, 8836. (doi: https://doi.org/10.1038/s41598-021-87786-8) (IF 4.996)

	2. **Prof. Sunil Kumar Maity** 1. Kunamalla, SK. Maity, Production of green jet fuel from furanics via hydroxyalkylation-alkylation over mesoporous MoO3-ZrO2 and hydrodeoxygenation over Co/γ-Al2O3: Role of calcination temperature and MoO3 content in MoO3-ZrO2. Fuel 2023, 332, 125977. 2. M Varkolu, A Kunamalla, SAK Jinnala, P Kumar, SK Maity, D Shee, Role of CeO2/ZrO2 mole ratio and nickel loading for steam reforming of n-butanol using Ni–CeO2–ZrO2–SiO2 composite catalysts: A reaction mechanism. International Journal of Hydrogen Energy 2021, 46, 7320-7335. 3. Sudhakara Reddy Yenumala, Pankaj Kumar, Sunil K. Maity, Debaprasad Shee, Hydrodeoxygenation of karanja oil using ordered mesoporous nickel-alumina composite catalysts, Catalysis Today, 2020, 348, 45-54. 4. Venkata Chandra Sekhar Palla, Debaprasad Shee, and Sunil K. Maity, Production of Aromatics from n-Butanol over HZSM-5, H-β, and γ-Al2O3: Role of Silica/Alumina Mole Ratio and Effect of Pressure, ACS Sustainable Chemistry and Engineering, 2020, 8, 15230-15242. 5. Sudhakara Reddy Yenumala, Pankaj Kumar, Sunil K. Maity, Debaprasad Shee, Production of green diesel from karanja oil (Pongamia pinnata) using mesoporous NiMo-alumina composite catalysts, Bioresource Technology Reports, 2019, 7, 100288.
Essential qualifications	B.E./M.Tech./M.Sc. in Science and Engineering
Desirable qualifications	B.E./M.Tech./M.Sc. in Materials Science, Metallurgical Engineering, Chemical Engineering, Chemistry, Nanotechnology
Broad proposal objectives	https://drive.google.com/open?id=1V8J4AQa7WfB0I3gh4qXFbPaiHju3nrwI

PROPOSAL No. - IDPHD2024030

Title of the Proposal	**Point Defect Engineering of two-(2D) Materials for Application in Quantum Technologies**
Supervisor-1	Anuj Goyal, *Materials Science and Metallurgical Engineering*
Supervisor-2	Manish K. Niranjan, *Physics*
Email IDs	anujgoyal@msme.iith.ac.in manish@physics.iith.ac.in
Abstract	Point defects in semiconductors and insulators form an exciting system for realizing atomic defect-based quantum technologies, such as quantum bits (qubits) for quantum computation and single-photon emitters (SPEs) for quantum communication. Our objective in the proposed plan is to develop a computational approach to characterize and engineer point defect qubits in 2D TMs chalcogenides for applications in quantum technologies, spintronics and nanoelectronics.
Keywords	First-principles quantum mechanical DFT calculations; Point defect engineering; excited state properties; quantum technologies
Background and Motivation	One of the pathways to achieve qubits is to engineer deep-level defects analogous to NV centers in diamond. This isolate point defect from the host material such that the localized defect exhibit quantum properties of an isolated atom. Notable works elucidating the interaction between strain and defect qubits tell us that strain may be an important tool in manipulating spin qubits properties with huge implications for quantum technologies and emergent phenomena.
Relevant publications	• M. Ramesh and M. K. Niranjan,"Influence of temperature on bandgap shifts, optical properties and photovoltaic parameters of GaAs/AlAs and GaAs/AlSb p-n heterojunctions: Insights from ab-initio DFT+NEGF studies", Journal of Physics: Condensed Matter, 36, 205504 (2024) DOI: 10.1088/1361-648X/ad2793 • D. Rani et al., "First-Principle Investigation of Structural, Electronic, and Phase Stabilities in Chalcopyrite Semiconductors: Insights from Meta-GGA Functionals", Journal of Physics: Condensed Matter, 36, 165502 (2024) DOI: 10.1088/1361-648X/ad1ca3 • A. Ghosh et al.,"Accurate and efficient prediction of the band gaps and optical spectra of chalcopyrite semiconductors from a non-empirical range-separated dielectric- dependent hybrid: Comparison with many-body perturbation theory", Physics Review B, 109, 045133 (2024), DOI:https://doi.org/10.1103/PhysRevB.109.045133 • Ghosh et al., "Efficient and improved prediction of the band offsets at semiconductor heterojunctions from meta-GGA density functionals: A benchmark study". The Journal of Chemical Physics 157 (12), 124108 (2022). DOI: 10.1063/5.0111693 • Manish K. Niranjan, "Significance of Coulomb interaction in interlayer coupling, Polarized Raman Intensities and Infrared activities in layered van der Walls semiconductor GaSe", Physical Review B, 103, 195437 (2021), DOI: https://doi.org/10.1103/PhysRevB.103.195437 • Goyal, Michael D. Sanders, Ryan P. O'Hayre, and Stephan Lany, "Predicting thermochemical equilibria with interacting defects: Sr1−xCexMnO3−δ alloys for water splitting", Physical Review X Energy 3, 013008 2024. DOI: 10.1103/PRXEnergy.3.013008. • Ximeng Wang, A. Goyal, Peng Zhou, Elizabeth Gager, Dylan McCord, Juan C. Nino, Jonathan Scheffe, Stephan Lany, and Simon R. Phillpot, "LaMnO3 dopants for efficient thermochemical water splitting identified by density functional theory calculations", Journal of Physical Chemistry C 127, 49, 23988 2023.DOI:10.1021/acs.jpcc.3c06835. • M. Witman∗, A. Goyal∗, T. Ogitsu, A. H. McDaniel, and S. Lany, "Defect graph neural networks for materials discovery in high-temperature clean-energy applications", Nature Computational Science 3, 675-686 2023. DOI:10.1038/s43588-023-00495-2. (∗authors contributed equally.) • Goyal, A. Zakutayev, V. Stevanovi´c and S. Lany, "Computational Fermi level engineering and doping-type conversion of Mg:Ga2O3 via three-step synthesis processing", Journal of Applied Physics 129, 245704 2021. DOI: 10.1063/5.0051788.
Essential qualifications	Physics (MSc), Electrical engineering (B.Tech, M.Tech), Material Science and Engineering (B.Tech, M.Tech), Chemical Engineering (B.Tech, M.Tech), Chemistry (MSc)
Desirable qualifications	Solid-state physics, Quantum mechanics, Electronic Structure Methods, Coding skills (Fortran, Python, C/C++)
Broad proposal objectives	https://drive.google.com/open?id=1QnUjCd02_xruIcktsNJPVO3Ne4JUOPre

PROPOSAL No. - IDPHD2024031

Title of the Proposal	**Assessment of growth of Intermetallics using ab-initio calculations and diffusion couple measurements**
Supervisor-1	Mayur Vaidya, *Materials Science and Metallurgical Engineering*
Supervisor-2	Shelaka Gupta, *Chemical Engineering*
Email IDs	vaidyam@msme.iith.ac.in shelaka@che.iith.ac.in
Abstract	In the current project the formation and growth of binary intermetallic phases will be assessed by using combination of computational materials science and diffusion couple experiments. Diffusivities in intermetallic phases will be estimated using DFT, which will serve as input for phase growth simulations.The systems to be examined include Ni-Al, Ti-Al and Fe-Cr.
Keywords	Diffusion, Intermetallics, DFT, CALPHAD
Background and Motivation	In several technological applications, dissimilar interfaces of metals and alloys are encountered. Its important to examine the phase growth at these interfaces, particularly as a function of temperature and time. A combination of experimental measurements and computational assessment provides a comprehseive understanding of phase growth behavior.
Relevant publications	1. **Dr. Mayur Vaidya** 1. S. Sen, M. Glienke, B. Yadav, M. Vaidya, K. Gururaj, K.G. Pradeep, L. Daum, B. Tas, L. Rogal, G. Wilde and S.V. Divinski (2024). Grain boundary self- and Mn impurity diffusion in equiatomic CoCrFeNi multi-principal element alloy. Acta Materialia, 264, 119588. 2. B. Yadav, A. Burla, J. Joardar, Guruvidyathri K., M. Sadhasivam, K. G. Pradeep & M. Vaidya (2024). Grain size effect on the phase growth in CoNi/Sn sandwich diffusion couples. Materialia, 33, 102011. 3. N. K. Chaitanya, B. Yadav, P. P. Bhattacharjee, M. Vaidya, Effect of ultrafine microstructure on interdiffusion-driven phase transformations in Ni-Sn sandwich diffusion couples, Mater. Today Commun. (2023): 105843. 4. B. Yadav, N. K. Chaitanya, M. Sadhasivam, J. Joardar, K. Guruvidyathri, K. G. Pradeep, M. Vaidya, Accelerated Phase Growth Kinetics During Interdiffusion of Ultrafine-grained Ni and Sn, J. Alloys Compd. 948 (2023) 169690. 5. A. Hassanpour, M. Vaidya, S.V. Divinski, G. Wilde, Impact of cryogenic cycling on tracer diffusion in plastically deformed Pd40Ni40P20 bulk metallic glass, Acta Mater. 209 (2021) 116785 2. **Dr. Shelaka Gupta** 1. Rajendran, K., Madampadi, R., Shee, S., Kumar, Subramaniam, R., Khan, T.S., Gupta, S*., Haider, M.A., Jagadeesan, D.* Oxygen Vacancy Mediated Reactivity of CaO/CuO Composite for the Synthesis of Amino-N-heterocycles. ChemCatChem, 15(24), (2023). 2. Rajendran, K., Yadav, J., Khan, T.S., Haider, M.A., Gupta, S*., Jagadeesan, D.* Oxygen Vacancy-Mediated Reactivity: The Curious Case of Reduction of Nitroquinoline to Aminoquinoline by CuO Journal of Physical Chemistry C, 127(18), 8576–8584 (2023). 3. Shenoy, C.S., Khan, T.S.*, Verma, K., Mesfin, T., Jha, K.C., Haider, M.A.*, Gupta, S.* Understanding the origin of structure sensitivity in hydrodechlorination of trichloroethylene on a palladium catalyst Reaction Chemistry and Engineering, 2021, 6(12), 2270–2279 (2021). 4. Rajendran, K., Pandurangana, N., Vinod, C.P., Khan, T.S., Gupta, S., Gupta, S*., Haider, M.A., Jagadeesan, D*., CuO as a reactive and reusable reagent for the hydrogenation of nitroarenes. Applied Catalysis B: Environmental, 297, 120417 (2021). 5. Khan, T.S.*, Gupta, S.*, Ahmad, M., Alam, M.I. & Haider, M.A.* Effect of Substituents and Promoters on Diels-Alder Cycloaddition Reaction in Biorenewable Synthesis of Trimellitic Acid, RSC Adv. 10(51),30656–30670 (2020) .
Essential qualifications	Btech in Metallurgy/ Materials/Computational Materials Science or related streams
Desirable qualifications	Project/internship in diffusion related topics
Broad proposal objectives	https://drive.google.com/open?id=1JXEWWQ6yjif93fRr68kmtT0SJ8KR49by

PROPOSAL No. - IDPHD2024032

Title of the Proposal	**Development of fast responsive pressure-sensitive paints (PSPs) for aerodynamic testing in aerobic and anaerobic flow field**
Supervisor-1	S. K. Karthick, *Mechanical & Aerospace Engineering*
Supervisor-2	M. Annadhasan, *Chemistry*
Email IDs	skkarthick@mae.iith.ac.in annadhasan@chy.iith.ac.in
Abstract	This proposal aims to develop fast-responding pressure-sensitive paints (PSPs) suitable for high-speed flows in aerobic and anaerobic environments. Utilizing thermochromic, piezochromic, and mechanochromic mechanisms, the research addresses challenges in conventional PSPs, offering enhanced sensitivity and versatility for aerodynamic testing. Interdisciplinary collaboration ensures innovative solutions to experimental challenges.
Keywords	Pressure-sensitive paints (PSPs), High-speed flows, Aerodynamic testing, Chromic mechanisms
Background and Motivation	Challenges in short-duration aerodynamic testing demand fast-responding pressure-sensitive paints (PSPs) adaptable to various gas environments. Conventional oxygen quenching mechanisms have become ineffective. Developing PSPs for both aerobic and anaerobic conditions is crucial for accurate measurements in high-speed flows.
Relevant publications	1. **S. K. Karthick** 1. SK Karthick, Soumya R Nanda, J Cohen: Unsteadiness in hypersonic leading-edge separation. Experiments in Fluids; 12/2022; 64(1):13. 2. S Janardhanraj, SK Karthick, A Farooq: A review of diaphragmless shock tubes for interdisciplinary applications. Progress in Energy and Combustion Science; 10/2022; 93(1):101042. 3. Ibrahim M Sugarno, R Sriram, SK Karthick, G Jagadeesh: Unsteady pulsating flow field over spiked axisymmetric Forebodies at hypersonic flows. Physics of Fluids; 01/2022; 34(1):016104. 4. Soumya R Nanda, SK Karthick, TV Krishna, A De, Ibrahim M Sugarno: On the unsteady dynamics of partially shrouded compressible jets. Experiments in Fluids; 10/2021; 62(8):221. 5. D Sahoo, SK Karthick, S Das, J Cohen: Shock-related unsteadiness of axisymmetric spiked bodies in the supersonic flow. Experiments in Fluids; 04/2021; 62(4):89. **M. Annadhasan** 1. D. Barman, M. Annadhasan, A. Bidkar, P. Rajamalli, D. Barman, S. S. Ghosh, R. Chandrasekar & P. K. Iyer, Highly Efficient Color-Tunable Organic Co-crystals Unveiling Polymorphism, Isomerism, Delayed Fluorescence for Optical Waveguides and Cell-imaging, Nat. Commun., (2023) 14, 6648. 2. M. Annadhasan, A. Vinod Kumar, S. Nandy, P. Giri, M. K. Panda, K. V. J. Jose, R. Chandrasekar, Dimension Engineering of Stimuli-Responsive 1D Molecular Crystals into Unusual 2D and 3D Zigzag Waveguides, Angew. Chem. Int. Ed. (2023), 62, e202302929. 3. M Annadhasan, VV Pradeep, AV Kumar, J Ravi, R Chandrasekar, Integrating Triply-and Singly-Bent Highly Flexible Crystal Optical Waveguides for Organic Photonic Circuit with a Long-Pass-Filter Effect, Small Structures (2022), 3, 2100163. 4. M. Annadhasan, A. Agrawal, S. Bhunia, V. V. Pradeep, S. S. Zade, C. M. Reddy, R. Chandrasekar, Mechanophotonics: Flexible Single-Crystal Organic Waveguides and Circuits, Angew. Chem. Int. Ed. (2020), 59, 13852-13858. 5. M. Annadhasan, D. P. Karothu, R. Chinnasamy, L. Catalano, E. Ahmed, S. Ghosh, P. Naumov, R. Chandrasekar, Micromanipulation of Mechanically Compliant Organic Single-Crystal Optical Microwaveguides, Angew. Chem. Int. Ed. (2020), 59, 13821-13830.
Essential qualifications	Fluid dynamics, Chemistry, Aerodynamics, Experimental research
Desirable qualifications	Innovation, Problem-solving, Interdisciplinary mindset, Research experience, Teamwork
Broad proposal objectives	https://drive.google.com/open?id=1q8hI7e9U4F80UlXf_8AB2FDSxSpFatN7

PROPOSAL No. - IDPHD2024033

Title of the Proposal	**Floquet engineering for molecular systems**
Supervisor-1	Atanu Rajak, *Physics*
Supervisor-2	Debasish Koner, *Chemistry*
Email IDs	atanu@phy.iith.ac.in debasishkoner@chy.iith.ac.in
Abstract	In this project, we consider a realistic molecular system that is strongly coupled to a cavity field and exposed to an external time-dependent electric field. Using an open quantum system approach, we want to investigate how the molecular vibrational modes get modified in the presence of periodic driving and how it can be controlled with respect to the amplitude and the frequency of the drive. This project will elucidate the quantum dynamics of molecular systems under electromagnetic fields. In addition, we will explore the possibility of tuning important physical/chemical phenomena e.g., electron transfer in molecule- metal interfaces, excitation energy transfer in condensed phase molecular systems using Floquet engineering and, as a consequence, manipulate target properties for our convenience.
Keywords	Floquet engineering, Quantum Dynamics, Open Quantum Systems, Reaction Rate, Electron Transfer
Background and Motivation	Periodic drives are used to create exotic phases of matter like Floquet topological phases and Floquet time crystals which do not have any static analogue. One common research direction, known as Floquet engineering, aims to design such novel states of matter using periodic driving in high frequency regime. Although the Floquet engineering in closed quantum systems is extensively studied with realizations in optical lattice experiments, the driven open quantum systems are comparatively less explored. In this context, the chemical systems are good candidates to investigate dissipative effects in the Floquet scenario. Also, excitation energy transfer is another elementary and important chemical processes in molecular systems which can be tuned using Floquet engineering. We aim to investigate the effect of periodic driving in the rate of chemical phenomena e.g., electron transfer in electrochemical processes.
Relevant publications	1. A. Rajak, S. Suzuki, A. Dutta, and B K Chakrabarti, Quantum annealing: an overview, Philos. Trans. R. Soc. A 381 20210417 (2022). 2. T. Nag and A. Rajak, Periodic and aperiodic dynamics of flat bands in diamond-octagon lattice, Phys. Rev. B 104, 134307 (2021). 3. A. Kundu, A. Rajak, and T. Nag, Dynamics of fluctuation correlation in a periodically driven classical system, Phys. Rev. B 104, 075161 (2021). 4. D. Koner, Quantum and quasiclassical dynamical simulations for the Ar2H+ on a new global analytical potential energy surface J. Chem. Phys. 154, 054303 (2021) 5. S. Ray, D. Koner, P. Mondal, High-resolution Electronic and Vibrational Spectroscopy of Small-to-medium Sized Molecules with ab initio Potential Energy Surface Electron. Struct. 5, 013001 (2023).
Essential qualifications	M.Sc. or equivalent degree in Physics or Chemistry
Desirable qualifications	Basic computer programming, Quantum Mechanics, Basis Mathematics, Analytical Skills, Good communication skill
Broad proposal objectives	https://drive.google.com/open?id=1TcIVSsrQWPlWPayDs4N27zFyRqiQf2XN

PROPOSAL No. - IDPHD2024034

Title of the Proposal	**Design and development of novel perovskite halides for multifunctional applications**
Supervisor-1	Suresh Perumal, *Materials Science and Metallurgical Engineering*
Supervisor-2	V. Sivakumar, *Chemistry*
Email IDs	suresh@msme.iith.ac.in vsiva@chy.iith.ac.in
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 a class of materials for near-room-temperature thermoelectric applications.
Keywords	Halide perovskite, Thermoelectrics, LEDs, carrier engineering, waste-heat recovery.
Background and Motivation	Recently, the clean energy technologies have received considerable attention 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 efficiency of TE devices is always low, and materials that show moderate 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 applications.
Relevant publications	1. 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. 2. 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. 3. 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. 4. Manojkumar Moorthy, Animesh Bhi, Manjusha Battabyal, Suresh Perumal*, Nanostructured CuFeSe2 Eskebornite: An efficient thermoelectric material with ultra-low thermal conductivity, Mater. Sci. Eng., B., 248,115914, 2022. 5. Madhuvathani Saminathan, Saravanan Muthaiah, Lokeswaran Ravi, Animesh Bhui, Reeshma Rameshan, Ravikirana, and Suresh Perumal*, Improved Thermoelectric properties of Fe-doped Si-rich Higher Manganese Silicides, Mater. Sci. Eng., B., 284, 115912, 2022. 6. Priyansha Sharma , Jaya Prakash Madda and Sivakumar Vaidyanathan, Narrow band dazzling red emitting (LiCaLa(MoO4)3:Eu3+) phosphor with scheelite structure for Hybrid White LEDs and LiCaLa(MoO4)3:Sm3+, Eu3+ Based Deep-Red LEDs for Plant Growth Applications, Dalton Trans., 52, 15043-15056, 2023. 7. Jaipal Devesing Girase, Mangey Ram Nagar, Shahnawaz, A. Choudhry, Jwo-Huei Jou and Sivakumar Vaidyanathan*, Highly Efficient Multifunctional luminogens for Near UV/Deep Blue (CIEy ~0.02) and Hybrid White OLEDs (CIE~0.33, 0.37) with Superior Color Stability – ACS Appl. Electron. Mater. 4, 9, 4368–4382, 2022.

	8. Jaipal Devesing Girase, S Singh, BP Debata, SR Nayak, Mangey Ram Nagar, Jwo-Huei Jou, S. Patel and Sivakumar Vaidyanathan* “Solution-processed imidazole-triphenylamine based fluorophores exceeding theoretical limit (>5%) for deep-blue organic light-emitting diodes: Combined theoretical and experimental study” J. Phys. Chem. C 127, 33, 16623–16635, 2023. 9. Sibani Mund, and Sivakumar Vaidyanathan*, "New Isomeric ancillary ligand and their EuIII complexes: A single component white light emissive phosphor and their applications in Red/White smart LEDs, Electronic Noses and Temperature sensing". J. Mater. Chem. C, 10 (18), 7201-7215, 2022 10. R. Marikumar, R Devi, S. Mund, K. Singh and Sivakumar Vaidyanathan*, Energy transfer cooperation between ligands and EuIII ion in molecular europium complexes for vapoluminescence sensor (reversible on/off emission switching) and hybrid white LEDs, J. Mater. Chem. C, 9 (42), 15034-15046, 2021.
Essential qualifications	As per IITH norms [M.Sc., (Phy/Chem/Materials science) with GATE/M.Tech (NanoScience &Technology and Any branch realted Materials Science)]
Desirable qualifications	Chemisty, Physics, Materials Science
Broad proposal objectives	https://drive.google.com/open?id=1Hgskmnuj78BbX68si4jB06rtTOx7ZKFM

PROPOSAL No. - IDPHD2024035

Title of the Proposal	**Quantum Materials for Integrated Photonics**
Supervisor-1	Shinde Satish Laxman, *Physics*
Supervisor-2	Ranajit Mondal, *Chemical Engineering*
Email IDs	shindesl@phy.iith.ac.in ranajit@che.iith.ac.in
Abstract	Quantum materials for integrated photonics represent a convergence of nanotechnology, quantum science, and photonics, offering transformative opportunities for realizing next-generation photonic devices with unprecedented functionality and performance. This project aims to self-assemble the quantum materials and integrate quantum emitters with photonic waveguides and cavities for the realization of on-chip quantum devices.
Keywords	Self-assembly, Quantum materials, Photonics, Detectors
Background and Motivation	Traditional integrated photonic devices face inherent limitations in terms of efficiency, bandwidth, and scalability. Quantum materials/dots (QDs) offer unprecedented opportunities to overcome these challenges by exploiting the unique quantum properties exhibited by nanoscale structures. This research proposal outlines a comprehensive plan to investigate this integration and its potential applications.
Relevant publications	1. Carbon dioxide adsorption and conversion to methane and ethane on hydrogen boride sheets, T. Goto, S. Ito, S. L. Shinde, R. Ishibiki, Y. Hikita, I. Matsuda, I. Hamada, H. Hosono and T. Kondo, Communications Chemistry, 2022, 5, 1, 1-10. 2. 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. 3. 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. 4. 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. 5. Sub-bandgap photodetection from titanium nitride/germanium heterostructure, S. L. Shinde, S. Ishii, and T. Nagao, ACS Applied Materials & Interfaces 2019, 11 (24), 21965-21972. 6. Jamming of nano-ellipsoids in a micro-sphere: a quantitative analysis of packing fraction by small-angle scattering, A. Das, R. Mondal, D. Sen, J. Bahadur, D. K. Satapathy and M. G. Basavaraj, Langmuir, 2022, 38, 3832–3843. 7. Patterning of colloids into spiral via confined drying, R. Mondal, M. G. Basavaraj, Soft Matter, 2020, 16, 3753-3761. 8. Influence of the drying configuration on the patterning of ellipsoids- concentric rings and concentric cracks, R. Mondal, M. G. Basavaraj, Phys. Chem. Chem. Phys., 2019, 21, 20045-20054. 9. Spray drying of colloidal dispersions containing ellipsoids, R. Mondal, A. Das, D. Sen, D. K. Satapathy, M. G. Basavaraj, Journal of Colloid and Interface Science, 2019, 551, 242-250. 10. Patterns in drying drops dictated by curvature-driven particle transport, R. Mondal, S. Semwal, P. L. Kumar, S. P. Thampi, M. G. Basavaraj, Langmuir, 2018, 34, 11473-11483.
Essential qualifications	M.E/M. Tech. (Chemical, Materials, Nanotechnology, Electrical Engineering) OR M.Sc. (Physics, Applied physics, Electronics, Nanotechnology) with a valid GATE score/CSIR/UGC-NET
Desirable qualifications	Expertise in materials synthesis, their characterization and knowledge on simulation tools are highly encouraged. Proficiency in instrumentation and device fabrication will be viewed as an added advantage.
Broad proposal objectives	https://drive.google.com/open?id=1aa7nztkFhnsKfbXkE76fRkixh0CvStHo

PROPOSAL No. - IDPHD2024036

Title of the Proposal	**Fabrication and multiscale modeling of 2D nanomaterials for sensing applications.**
Supervisor-1	Sushmee Badhulika, *Electrical Engineering*
Supervisor-2	Viswanath Chinthapentha, *Mechanical & Aerospace Engineering*
Email IDs	sbadh@ee.iith.ac.in viswanath@mae.iith.ac.in
Abstract	Two-dimensional (2D) nanomaterials have gained wide attention in applications like sensors, energy storage and harvesting etc. In this work, we propose to synthesize 2D nanomaterials such as hexagonal boron nitride (h-BN), MXenes, transition metal dichalcogenides (TMDs), fabricate devices and perform multiscale modeling for developing various types of multifunctional sensors to detect both physical and chemical stimuli, useful in healthcare applications.
Keywords	Nanoelectronics, 2D nanomaterials, Multiscale modelling, Finite element, Materials, Mechanical Behaviour
Background and Motivation	The proposed work aims at developing 2D nanomaterials for developing various types of multifunctional sensors that have immense potential in healthcare applications. Given the highly interdisciplinary nature of this work, it is required to synthesize 2D nanomaterials, fabricate sensors on various substrates and also focus on the multiscale modeling of structures and devices, exploiting the properties of 2D materials through computational methods to optimize their performance.
Relevant publications	1. S. Veeralingam, L. Sang, H. Pang, R. Ma, S. Badhulika*. High Responsivity of Zero-power-consumption Ultraviolet Photodetector using 2D-MoS2/ i-GaN Vertical Heterojunction. ACS Photonics, 2023, 10, 12, 4408–4416 2. M. Thomas, S. Veeralingam, S. Badhulika*. MoSe2/PVA-based wearable multi-functional platform for pulse rate monitoring, skin hydration sensor and human gesture recognition utilizing electrophysiological signals. Journal of Applied Physics, 2022 132, 224303 3. S. Veeralingam, L. Durai, P. Yadav, S. Badhulika*. Record high responsivity and detectivity of flexible DUV photodetector based on solid state assisted synthesized hBN nanosheets. ACS Applied Electronic Materials, 2021,3, 3, 1162-1169 (ACS Editors' Choice) 4. T Chaitanya Sagar, Viswanath Chinthapenta, Effect of the substitutional and vacancy defects on 2D h-Boron Nitride. Journal of Molecular Modelling, 26 (8), 192,2020 5. T Chaitanya Sagar, Viswanath Chinthapenta, and MF Horstemeyer, Effect of defect guided out-of-plane deformations on the mechanical properties of graphene. Fullerenes, Nanotubes and Carbon Nanostructures, published online, 2020
Essential qualifications	Mtech in EE/ECE/Mechanical & Aerospace (preferably with Nanotechnology as specialization); Btech in in EE/ECE/Mechanical &Aerospace with First class
Desirable qualifications	Knowledge of nanomaterials, semiconductor fundamentals; Knowledge of Finite element methods; Knowledge of Mechanical Behaviour; Comfortable with basic experiments for Mechanical characterization;
Broad proposal objectives	https://drive.google.com/open?id=1Lnp1Y_l3YtyveyqzQ6I4uctl9Ke5RkkU

PROPOSAL No. - IDPHD2024037

Title of the Proposal	**Impact performance of cold-formed steel sheathed wall panels subjected to wind-borne debris**
Supervisor-1	Mahendrakumar Madhavan, *Civil Engineering*
Supervisor-2	Chandra Prakash, *Mechanical & Aerospace Engineering*
Email IDs	mkm@ce.iith.ac.in cprakashj@mae.iith.ac.in
Abstract	The proposed research study will be focused on structural assessment of CFS sheathed wall panels subjected to impact loading. A comprehensive system of experimentally validated computational models for analysis is proposed that will lead to development of design provisions for CFS wall panels under impact loading and prevent penetration threats.
Keywords	Cold-Formed Steel, CFS Sheathed wall panels, Impact loading, Sustainable construction, LGSF building systems
Background and Motivation	Seasonal cyclones hit the coastal region of India almost every year. In such a case, studying the behaviour of structural members subjected to extreme events (cyclones) is imperative to prevent loss of lives and properties. Limited research has been carried out on the impact behaviour of CFS sheathed wall panels.
Relevant publications	1. Sivaganesh Selvaraj and Mahendrakumar Madhavan. (2023). "Direct Stiffness-Strength Method: An Alternative Design Approach to AISI for Sheathed Cold-Formed Steel Z Section Structural Members subjected to bending". Journal of Structural Engineering (ASCE). DOI:org/10.1061/JSENDH/STENG-12340. (Impact factor: 3.858) 2. Sivaganesh Selvaraj and Mahendrakumar Madhavan. (2022). "Application of Direct Stiffness-Strength Method for Design of Gypsum and Plywood sheathed CFS wall panels Subjected to Bending". Thin-Walled Structures. Article Link. (Impact factor: 5.881) 3. Sivaganesh Selvaraj, Mahendrakumar Madhavan, and Lau. H. H (2021). "Sheathing-Fastener Connection Strength-Based Design Method for Sheathed CFS Point-symmetric Wall Frame Studs", Structures. Article Link. (Impact factor: 4.01) 4. Prakash, C. and Ghosh, S., 2023, Self-consistent homogenization-based parametrically upscaled continuum damage mechanics model for composites subjected to high strain-rate loading, Journal of Composite Materials, Vol. 57 (4), pages 545-563. 5. Prakash, C. and Ghosh, S., 2022, Self-Consistent Homogenization-based Parametrically Upscaled Continuum Damage Mechanics Model for Composites Subjected to High Strain-Rate Loading, Journal of Composite Materials.
Essential qualifications	decent CGPA who is technically sound with good analytical and communication skills
Desirable qualifications	fundamentally strong in Mechanics of solids, Structural Analysis, Finite Element Method, and Experimental techniques
Broad proposal objectives	https://drive.google.com/open?id=1vGJd_H9qKT8lREHPL3c6PNHr8MRyEtEX

PROPOSAL No. - IDPHD2024038

Title of the Proposal	**Unsteady dispersion in granular flows**
Supervisor-1	Jyotirmoy Rana, Mathematics
Supervisor-2	Ramkarn Patne, Chemical Engineering
Email IDs	jrana@math.iith.ac.in ramkarn@che.iith.ac.in
Abstract	Despite the importance of the dispersion in granular flows in industrial processes and natural settings, the dispersion of a passive solute is poorly understood. Thus, the goal of the proposed project is to analyse the solute dispersion in granular flows and to present solutions for effective dispersivity using Gill's procedure.
Keywords	Granular flow, dispersion, fluid mechanics
Background and Motivation	Industrial and natural settings necessitate an understanding dispersal of one type of granular material. Modelling the transport of particulate materials is also important in geophysical flows such as snow avalanches, mud and landslides. Despite the importance of the dispersion in granular flows, it is poorly understood.
Relevant publications	1. P Das, Sarifuddin, J Rana, P Kumar Mandal (2022): Unsteady solute dispersion in the presence of reversible and irreversible reactions, Proceedings of the Royal Society A 478 (2264), 20220127. 2. P Das, Sarifuddin, J Rana, P Kumar Mandal (2021): Solute dispersion in transient Casson fluid flow through stenotic tube with exchange between phases, Physics of Fluids 33 (6). 3. R Patne (2024): Effect of inhaled air temperature on mucus dynamics in the proximal airways, Journal of Fluid Mechanics 978, A15. 4. R Patne, J Chandarana (2023): Spatio-temporal dynamics of a two-layer pressure-driven flow subjected to a wall-normal temperature gradient, Journal of Fluid Mechanics 957, A11.
Essential qualifications	M.Sc. in Mathematics/Physics, B.Tech./M.Tech. in Chemical/Mechanical Engineering
Desirable qualifications	M.Sc. in Mathematics/Physics, B.Tech./M.Tech. in Chemical/Mechanical Engineering
Broad proposal objectives	https://drive.google.com/open?id=19MpE6YHSSD4ZNNuH2F0dd0dsJPOmcKA0

PROPOSAL No. - IDPHD2024039

Title of the Proposal	**In-situ monitoring of single drops in droplet microfluidic devices**
Supervisor-1	Suhanya Duraiswamy , Chemical Engineering
Supervisor-2	Shourya Dutta Gupta, Materials Science and Metallurgical Engineering
Email IDs	suhanya@che.iith.ac.in shourya@msme.iith.ac.in
Abstract	Single drop monitoring and identification of variations in successive drops is vital in several applications. Current drop monitoring strategy is to obtain an averaged variation over several drops which leads to loss of real-time information. Here we propose a strategy to resolve this issue and show that real-time in-situ drop monitoring is indeed possible and will be ideal for obtaining desired results through droplet microflows.
Keywords	Droplet Microfluidics, single drop analysis, real-time feedback
Background and Motivation	Droplet microfluidics is currently being used as lab on chip solutions for several applications. However, single drop monitoring, which will be ideal for droplet microfluidic applications, suffer from severe drawbacks due to the lack of proper integration of optical devices, time consuming data acquisition and data post processing. We would like to use our complementary expertise in droplet microflows and optics to overcome these challenges and provide an optimal solution to in-situ single drop monitoring.
Relevant publications	1. Eshita Mukherjee, Jayakumar Pillanagrovi, Dhruv Bhatnagar, and Shourya Dutta-Gupta, "In situ optical spectroscopy for monitoring the assembly of gold nanoparticles for plasmonic applications" Journal of Applied Physics, 133, 073101 (2023) 2. Suhanya Duraiswamy, Saif A. Khan, Dual-Stage Continuous-Flow Seedless Microfluidic Synthesis of Anisotropic Gold Nanocrystals, Particle and Particle Systems Characterization, 2014, 31, 429-432. 3. Suhanya Duraiswamy, Saif A. Khan, Plasmonic Nanoshell Synthesis in Microfluidic Composite Foams, Nano Letters, 2010, 10, 3757–3763. 4. Duraiswamy S., Khan S. A., Droplet-Based Microfluidic Synthesis of Anisotropic Metal Nanocrystals, Small, 2009, 5(24), 2828–2834.
Essential qualifications	BTech and/or MTech in Chemical engineering/Materials/Biotechnology
Desirable qualifications	Nanotechnology or opto-fluidics
Broad proposal objectives	https://drive.google.com/open?id=1EGpd-PBq_-FWAIGvw3IjZaAqXbGYUVpI

PROPOSAL No. - IDPHD2024040

Title of the Proposal	**Phase separation in a binary mixture of active particles in a viscoelastic medium**
Supervisor-1	Ranabir Dey, *Mechanical & Aerospace Engineering*
Supervisor-2	Anupam Gupta, *Physics*
Email IDs	ranabir@mae.iith.ac.in agupta@phy.iith.ac.in
Abstract	We will study the dynamics of phase separation in a binary mixture of self-propelled microswimmers, with different motility, in a viscoelastic medium. We will study both artificial (mixture of isotropic and liquid crystal active droplets) and biological (mixture of bacteria with different motility characteristics) systems using experimental and numerical methods.
Keywords	activity; microswimmers; collective behaviour; phase separation; viscoelasticity
Background and Motivation	Phase separation in a viscoelastic suspension of microswimmers is relevant in the context of biofilm formation in diseases like cystic fibrosis in lungs and in emergent antibacterial resistance. Although the dynamics of a single microswimmer in a viscoelastic medium has been studied, their collective interactions and phase separation remain understudied.
Relevant publications	1. C. M. Buness, A. Rana, C. C. Maass†, R. Dey†, “Electrotaxis of artificial microswimmers in microchannels”, arXiv:2401.14376v1, 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. Elosegui-Artola*, A. Gupta*, A. J. Najibi, B. R. Seo, R. Garry, M. Darnell, W. Gu, Q. Zhou, D. A. Weitz, L. Mahadevan, D. J. Mooney, “Matrix viscoelasticity controls spatio-temporal tissue organization” Nature Materials, 22, 117-127, 2023. (∗Equal contribution). 5. A. Gupta, D. Vincenzi, “Effect of polymer-stress diffusion in the numerical simulation of elastic turbulence”. J. Fluid Mech., 870, 405-418, 2019.
Essential qualifications	Mechanical engineering; Physics; Chemical engineering
Desirable qualifications	Fluid mechanics; vector/tensor algebra and calculus; microfluidics; numerical analysis
Broad proposal objectives	https://drive.google.com/open?id=1nEO-uu7qbVX96KSWuCbm9Js9d3hBQcsm

PROPOSAL No. - IDPHD2024041

Title of the Proposal	**Active particles as a Lego block for materials development**
Supervisor-1	Alan Ranjit Jacob , *Chemical Engineering*
Supervisor-2	Mohd Suhail Rizvi, *Biomedical Engineering*
Email IDs	arjacob@che.iith.ac.in suhailr@bme.iith.ac.in
Abstract	Self-propelled particles hold promise for environmental clean-up, medical diagnostics, and targeted drug delivery. This research explores how these particles' activity affects the macroscopic properties of the materials like glasses and gels. Using computational methods and modeling we will study active materials as an ingredient in materials development.
Keywords	active particles, rheology, material development
Background and Motivation	Active gels are an emerging front of science and engineering with potential applications in the areas of environmental and biomedical engineering. In order to design active gel-based materials it is important to understand the dependence of microscopic structure and activity on macroscopic material behavior.
Relevant publications	1. Pradeep et al., Jamming distance dictates colloidal shear thickening, Physical Review Letters 2021; 2. Kavya et al., Pectin emulsions and emulgels: Bridging the correlation between rheology and microstructure, Food Hydrocolloids 2023; 3. Rizvi et al., Flow driven vesicle unbinding under mechanosensitive adhesion Soft Matter 2022; 4. Mech and Rizvi, Micromechanics of fibrous scaffolds and their stiffness sensing by cells Biomedical Materials 2024
Essential qualifications	BTech/Mtech in any engineering discipline, or M.Sc. in Physics or Mathematics
Desirable qualifications	Comfortable with programming and numerical calculations
Broad proposal objectives	https://drive.google.com/open?id=1e1vGnHV_ok1C42Avf3oBY6tHZFVC5FD7

PROPOSAL No. - IDPHD2024042

Title of the Proposal	**Thermo-mechanical anisotropic fracture in composites**
Supervisor-1	Amirtham Rajagopal, *Civil Engineering*
Supervisor-2	Sai Siddarth, *Mechanical & Aerospace Engineering*
Email IDs	rajagopal@ce.iith.ac.in sidhardh@mae.iith.ac.in
Abstract	Thermo-mechanical fracture is a common occurrence in the components in nuclear reactors, pressure vessels, and advanced additive manufacturing that experience significant thermo-mechanical stress. Phase-field methods offer a promising approach to overcome these limitations and provide a comprehensive understanding of fracture phenomena. The present study would focus on developing a robust thermodynamically consistent phase-field model that incorporates thermo-mechanical coupling to simulate crack initiation and propagation under combined thermal and mechanical loads in Composites.
Keywords	Fracture; Phase-field modeling; Additive Manufacturing; FFT Solvers; Thermo-mechanical loading
Background and Motivation	Phase-field fracture mechanics has emerged as a powerful tool for fracture. Material failure due to the combined effects of temperature and mechanical stress termed Thermo-mechanical fracture is a critical concern in various engineering disciplines. The project aims to develop a robust thermodynamically consistent phase-field model that incorporates thermo-mechanical coupling to simulate crack initiation and propagation.
Relevant publications	1. Pranavi, D., Rajagopal, A., & Reddy, J. N. (2021). Interaction of anisotropic crack phase field with interface cohesive zone model for fiber reinforced composites. Composite Structures, 270, 2021, 114038, https://doi.org/10.1016/j.compstruct.2021.114038. 2. Pranavi, D., Rajagopal, A. & Reddy, J.N. Phase field modeling of anisotropic fracture. Continuum Mech. Thermodynamics. (2023). https://doi.org/10.1007/s00161-023-01260-6. 3. Pranavi, D., Steinmann, P. & Rajagopal, A. A unifying finite strain modeling framework for anisotropic mixed-mode fracture in soft materials. Computational Mechanics 73, 123–137 (2024). https://doi.org/10.1007/s00466-023-02359-y 4. Patnaik, S., Sidhardh, S., & Semperlotti, F. (2020). A Ritz-based finite element method for a fractional-order boundary value problem of nonlocal elasticity. International Journal of Solids and Structures, 202, 398-417. 5. P. Aurojyoti, A. Rajagopal, K.S.S. Reddy, Modeling fracture in polymeric material using phase field method based on critical stretch criterion, International Journal of Solids and Structures, Volume 270, 2023, 112216, ISSN 0020-7683, https://doi.org/10.1016/j.ijsolstr.2023.112216. 6. Rajan A, Desai S, Sidhardh S. Element-free Galerkin method for a fractional-order boundary value problem. Int J Numer Methods Eng. 2024; 125(8):e7429. doi: 10.1002/nme.7429
Essential qualifications	M.Tech in (Civil -Structural/Mechanical- Design/ Aerospace/ Applied Mechanics), CGPA 7.5 and above, B.Tech (Civil/Mechanical/Aerospace/Applied mechanics) CGPA 7.5 and above
Desirable qualifications	Conversant with Programing using MATLAB/C/FORTRAN/PYTHON, COnversant with any of Commercial FEA packages ABAQUS/ANSYS/LSDYNA/COMSOL
Broad proposal objectives	https://drive.google.com/open?id=1WIwWcVdgbXVcY4llSS7LtBLOCB9kEblf

PROPOSAL No. - IDPHD2024043

Title of the Proposal	**Modeling and Experimental Studies on Warpage and Spring-in Behaviour of Hybrid Composite Structures**
Supervisor-1	Gangadharan Raju, *Mechanical & Aerospace Engineering*
Supervisor-2	Balaji Iyer Vaidyanathan Shantha, *Chemical Engineering*
Email IDs	gangadharanr@mae.iith.ac.in balaji@che.iith.ac.in
Abstract	In this project, a thermo-chemo-mechanical semi-analytical/numerical model will be developed to study the warpage deformation of flat laminates and the spring-in deformation of curved hybrid composites. The advantage of semi-analytical methods is that they can provide accurate predictions of deformation behavior while requiring less computational resources than fully numerical methods. They can also provide insights into the physical behavior of the composite material and inform preliminary design decisions. However, semi-analytical methods may not capture all the complex interactions during composite manufacturing and may not be suitable for highly complex geometries or material behavior. To address these issues, a finite element framework based on ABAQUS/COMSOL commercial software is proposed to study CFRP laminates' warpage and spring-in behavior with complex geometries. Further, an experimental campaign will be carried out to study the process-induced deformations of CFRP laminates. As a part of this project, the known geometries like a flat plate, 'L' angle, semi-circular section, and finally, half area of rectangular to circular section will be studied experimentally for the spring in-out effects. CMM is used to measure the warpage and spring-in angle of the fabricated CFRP laminate, and the results are compared with semi-analytical/numerical solutions.
Keywords	Hybrid composites, Warpage, Polymer Cure kinetics, Spring back, Finite element modeling
Background and Motivation	Manufacturing composite components in the aerospace industry has always posed many challenges in the case of polymer matrix composites (PMC). This issue is more critical when the composite structures are fabricated using the Cocuring/Bonding process. A common problem is process-induced deformations like Warpage, Spring in (-), or out (+) encountered during the fabrication of hybrid composite structures of complex geometry. These process-induced deformations will affect the aerodynamic profile of the structures and some assembly mismatches with mating parts. These problems are more common in stealth aircraft structures due to using multiple materials like carbon and glass prepregs during fabrication. Results available in the literature are limited to feature-level elements like L, T, and C stiffeners configuration using unidirectional carbon or glass prepreg materials. Very limited research has been reported on the warpage and spring-in of hybrid composites used for stealth applications. This work investigates the influence of stacking sequence, specimen thickness, tooling material, and cure cycle on the warpage and spring-in of hybrid composite structures using semi-analytical and experimental approaches.
Relevant publications	1. 1) P Mahesh, Viswanath Chinthapenta, Gangadharan Raju, M Ramji, Experimental investigation on open-hole CFRP laminate under combined loading using acoustic emission and digital image correlation, Theoretical and Applied Fracture Mechanics, 130, 2024. 2) Lala Bahadur Andraju, Gangadharan Raju, Damage characterization of CFRP laminates using acoustic emission and digital image correlation: Clustering, damage identification and classification, Engineering Fracture Mechanics, 277, 2023. 3) Lala Bahadur Andraju, M Ramji, Gangadharan Raju, Snap-buckling and failure studies on CFRP laminate with an embedded circular delamination under flexural loading, Composites Part B: Engineering, 214, 2021. 4) Monmee Phukan, Pindi Haritha, Talem Rebeda Roy, Balaji VS Iyer,Mechanical response of networks formed by end-functionalised spherical polymer grafted nanoparticles, Soft matter, 18, 2022. 5) Balaji VS Iyer, Effect of functional anisotropy on the local dynamics of polymer grafted nanoparticles, 18, 2022.
Essential qualifications	Masters in Mechanical, Aerospace or Chemical Engineering,
Desirable qualifications	Computational mechanics, Composites, Polymers, Finite element modeling
Broad proposal objectives	https://drive.google.com/open?id=1klFp-0Jht8IyT2rvBnUCoimnDnAk9PRG

PROPOSAL No. - IDPHD2024044

Title of the Proposal	**Production of polymeric nanofibers from liquid jets using electric fields**
Supervisor-1	Satyavrata Samavedi, *Chemical Engineering*
Supervisor-2	Harish N. Dixit, *Mechanical & Aerospace Engineering*
Email IDs	samavedi@che.iith.ac.in hdixit@mae.iith.ac.in
Abstract	We aim to study the processing of nanofibers prepared using the industrially important process of electrospinning. Experimental tools from fluid mechanics (e.g., PIV) and polymer processing (e.g., rheology), combined with cutting-edge imaging and image-processing techniques, will be used to study the behavior of nanofiber jets under an electric field.
Keywords	Nanofibers, Real time imaging, Flow visualization, Image processing, Rheology
Background and Motivation	Nanofibrous membranes are prepared by subjecting a liquid droplet to an external electric field. They find wide use in advanced applications such as filtration, catalysis and bio-engineering due to specialized properties. This project aims to understand nanofiber initiation, extension and collection to help obtain tightly controlled membrane properties.
Relevant publications	1. N Joy, R Anuraj, A Viravalli, HN 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, 2021, 116200 2. N Joy, D Venugopal, S Samavedi, “Robust strategies to reduce burst and achieve tunable control over extended drug release from uniaxially electrospun composites”, European Polymer Journal, 168, 2022, 111102 3. C. Gupta, L. D. Chandrala, HN Dixit, An experimental study of flow near an advancing contact line: a rigorous test of theoretical models, To appear soon in J. Fluid Mechanics, (2024), arXiv:2311.09560v1 4. C. Gupta, L. D. Chandrala, HN Dixit, An experimental investigation of flow fields near a liquid-liquid moving contact line, Accepted, Euro. Phys. Journal: Special Topics (2024), arXiv:2401.09347v1
Essential qualifications	M.Tech in Chemical Engineering or Mechanical Engineering or Materials Science & Engineering and Allied areas
Desirable qualifications	Interest in nanofibers, experimental fluid mechanics, flow visualization, image processing, polymers
Broad proposal objectives	https://drive.google.com/open?id=1LE9fr6i7gFdPLjokmqBXSD2xXCWrWhVO

PROPOSAL No. - IDPHD2024045

Title of the Proposal	**High Strain Rate Behaviour of Ultra High Performance Concrete under Tensile Loading**
Supervisor-1	S. Suriya Prakash, *Civil Engineering*
Supervisor-2	Syed Khaderi, *Mechanical & Aerospace Engineering*
Email IDs	suriyap@ce.iith.ac.in snk@mae.iith.ac.in
Abstract	The exceptional mechanical qualities of Ultra-High-Performance Concrete (UHPC) are drawing much interest in structural engineering. Its tensile behaviour in extreme conditions, such as high temperatures and strain rates, remains largely unknown. The tensile behaviours mainly govern the design applications in blast-resistant buildings, high-speed impact situations, and fire-resistant structures. It is essential to comprehend how UHPC responds in such circumstances.
Keywords	Ultrahigh performance concrete, high strain rate, tension, SHPB
Background and Motivation	Events like the deadly blast at the BPCL refinery in Mumbai or the catastrophic explosion in a chemical factory in Gujarat's Vadodara district have highlighted the extreme risk that industrial accidents pose in India. These accidents cause environmental dangers, human casualties, and building structural damage. This event urges the researchers to conduct elevated temperature tests on Ultra-High-Performance Fiber-Reinforced Concrete (UHPFRC) under tensile loading at high strain rates. It is critical to understand its behaviour in extreme and dynamic conditions, such as fire-induced scenarios or blast events. Elevated temperatures can significantly affect the mechanical properties of concrete, while high strain rates impose rapid loading, challenging the material's response and structural integrity.
Relevant publications	1. S Ranjithkumar, SN Khaderi, SS Prakash (2021), Development of a 100 mm-Diameter Split-Hopkinson Pressure Bar for High Strain Rate Characterization of Concrete. Proceedings of Recent Advances in Applied Mechanics, Springer, 2. Muthuraja M; Ranjithkumar S; Khaderi S N; Suriya Prakash (2024), High Strain Rate Behavior of Ultra-High-Performance Concrete under Compression at Different Ages, ASCE journal of Materials in Civil Engineering, USA
Essential qualifications	consistent and good academic credentials, experimental background is desirable
Desirable qualifications	Mtech in Structural Engineering, B.E in civil engineering
Broad proposal objectives	https://drive.google.com/open?id=1Ge0EQV3X-cA1nBVddze55lgORr3mXlav

Please Note that this proposal is for a Project-funded position from the research funds of the supervisors. For more information, please contact the supervisors directly.