2023

Interdisciplinary PhD Project Proposals

Center for Interdisciplinary Programs (CIP)

RESEARCH AREAS

- *ARTIFICIAL INTELLIGENCE, COMPUTING, COMMUNICATIONS & NETWORKS*
- *BIOENGINEERING & HEALTHCARE*
- *ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT*
- *NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES*

For any enquires Email us at office.cip@iith.ac.in

భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

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ARTIFICIAL INTELLIGENCE, COMPUTING, COMMUNICATIONS & NETWORKS

Project 1		
Title of the Proposal	:	**Revealing Quantum Supremacy in Communication Games**
Guide-1	:	**Alok Kumar Pan**, *Department of Physics*
Guide-2	:	**M.V. Panduranga Rao**, *Department of Computer Science*
Email	:	akp@phy.iith.ac.in mvp@cse.iith.ac.in
Abstract	:	Communication games are one of the widely used tools that are designed to demonstrate quantum supremacy over classical resources. We plan a focus research on various communication games in prepare-measure and entanglement-assisted scenarios involving an arbitrary inputs and compare the optimal success probability of winning such games in quantum and classical theories.
Keywords	:	Communication game, Quantum supremacy, Quantum nonlocality, Quantum entanglement
Background and Motivation	:	Communication games are novel information processing tasks in which two or more parties collaborate to perform a given task with the highest possible efficiency, provided the amount and type of communication are limited. The nonclassicality of such quantumness has to be adequately analyzed so that the quantum success probability should not be reproduced by classical models.
Essential Qualifications	:	MSc in Physics, Mathematics. BTech and MTech in Theoretical computer science
Desirable Qualifications	:	Strong mathematical background with good knowledge on python, MATLAB. Prior knowledge on quantum information theory is a plus.
Broad Proposal objectives	:	https://drive.google.com/open?id=1AeLnF-wEk7zShOQGzPqu1RO8tYK-31xk

Project 2		
Title of the Proposal	:	**Design of Photonic integrated Circuits for QKD Applications**
Guide-1	:	**Naresh Kumar Emani**, *Department of Electrical Engineering*
Guide-2	:	**Sai Santosh Kumar Raavi**, *Department of Physics*
Email	:	naresh@ee.iith.ac.in sskraavi@phy.iith.ac.in
Abstract	:	The PhD student will work on design, tape-out and characterise scalable, reliable, and low-cost QKD transceivers using photonic integrated circuits. The project will give the student an opportunity to work at the leading edge of integrated photonics and quantum communications.
Keywords	:	QKD, Quantum Photonics, Lasers, Photonics Integrated Circuits
Background and Motivation	:	We are currently in the midst of the second quantum revolution with significant advances in quantum science and technology. Large-scale quantum networks which can enable secure communications over long distances are a key aspect of this ongoing revolution. Various Quantum Key Distribution (QKD) schemes that enable the exchange of quantum keys over a few hundred kilometres have been demonstrated. Most of the present QKD architectures are made of bulky discrete components which are limited in scalability, reliability and cost. We will address these challenges in the PhD research work
Essential Qualifications	:	BTech(ECE/EE), MSc(Physics), MTech(ME&VLSI), MTech(Photonics)
Desirable Qualifications	:	Basic knowledge of quantum mechanics, Semiconductor devices, Electromagnetics, Differential equations and numerical modelling
Broad Proposal objectives	:	https://drive.google.com/open?id=18MDZfCHXCYFplYjUg62QPI7ePOLw94KR

Project 3

Title of the Proposal	:	**Development of Machine Learning Based Surrogate Models for integration of Finite Rate Chemistry in Turbulent Combustion Codes in Openfoam Architecture**
Guide-1	:	**Sayak Banerjee**, *Department of Mechanical and Aerospace Engineering*
Guide-2	:	**Kishalay Mitra**, *Department of Chemical Engineering*
Email	:	sayakb@mae.iith.ac.in kishalay@che.iith.ac.in
Abstract	:	The project aims to develop an OpenFoam compatible ANN-based module for automated reduction and integration of detailed chemical kinetic mechanisms in flamelet based turbulent CFD codes. This will be done by constructing well-validated ANN based surrogate models for Global Sensitivity Analysis based mechanism reduction technique and ANN based look-up table construction for chemical source terms for flamelet CFD codes. This modules are expected to significantly accelerate the simulation of complex combustors in gas turbine and IC engine applications where finite rate chemistry dynamics play an important role.
Keywords	:	Artifical Neural Networks, Chemical Kinetics, Combustion CFD
Background and Motivation	:	Concerns about Climate Change and Pollution have driven the combustor systems in energy, heat and propulsion applications into more challenging regimes of operations with novel carbon neutral fuel blends. Examples include the Homogeneous Charged Compression Ignition Engines, Gas Turbines with ultra-lean premixed and partially premixed combustion regimes, introduction of novel carbon neutral or low carbon fuels like Hydrogen, Ammonia, Methanol, Dimethyl Ether, second and third generation of biofuels like butanol, Lemon Peel Oil etc. Novel fuels introduce novel combustion and pollution chemistry kinetics in the combustor, while the new combustion regimes often suffer from finite rate chemistry limited phenomena like ignition, quenching, flashback and thermos-acoustic instabilities caused by heat release rate fluctuations. Hence it is essential to properly elucidate and integrate finite rate chemistry mechanisms for these fuels into the turbulent combustion CFD codes used to model these new combustor designs. However detailed kinetic mechanisms incorporate hundreds of species and radicals thereby creating a stiff system of ODEs that has to be solved along with the mass, energy, momentum and turbulent closure equations in every iteration. This is too computationally expensive to be tractable in anything but the simplest of systems.

		Traditionally a two-step process had been used to resolve this difficulty. Firstly, the size and stiffness of the detailed chemical mechanism is decreased through computational methods like global sensitivity analysis, directed relations graphs etc. to develop a skeletal mechanism that provides reasonable predictions for important target combustion properties (like flame speed, ignition delay etc.). Secondly, instead of real time computation of the chemical source term, the chemical source term is pre-computed over a range of relevant flamelet configurations and stored in a Look-Up Table from which the relevant data is accessed through suitable interpolation. However, such tabulations also create large memory requirements and becomes difficult as geometry becomes more complicated, the grid size increases and the number of species increase. Recently Machine Learning based models have become an attractive option to partially replace many of the traditionally computationally expensive techniques of combustion modelling [1]. Two particularly promising application of Machine Learning based surrogate models is in the development of high fidelity compact reaction schemes using Global Sensitivity Analysis Methods that were too computationally expensive otherwise [2]; and the potential replacement of the memory intensive chemical source term look up tables with on-the-fly ML based surrogate models [3]. In the current project we propose to develop the Artificial Neural Network (ANN) model surrogates to firstly reduce a detailed chemical kinetic mechanism using Global Sensitivity Analysis into a skeletal mechanism containing the most important species that are relevant to the combustion regime being modelled. Then subsequently an ANN model will also be developed to perform ANN-based Look-Up Table tabulation of the species source terms from the mixture fraction and scalar dissipation rate flamelet manifolds. Well-trained ANN models are both accurate and computationally inexpensive. Thus these ANN based surrogate models, once developed, will greatly accelerate the generation of targeted skeletal mechanisms and the integration of skeletal mechanism based finite rate chemistry into the high-fidelity turbulent CFD codes.
Essential Qualifications	:	Chemical Engineering, Mechanical Engineering, CFD, Machine Learning, Combustion
Desirable Qualifications	:	OpenFoam, Chemical Kinetics
Broad Proposal objectives	:	https://drive.google.com/open?id=1RC5eL8XedZ3RHAf8336PqsmXUTjLZ6GV

Project 4

Title of the Proposal	:	**Nonconvex Sparse Optimization Methods for Electrical Resistance tomography**
Guide-1	:	**Phanindra Jampana**, *Department of Chemical Engineering*
Guide-2	:	**C S Sastry**, *Department of Mathematics*
Email	:	pjampana@che.iith.ac.in csastry@math.iith.ac.in
Abstract	:	In this project, nonconvex sparse recovery algorithms for the systems that arise in Electrical Resistance Tomography will be studied. The developed methods will be experimentally validated on multi-phase flows on Hydrocyclones and Bubble Columns. Further, the proposal will look as well into the data-driven methods as applied to ERT.
Keywords	:	Non-convex sparse optimization, Electric Resistance Tomography, Data-driven methods
Background and Motivation	:	Electrical Resistance Tomography is a non-intrusive technique for visualizing multi-phase flows in real time. However, the main issue with ERT is the low spatial resolution. Nonconvex sparse optimization algorithms can alleviate this problem. This proposal aims to study the theoretical and numerical aspects of nonconvex optimization in ERT along with experimental validation.
Essential Qualifications	:	M.Sc(Applied Mathematics), B.Tech/M.Tech (Chemical Engineering)
Desirable Qualifications	:	Coding experience is essential, Understanding of linear algebra
Broad Proposal objectives	:	https://drive.google.com/open?id=1HBv_TPz4rqRTIsUtI_V1iIVqr6PpE1Tt

BIOENGINEERING & HEALTHCARE

Project 5		
Title of the Proposal	:	**In-Silico Identification of Clinically Relevant Biomarkers from Multi-Modal Biological & Clinical Data analysis for Diagnosis of Lower Respiratory Tract infections**
Guide-1	:	**Dr. Abhishek Subramanian**, *Department of Biotechnology*
Guide-2	:	**Dr. Nagarajan Ganapathy**, *Department of Biomedical Engineering*
Email	:	abhisheks@bt.iith.ac.in gnagarajan@bme.iith.ac.in
Abstract	:	As the diagnosis of lower respiratory tract infections (LRTIs) poses a major challenge, we propose an in-silico diagnostic methodology using multi-modal deep learning algorithms including transformers, few-shot learning and zero-shot learning for integration of multi-omics data, known clinical markers and physiological parameters from patient cohorts to identify novel biomarker combinations for improved assessment and enhancing knowledge in LRTI diagnosis.
Keywords	:	Multi-omics, biomarkers, diagnosis, multi-modal learning, physiology, Deep learning, hybrid architecture
Background and Motivation	:	LRTIs were the 6th leading cause of death in India even before COVID19. To curb rapid infection spread, inappropriate antimicrobial treatments are preferred over-diagnoses. This has led to antimicrobial resistance in LRTIs. A quick way of diagnosing the nature of infection and causal species needs to be established. In recent years, multi-omics data have been explored to understand the biology, the pathway and improved drug discovery of the disease. Thus, multi-omics data assessment using advanced machine learning approaches for LRTIs will help us improved patient-specific models.
Essential Qualifications	:	Bioinformatics, Biomedical engineering, Computer science
Desirable Qualifications	:	Computational biology, Biotechnology, Systems biology
Broad Proposal objectives	:	https://drive.google.com/open?id=1YDZIoaZymwm4eMuYGoiEM29k8njf79i9

Project 6		
Title of the Proposal	:	**Insights into the Genetic Architecture of Cardiovascular Diseases Beyond the Scope of Genome-Wide Association Studies**
Guide-1	:	**Arunabha Majumdar**, *Department of Mathematics*
Guide-2	:	**Rahul Kumar**, *Department of Biotechnology*
Email	:	arun.majum@math.iith.ac.in rahulk@bt.iith.ac.in
Abstract	:	Cardiovascular disease (CVD) is a leading cause of mortality. The common genetic variants associated with CVD, identified by genome-wide association studies (GWAS), often fall in the non-coding region of the human genome, limiting the understanding of their underlying molecular mechanism. We propose to carry out post-GWAS genomic analysis for CVDs.
Keywords	:	Cardiovascular diseases, multiple ancestries, fine mapping, transcriptome-wide association study, polygenic risk prediction.
Background and Motivation	:	CVDs affect the blood or heart vessels. The risk of CVD has increased substantially among COVID-19-infected individuals. Both genetic and non-genetic risk factors contribute to the pathogenesis of CVDs. GWAS signals lack adequate biological interpretation. The exploration of the genetic basis of CVDs in non-Europeans, e.g., Asians, is limited.
Essential Qualifications	:	First class degree in Bioinformatics / Mathematics / Statistics / Computer science / Biotechnology
Desirable Qualifications	:	Interests to learn computer programming, statistics, quantitative science, genomics, cardiovascular diseases
Broad Proposal objectives	:	https://drive.google.com/open?id=1sYeIHmbygmOZ7cNUQTZhVCwBgy5fklSs

Project 7		
Title of the Proposal	**:**	**Catch Bond inspired Biomimetic Climbers for Soft Robotic Applications**
Guide-1	**:**	**Balaji Iyer V S,** *Department of Chemical Engineering*
Guide-2	**:**	**Safvan Palathingal,** *Department of Mechanical and Aerospace Engineering*
Email	**:**	balaji@che.iith.ac.in safvan@mae.iith.ac.in
Abstract	**:**	Unlike normal slip bonds, catch bonds exhibit an enhanced lifetime under action of an external force. There are distinct energy landscapes that can lead to such catch bond behaviour. In this project, we propose to translate these energy landscapes into mechanical designs that can be a useful in designing biomimetic climbers for soft robotic applications.
Keywords	**:**	Catch bonds, Soft Robotics, Compliant Mechanisms, Multiscale Simulations
Background and Motivation	**:**	The efficiency of a Gecko's climb has been an inspiration in conceiving a wide range of robotic applications. There are variety of maneuvers that enables a robotic climber change its location and direction of motion on a vertical wall. We intend to design a biomimetic climber that is flexible like a Gecko and has force-dependent multi-state mechanics as in a catch bond. Such climbers can climb without an active control on a vertical wall and mimic the motion of the Gecko that enables both a change in its location and direction of motion.
Essential Qualifications	**:**	Candidates with Mechanical Engineering, Chemical Engineering, Applied Mathematics, or Physics background
Desirable Qualifications	**:**	C Programming, Knowledge of CAD/CAE, Python Scripting
Broad Proposal objectives	**:**	https://drive.google.com/open?id=1F5o5p8UG5k-my-5vjOxk5ETyslX3XUbT

Project 8		
Title of the Proposal	:	**Conductive Composite Hydrogels of Bioinspired Small Molecules and Conductive Polymers towards Cardiac Tissue Engineering**
Guide-1	:	**Dr. Priyadarshi Chakraborty**, *Department of Chemistry*
Guide-2	:	**Dr. Falguni Pati**, *Department of Biomedical Engineering*
Email	:	priyadarshi@chy.iith.ac.in falguni@bme.iith.ac.in
Abstract	:	We propose the development of adhesive scaffolds utilizing bioinspired supramolecular co-assembled hydrogels and conductive polymers for cardiac tissue engineering. While the adhesive property will help in successful application of the engineered patch into the damaged area, the conductivity ensures better coordination between the cardiomyocytes towards constructive tissue healing and regeneration.
Keywords	:	Hydrogels, Cardiac tissue engineering, Conductive polymer, Peptides
Background and Motivation	:	Cardiovascular diseases in India are in an epidemic state and have led to 23% of total deaths in 2010-2013. Tissue engineering is an effective approach to treat cardiovascular diseases using cell instructive 3D biomaterials for formation of functional tissues. Our approach could open new avenues in cardiac tissue engineering.
Essential Qualifications	:	MSc in Biotechnology (60% and above) or Chemistry (60% and above) or Biology (60% and above), OR MTech in Biomedical or Chemical or Biotechnology or related disciplines
Desirable Qualifications	:	Basic knowledge on biomaterials and cell culture
Broad Proposal objectives	:	https://drive.google.com/open?id=1C7AdUCgO7zbeKv--nnw6ZPs2XJs75zQO

Project 9		
Title of the Proposal	:	**Investigation of Disruptions in Biological Clock, Sleep, and Cognitive Functions in Alzheimer's Disease for Novel theranostic Implications**
Guide-1	:	**Dr. Sandipan Ray**, *Department of Biotechnology*
Guide-2	:	**Dr. Neeraj Kumar**, *Department of Liberal Arts*
Email	:	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.
Essential Qualifications	:	MSc/MTech in any area of Life Sciences or Biology
Desirable Qualifications	:	Basic background in the programming languages (R or Python), Experience in regular molecular biology techniques, Dissertation/internship experience in any reputed national institutes
Broad Proposal objectives	:	https://drive.google.com/open?id=1vi-mU1GPIjqx7PTqh8W9qCVDxdcfQmvO

Project 10		
Title of the Proposal	:	**Microfluidic Paper-Based Device for Rapid Colorimetric Detection of Urinary Copper for Diagnosis of Wilson's Disease**
Guide-1	:	**Dr. Somnath Maji,** *Department of Chemistry*
Guide-2	:	**Dr. Anindya Roy,** *Department of Biotechnology*
Email	:	smaji@chy.iith.ac.in anindya@bt.iith.ac.in
Abstract	:	Wilson's disease is an autosomal recessive Mendelian disorder characterized by excessive copper deposition in vital organs. This disorder is found throughout the World, however, the prevalence is much higher in the consanguineous populations of India. If the urinary copper level is higher than 100 mcg/dL, the WD is confirmed. Commonly, atomic absorption spectrophotometry is used to determine urinary copper level. However, this instrument is expensive, requires skilled manpower. Therefore, we propose to develop a simple paper-based point-of-care diagnostic device to colorimetrically detect high urinary copper levels relevant to Wilson's disease. The microfluidic pattern will be printed on chromatographic paper and detection will be based on two mechanisms: (i) inhibition of an enzyme-coupled redox reaction leading to the reduction of tetrazolium salt into coloured compound and (ii) binding of copper to a synthetic compound having ligand architecture and concomitant colour change.
Keywords	:	Wilson disease, redox reaction, microfluidics, Copper detection
Background and Motivation	:	Urinary Cu level analysis is the most popular biochemical test for WD because the amount of copper in the urine in WD patients is often higher (100 mcg/dL) than normal (10-50 mcg/dL). Thus, to diagnose WD, it is crucial to develop a simple biochemical test that will be able to show when the -urinary Cu level is more than 100 mcg/dL. To analyse the urinary Cu level, various techniques can be used. For efficiently measuring copper (II) ions in white wine, Doumani et al. used a chemosensor based on rhodamine-B coupled to a tetra-azamacrocyclic ring. However, this novel chemical requires organic synthesis and spectroscopic measurement. As there are no rapid point-of-care (POC) tests available for urinary Cu detection, we aimed to develop a simple paper-based test that can provide a visual readout when urinary Cu exceeds 100mcg/dL suitable for field use.
Essential Qualifications	:	MSc., MTech, GATE
Desirable Qualifications	:	Chemistry, Biochemistry
Broad Proposal objectives	:	https://drive.google.com/open?id=15-6HQjklm2hUc2-vJL_40Pezzlw5mW1p

Project 11		
Title of the Proposal	:	**Computational Identification, Experimental Validation, and Selective Chemical Engineering of Myxobacterial Lanthipeptides for Enhanced Pharmacological Properties**
Guide-1	:	**Dr. Gaurav Sharma**, *Department of Biotechnology*
Guide-2	:	**Dr. Ashutosh Kumar Mishra**, *Department of Chemistry*
Email	:	sharmag@bt.iith.ac.in akm@chy.iith.ac.in
Abstract	:	The emergence of multidrug-resistant bacteria has triggered an increased requirement for novel antibiotic alternatives. Lanthipeptides have been suggested to be promising alternatives to conventional antibiotics. Myxobacteria are one of the largest sources of secondary metabolites, including antimicrobial lanthipeptides. The present study aims to explore the diversity, organization, structure, antibacterial spectrum, and chemical biosynthesis/modification approaches of myxobacterial lanthipeptides.
Keywords	:	Secondary metabolites, Comparative genomics, Evolution, Chemical synthesis, Chemical modifications
Background and Motivation	:	Nowadays, Bacteria are becoming more and more resistant to diverse, widely used antibiotics; however, the rate at which new molecules are discovered has recently decreased. This project will aim for computational genomics-focused identification of novel secondary metabolites (especially lanthipeptides) from Myxobacteria, from which selected lanthipeptides will be chemically engineered to enhance their pharmacological properties.
Essential Qualifications	:	• MSc or MTech with Biological/chemical Science related subject • Exposure/Experience in Bioinformatics or sequencing data handling • Willingness to work in an interdisciplinary research project (both biology and chemistry-oriented) work
Desirable Qualifications	:	• Exposure to experimental biotechnology or chemistry labs • CSIR/ICMR/DBT/INSPIRE/GATE fellowship
Broad Proposal objectives	:	https://drive.google.com/open?id=1P4Y7jwFElDffc1EETZT1GTRAgH2fSx4r

Project 12		
Title of the Proposal	:	**Study of Biomolecular Docking Using Electronic Spectroscopy and Imaging Techniques**
Guide-1	:	**Dr. Surajit Maity**, *Department of Chemistry*
Guide-2	:	**Dr. Vandana Sharma**, *Department of Physics*
Email	:	surajitmaity@chy.iith.ac.in vsharma@phy.iith.ac.in
Abstract	:	The structure and energetics of molecular docking on the surface of aromatic molecules will be investigated for potential application in analgesia, anesthesia, drug delivery. Here, we propose to study the preferential docking sites in multifunctional molecule 22'peridylbenzimidazole (PBI) using R2PI and velocity map imaging spectroscopy and investigate the dissociation dynamics.
Keywords	:	Molecular Docking, non-covalent interaction, Laser spectroscopy, Velocity map imaging
Background and Motivation	:	The molecular docking via noncovalent interactions involving π electrons density are observed in tertiary structure of proteins and nucleic acids. The reversible nature of the interaction is suitable to apply in biological processes (anesthesia). Spectroscopic determination of the docking sites, energetics, and dissociation dynamics are crucial to investigate practical application.
Essential Qualifications	:	MSc in Physics/Chemistry and related areas.
Desirable Qualifications	:	Knowledge in Laser Spectroscopy, Physical Chemistry, Chemical Physics, Optics, Ion and Electron imaging
Broad Proposal objectives	:	https://drive.google.com/open?id=1jqWQoNUZbcIBHnSSSZbrY9tr1Uxz7dvh

Project 13

Title of the Proposal	:	**Plants and/as Medicines: an interdisciplinary Study on Diabetic Neuropathy**
Guide-1	:	**Dr. Haripriya Narasimhan**, *Department of Liberal Arts*
Guide-2	:	**Dr. Lopamudra Giri**, *Department of Chemical Engineering*
Email	:	haripriya@la.iith.ac.in giril@che.iith.ac.in
Abstract	:	This project will look at the use of traditional knowledge of medicinal plants among local population in developing a pharmacological project to treat conditions diabetic neuropathy. This project will study ethnomedicine and in vitro drug screening approaches based on bioengineering platforms to treat chronic health conditions like diabetic neuropathy.
Keywords	:	medical anthropology, traditional medicine, ethnopharmacology, in vitro drug testing, in silico drug analysis.
Background and Motivation	:	This study harnesses traditional medicinal knowledge to develop ethnopharmacological product for diabetic neuropathy. There are no suitable methods to test multi-target plant-extracts on the cell level, although they are known to alleviate symptoms. This study will understand the multiple targets through biochemical and imaging methods. Our aim is to combine our skills in social science and engineering.
Essential Qualifications	:	background in anthropology/Botany/Zoology/Biological sciences/Biotechnology/ Pharmacy/ (BSc/MSc in these subjects)
Desirable Qualifications	:	Training in some social science methods. Experience in doing field-based research will help. Knowledge of vernacular languages (written and spoken) is also useful. -Experience in preparing plant extract using solvent extraction, in silico analysis , data collection.
Broad Proposal objectives	:	https://drive.google.com/open?id=1EF1YpoGevWva5PFj1wEE8jaD3jYG8mz6

Project 14		
Title of the Proposal	:	**Ultrasonics and Sensors for Medical Applications**
Guide-1	:	**Avinash Eranki**, *Department of Biomedical Engineering*
Guide-2	:	**Suresh Garlapati**, *Department of Materials Science and Metallurgical Engineering*
Email	:	aeranki@bme.iith.ac.in gsuresh@msme.iith.ac.in
Abstract	:	Ultrasound imaging/therapy and sensors are used widely in understanding and treating diseases non-invasively. We are building sensors and ultrasonic capabilities to non-invasively, accurately, and safely treat solid tumors. In addition, we are building novel surface sensors that can monitor different metabolites and perform ultrasonic sensing of blood flow.
Keywords	:	Sensors, Ultrasound, Cancer Therapy, Solid Tumors
Background and Motivation	:	Many solid tumors tend to be refractory, and most patients exhaust treatment options. We are developing novel sensing technologies that can pick up analytes and changes in blood flow in tumors as they evolve and help track their progression. In addition, these sensors help improve ultrasound therapy of solid tumors.
Essential Qualifications	:	M.Tech. in Electrical or Biomedical engineering; M.Tech in Materials Science or Nanotechnology; M.Sc. in Physics
Desirable Qualifications	:	Experimental skills, Prior experience in sensors/ultrasound; Expertise in functional materials and characterization techniques.
Broad Proposal objectives	:	https://drive.google.com/open?id=1IalJoRhPQG4YJq3lxsRjNgxKf5BXsy1p

Project 15

Title of the Proposal	:	**An Efficient Finite Element Method for Blood Flow in Arteries**
Guide-1	:	**Anand Mohan**, *Department of Chemical Engineering*
Guide-2	:	**Sathya Peri**, *Department of Computer Science & Engineering*
Email	:	anandm@che.iith.ac.in sathya_p@cse.iith.ac.in
Abstract	:	Computational simulation is a valuable tool to predict the flow field during blood flow in arteries. However, simulation is time-consuming. One reason is that the methods for solid deformation (finite-element/-difference) are different from fluid flow (finite-difference/-volume): a solution is to develop a unifying method as proposed here.
Keywords	:	Blood flow, Finite elements, Non Newtonian fluid, Elastic wall
Background and Motivation	:	Cardiovascular disease is the leading cause of mortality in India. Atherosclerosis is responsible for more than 50% of these deaths. Atherosclerosis is characterized by the deposition of fatty material in the artery wall leading to a reduction of the flow area. Blood flow in blocked flexible-walled tubes must be understood to understand atherosclerosis.
Essential Qualifications	:	BTech & MTech in Mechanical Engg/Chemical Engg in any combination
Desirable Qualifications	:	Numerical Methods, Non Newtonian fluids, Continuum Mechanics, Transport Phenomena,Interest/Experience in C++
Broad Proposal objectives	:	https://drive.google.com/open?id=1or1J-VtLvym-h_MTC_-p85mmA7K9JNaQ

ENERGY, ENVIRONMENT, CREATIVE DESIGN & MANAGEMENT

Project 16		
Title of the Proposal	:	**Digitization of Tangible Heritage for 3D Reconstruction**
Guide-1	:	**Prasad Onkar**, *Department of Design*
Guide-2	:	**Surendra Nadh Somala**, *Department of Civil Engineering*
Email	:	psonkar@des.iith.ac.in surendra@ce.iith.ac.in
Abstract	:	Digital documentation of heritage sites is important as they get wiped off the face of the earth during natural disasters and other anthropogenic reasons. Preserving them would help in reconstruction at a later stage. Advances in 3D printing help in making toy models, replicas, and prototypes of heritage structures. Future improvements make even permit full-scale models of those heritage structures and in such cases also digitally preserving the structural model is essential.
Keywords	:	digital documentation; heritage; 3D reconstruction
Background and Motivation	:	Several heritage gets destroyed every now and then due to various reasons, including but not limited to, disasters. The idea is to store digital replicas of heritage. This can help 2 fold. Firstly, preserving them and possibly doing 3D printing of them. Secondly, facilitate head-mounted displays and cave immersive environments of how it would have been to enter those heritage sites, without actually going all the way.
Essential Qualifications	:	GATE/CSIR-NET qualified; Bachelors and Masters scores greater than 70%; Masters degree with a 4 year Bachelors;
Desirable Qualifications	:	AR/VR; Unity; Blender; Unreal Engine; LiDAR; Photogrammetry
Broad Proposal objectives	:	https://drive.google.com/open?id=1ixz2RY3IUcaWl223UVUuZuogw6dbI-5m

Project 17		
Title of the Proposal	:	**H2-Storage Materials**
Guide-1	:	**Subrahmanyam**, *Department of Chemistry*
Guide-2	:	**Sai Ramakrishna Malladi**, *Department of Materials Science and Metallurgical Engineering*
Email	:	csubbu@chy.iith.ac.in srkm@msme.iith.ac.in
Abstract	:	Hydrogen could offer higher the energy density (120 MJ/kg versus 35 MJ/kg) over gasoline without pollution effects. The DoE set a target of 7 wt% hydrogen storage capacity by solid state materials for on-board applications. Specifically, mobility based applications would require hydrogen storage/release under ambient conditions ideally. In this scenario, solid materials for storing hydrogen would be attractive either through physi-sorption or chemisorption. The objectives of this project is to develop M-xenes with tunable physico- chemical properties for reversible storage of more than 6 wt%.
Keywords	:	Solid state hydrogen storage, Mxenes, COFs
Background and Motivation	:	Solids with more than 6 wt% hydrogen storage
Essential Qualifications	:	M.Tech (Chemical/Materials), M.Sc (Chemistry)
Desirable Qualifications	:	M.Tech/M.Sc
Broad Proposal objectives	:	https://drive.google.com/open?id=1my8eNItl48Mw8CoWoAMLOhBoDQPZHYon

Project 18		
Title of the Proposal	:	**Exploring the influence of Consumer and Non-Consumer Behavioural Attributes on Socially Sustainable Supply Chain Design**
Guide-1	:	**Lohithaksha Maniraj Maiyar**, *Department of Entrepreneurship and Management*
Guide-2	:	**M. P. Ganesh**, *Department of Liberal Arts*
Email	:	l.maiyar@em.iith.ac.in mpganesh@em.iith.ac.in
Abstract	:	The study will be aimed at investigating the influence of considering social factors especially the behavioral side of consumers as well as non-consumers, stakeholder engagement and cross cultural consideration on sustainable supply chain performance.
Keywords	:	Sustainable Supply Chain Design, Consumer behaviour and stakeholder engagement, risk attitude
Background and Motivation	:	This research is motivated by the need for considering behavioral aspects such as human behavior, stakeholder collaboration, communication, decision-making for enhancing the supply chain performance considering the social front. The increasing awareness amongst decision-makers calls for supply chain design for cognitive biases, behavioral attributes, stakeholder engagement, sustainability and cross-cultural studies.
Essential Qualifications	:	Valid JRF NET/GATE score
Desirable Qualifications	:	MTech or equivalent in Industrial Engineering or Humanities and social sciences
Broad Proposal objectives	:	https://drive.google.com/open?id=1d5xw31raI3IjqD7es2dvT13ZC4_D6yo_

Project 19		
Title of the Proposal	:	**Variability in the Dynamics of inter-Tropical Convergence Zone Across Tropics**
Guide-1	:	**Vishnu R. Unni**, *Department of Mechanical and Aerospace Engineering*
Guide-2	:	**Maheswaran R,** *Department of Civil Engineering and Climate Change*
Email	:	vishnu.runni@mae.iith.ac.in rmaheswaran@ce.iith.ac.in
Abstract	:	This project will study the spatial and temporal variability in seasonal dynamics of the Intertropical Convergence Zone (ITCZ) by studying the dynamics of Outgoing Longwave Radiation (OLR) in conjecture with other climate variables such as rainfall, sea surface temperature, pressure levels and wind anomaly. The study will explore the dynamics of a complex network representing the ITCZ.
Keywords	:	Intertropical Convergence Zone, Climate Networks, Network Dynamics, Precursors to weather events, Multiscale Process
Background and Motivation	:	Intertropical convergence zone (ITCZ) forms a critical part of the Earth's climate system. Dynamics of ITCZ have significant socioeconomic implications for the countries along the tropics, affecting a large portion of the world population. Understanding the dynamics of seasonal migration of ITCZ is essential in predicting the onset of monsoon and other critical weather events across this region.
Essential Qualifications	:	BTech/ MTech (Mechanical, Aerospace, Civil, Chemical, Computer Science, Climate Change) or MSc (Physics, Geology, Climate Physics) or any allied area
Desirable Qualifications	:	Good Mathematical Background, Coding Ability, Agile and Motivated
Broad Proposal objectives	:	https://drive.google.com/open?id=1VvclYWMDXoFGa4F3CQ6vkGgoIRpfOLzS

Project 20		
Title of the Proposal	:	**Durability Studies on Glass Fiber Reinforced Polymer Rebars Used in Civil infrastructure Applications**
Guide-1	:	**S. Suriya Prakash**, *Department of Civil Engineering*
Guide-2	:	**Dr R Gangadharan**, *Department of Mechanical and Aerospace Engineering*
Email	:	suriyap@ce.iith.ac.in gangadharanr@mae.iith.ac.in
Abstract	:	GFRP rebars are a composite material of glass fibres embedded in the epoxy resin matrix. GFRP rebars have many benefits over conventional steel rebar, like superior mechanical properties, corrosion resistance, high strength-to-weight ratio, and low carbon footprint. Although GFRP bars have better properties than steel bars, their behaviour is vulnerable under different environmental conditions. The resin matrix in the rebar first comes in contact with the external environment acting as a shield to the internal fibres. The interface mechanisms are the most critical area in degradation. First, the resin is dissolved in various environmental conditions causing delamination and crack. Therefore, studying the durability aspects of GFRP rebars is of prime importance. This research project will propose different reduction factors according to the Indian environmental conditions. These reduction factors are generally considered in the design of GFRP rebar-reinforced concrete structures, considering serviceability. IIT Hyderabad has state of an art facility to study and provide quality research to develop knowledge on GFRP rebars. GFRP rebar under tension using a strain gauge and extensometer to record the strains. Various experimental studies, such as tension, shear, compression, and fatigue tests, with a capacity of 250 kN. The alkaline boxes are fabricated in IIT Hyderabad with a width of 10 mm immersion to stimulate the concrete environment. Alkaline solution (pH 12-14) is poured into it at a certain temperature and then tested. The creep Setup has been designed and built in IIT Hyderabad with a capacity of 500 KN and a magnifying factor of 100 times. Creep performance of GFRP rebars under alkaline environment will also be studied in this work.
Keywords	:	GFRP rebars, Tension test, Corrosion resistance, Creep, Alkaline Environement
Background and Motivation	:	It is critical to study the durability aspects of GFRP rebars as they are more complex in their material composition than steel rebars. GFRP rebar properties depend not only on fibres and resin matrix but also on production quality. Studying the durability of GFRP rebar is essential as physical and environmental factors affect the rebar's properties when we stimulate the real concrete environment.
Essential Qualifications	:	Civil Engineering, Structural Engineering, Engineering mechanics, Experiemental Research
Desirable Qualifications	:	B.E/ Btech in civil Engineering, M-tech in Civil Engineering
Broad Proposal objectives	:	https://drive.google.com/open?id=1SEFIRsM1BjPhoZfx8cBa87eGZNd2XI4m

Project 21		
Title of the Proposal	:	**Carbon Nanofibers Based Next-Generation High-Performance Potassium-Sulphur Batteries: Looking Beyond Lithium**
Guide-1	:	**Chandra Shekhar Sharma**, *Department of Chemical Engineering*
Guide-2	:	**Mudrika Khandelwal**, *Department of Materials Science and Metallurgical Engineering*
Email	:	cssharma@che.iith.ac.in mudrika@msme.iith.ac.in
Abstract	:	In the development of next-generation energy storage devices, potassium-sulfur batteries are among the most appealing candidate owing to the great abundance of potassium and sulfur in India. This battery can replace the current state-of-art lithium-ion batteries at a lower cost, which have dominated the current market for various applications.
Keywords	:	Energy Storage Devices, Carbon Nanomaterials, Metal-Sulfur Batteries
Background and Motivation	:	Previous studies on the K-S battery chemistry demonstrated low cycle life, which needs considerable improvement to realize the practical development of K-S batteries. One such future scope is to explore the different sulfur hosts with an effective conductive matrix that can enable the long cycle life of KSB chemistry.
Essential Qualifications	:	B.Tech. (Chemical/Materials Sci Engg), M.Tech. (Chemical/Materials Sci. Engg./Nanotechnology/Energy), M.Sc. (Physics/Chemistry) with NET/GATE
Desirable Qualifications	:	Electrochemistry, Nanomaterials, Carbon Nanofibers, Batteries and Supercapacitors
Broad Proposal objectives	:	https://drive.google.com/open?id=1yVkpfEGNZDolDYYQ_pupBXmfkNcEPlMP

Project 22		
Title of the Proposal	:	**Wind Power forecasting Using High-Performance Computing and Machine Learning**
Guide-1	:	**Niranjan S Ghaisas**, *Department of Mechanical and Aerospace Engineering*
Guide-2	:	**Sathya Peri**, *Department of Computer Science and Engineering*
Email	:	nghaisas@mae.iith.ac.in sathya_p@cse.iith.ac.in
Abstract	:	This project combines high-performance (HPC) computational fluid dynamics simulations of wind-farms, semi-analytic wake models, and novel machine-learning techniques to develop a suite of well-validated and computationally efficient wind-power forecasting tools. The student will gain experience in CPU/GPU parallel computing, conducting 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 these through machine-learning is promising.
Essential Qualifications	:	BE/BTech/ME/MTech in Computer Science, Mechanical Engineering or affiliated areas The student should be comfortable with programming and be eager to write numerical codes in a language such as C/Fortran/Matlab/Python.
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=19w-hxEXuEeILg8pipN1Qyt_Ee8Y2w42w

NOVEL MATERIALS & COMPUTATIONAL TECHNIQUES

Project 23		
Title of the Proposal	:	**Development and Application of Multi-Phase CFD Model for Dispersive/Particulate Flows At Moderate to High Concentrations**
Guide-1	:	**Narasimha Mangadoddy**- *Department of Chemical Engineering*
Guide-2	:	**Raja Banerjee**- *Department of Mechanical and Aerospace Engineering*
Email	:	narasimha@che.iith.ac.in rajabanerjee@mae.iith.ac.in
Abstract	:	Modeling multi-phase industrial flows is very complex and requires detailed incorporation of the forcing models, turbulence, phasic stress and rheology. The broad objective this project is to develop the forcing models incorporating in a multiphase CFD solver, validate and simulate flows under various flow configurations at moderate to high concentrations
Keywords	:	Algebraic slip mixture model, Phasic-stress, rheology, Turbulence modeling
Background and Motivation	:	Several industrial flows consist of multiphase fluid flow involving one or more dispersed phases. Interaction of these phases among themselves and with the continuum medium of significant interest. Forcing models to simulate such interactions under moderate to high dispersive phase concentration in CFD solvers need to be developed. The goal of this project would be developing such models and simulate industrial grade flows.
Essential Qualifications	:	M.Tech in either in Chemical Engineering or Mechanical Engineering
Desirable Qualifications	:	Multiphase flow, CFD, particulate flows, turbulence modeling, OpenFOAM
Broad Proposal objectives	:	https://drive.google.com/open?id=1TYbLzTBsBfywUiTPbvBGJm7DoeZJ46-q

Project 24		
Title of the Proposal	:	**Fluid Dynamics of Raindrops – Estimation of the Size Distribution of Raindrops At Different Altitudes Using an Existing State-of-The-Art Experimental Facility**
Guide-1	:	**Prof. Kirti Chandra Sahu,** *Department of Chemical Engineering*
Guide-2	:	**Prof. Lakshmana Dora Chandrala**, *Department of Mechanical and Aerospace Engineering*
Email	:	ksahu@che.iith.ac.in lchandrala@mae.iith.ac.in
Abstract	:	The size distributions of raindrops at different attitudes are determined by significant physical mechanisms, including coalescence, breakup, and phase change. These mechanisms are affected by various factors present in the atmosphere, such as temperature, humidity, air currents, and aerosols. Neglecting these microphysical processes in meteorological predictions and remote sensing of precipitation can lead to significant errors in rainfall prediction. To address this issue, our project intends to investigate how spatial and temporal variations in temperature, humidity, pressure, air currents, and aerosol presence influence the shape and size distributions of raindrops at various altitudes. As a part of this project, we will develop a separate experimental facility based on the acoustic levitation technique in a closed chamber that can be maintained at different pressures to investigate its effects on the microphysics of droplets. The proposed project is pertinent in a broad range of industrial applications, including combustion, surface coating, pharmaceutical production, disease transmission modeling, and artificial rain technology.
Keywords	:	Droplets, Interfacial flows, Coalescence, Breakup, Phase change
Background and Motivation	:	Accurate forecasting of weather and rainfall is crucial for our socioeconomic conditions and in addressing the threat of climate change. Despite the importance of rainfall prediction, it remains imperfect due to the lack of data on raindrop size distribution (DSD) at various altitudes. The size and shape of raindrops at different altitudes are key factors in predicting weather patterns and precipitation using remote sensing and weather radar technology. Due to the high level of unpredictability of the atmospheric variables, rainfall in India is a unique and complex process compared to other regions of the world. We established a unique experimental facility for accurately predicting raindrop size distribution, ultimately leading to more precise rainfall estimations (see: *https://www.youtube.com/watch?v=x6k-emUTnmA*). In the project, we intend to study the influence of temperature, humidity, aerosol content and air current on raindrop dynamics.
Essential Qualifications	:	BE/B-Tech or ME/MTech in Mechanical, Chemical, Aerospace Engineerings
Desirable Qualifications	:	Knowledge on Fluid Mechanics, Heat Transfer, Experiments, Mathematics
Broad Proposal objectives	:	https://drive.google.com/open?id=1mZHg_c_1oEXxSg8l6lSgR48AHd5ac3Ph

Project 25		
Title of the Proposal	:	**Impact Performance of Cold-formed Steel Sheathed Wall Panels Subjected to Wind-Borne Debris**
Guide-1	:	**Prof. Mahendrakumar Madhavan**, *Department of Civil Engineering*
Guide-2	:	**Dr. Chandra Prakash**, *Department of Mechanical and Aerospace Engineering*
Email	:	mkm@ce.iith.ac.in cprakashj@mae.iith.ac.in
Abstract	:	The proposed research study will be focused on the 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 the 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.
Essential Qualifications	:	A strong structural mechanics background with a passion to carry out impact testing and validate the same using computational models
Desirable Qualifications	:	M.Tech in Structural Engineering or in Mechanical Design preferably from IIT/NIT or reputed Government engineering colleges
Broad Proposal objectives	:	https://drive.google.com/open?id=1FCNLx3GsraAMrGA1YaiYdWwMuLNF2JC2

Project 26		
Title of the Proposal	:	**Development of Passive Microwave Components for Miniaturized RF Devices**
Guide-1	:	**Arabinda Haldar**, *Department of Physics*
Guide-2	:	**Shiv Govind Singh**, *Department of Electrical Engineering*
Email	:	arabinda@phy.iith.ac.in sgsingh@ee.iith.ac.in
Abstract	:	This proposal plans to demonstrate RF device component prototypes using electromagnetic simulations and complex multi-level nanofabrication processes (deposition, lithography, etching). Proposed miniaturized RF devices can potentially save space and weight in a Ku-front-end modules used in RADAR or other communication devices (space and airborne applications).
Keywords	:	Microwave, Microfabrication, Ku-front end
Background and Motivation	:	One of the most important RF components is a circulator which transfers RF signal only in a particular direction. However, the current circulators are bulky and therefore, signal processing is executed off the chip away from the active components. Here we intend to miniaturize such RF components and integrate them on-chip.
Essential Qualifications	:	BTech/ Mtech ;Electrical Engineering, Electronics, Radio Physics, Instrumentation and MSc. (Electronics/Physics)
Desirable Qualifications	:	BTech/ Mtech ;Electrical Engineering, Electronics, Radio Physics, Instrumentation and MSc. (Electronics/Physics)
Broad Proposal objectives	:	https://drive.google.com/open?id=1sTYohTDwcyDZUMHezDUwoCVaj6wTw3ln

Project 27		
Title of the Proposal	:	**Influence of Stacking Fault Energy on the Deformation Behavior Under High Strain Rate and High Temperature.**
Guide-1	:	**Rajesh Korla**, *Department of Materials Science and Metallurgical Engineering*
Guide-2	:	**Syed Nizamuddin Khaderi**, *Department of Mechanical and Aerospace engineering.*
Email	:	rajeshk@msme.iith.ac.in snk@mae.iith.ac.in
Abstract	:	Two model alloys will be designed and synthesize with wide difference in their stacking fault energies. Initially perform the room temperature quasi static tensile behaviour to understand the role of stacking fault energy on the activation of twin induced plasticity. Further, study the effect high strain rate and high temperature on the twin induced plastic deformation behavior.
Keywords	:	High strain rate, high temperature, stacking fault energy
Background and Motivation	:	Stacking fault energy plays a major role in determination active mechanism during plastic deformation. Further, strain rate and temperature also very importation factors affect the dominant deformation mechanism. It is interested to study the combined effect of low stacking fault energy and high strain rate on the deformation behaviour,
Essential Qualifications	:	Mechanical, metallurgical and materials engineering, production engineering
Desirable Qualifications	:	Mechanical, metallurgical and materials engineering, production engineering
Broad Proposal objectives	:	https://drive.google.com/open?id=1DF46Tvp1dlaaDiTVK1heEKhHuDLAI2zL

Project 28		
Title of the Proposal	:	**Theoretical, Computational and Experimental investigations of High-Performance Electromechanical Nano-Metamaterials**
Guide-1	:	**Dr. Prakhar Gupta**, *Department of Mechanical and Aerospace Engineering*
Guide-2	:	**Prof. Ranjith Ramadurai**, *Department of Materials Science & Metallurgical Engineering*
Email	:	prakharg@mae.iith.ac.in ranjith@msme.iith.ac.in
Abstract	:	In this proposal, we will fabricate ferroelectric architected nano-metamaterials (which are made from nanorods) for obtaining higher electromechanical response by exploiting the nanoscale flexoelectricity. The constitutive relations of these constituent nanorods will be derived through experimental studies. Theoretical studies (bending/buckling/stretching) will be utilized for guided experiments on fabricating the ferroelectric nanostructures.
Keywords	:	Piezoelectricity, Flexoelectricity, Ferroelectrics, Metamaterials, Nanorods
Background and Motivation	:	The applicability of architected nano-metamaterials ranges from sensors, transistors, probes, actuators, energy harvesters to resonators in nanoelectromechanical systems. In this context, the mechanics of ferroelectric nano-metamaterials have not been deeply understood. Furthermore, since strain-gradients exist in these metamaterials, flexoelectricity will also enhance the electromechanical responses.
Essential Qualifications	:	B.Tech. in Mechanical Engineering, engineering physics or M.Tech. in Mechanical, Materials Science and Metallurgical Engineering, Nanotechnology and/or related discipline
Desirable Qualifications	:	Candidates should have strong interest in solid mechanics, applied mathematics, finite element simulations, nanotechnology, fabrication and testing of nanoscale devices through experiments.
Broad Proposal objectives	:	https://drive.google.com/open?id=1kqNoiC4ESOAPahlFodjDgWxuXur59Yn-

Project 29		
Title of the Proposal	:	**Large Area 2D Materials for CMOS Digital Logic Device Applications**
Guide-1	:	**Dr. Shubhadeep Bhattacharjee**, *Department of Electrical Engineering*
Guide-2	:	**Dr. Chandrasekhar Murapaka**, *Department of Materials Science & Metallurgical Engineering*
Email	:	shubhadeep@ee.iith.ac.in mchandrasekhar@msme.iith.ac.in
Abstract	:	We aim to explore 2D materials based devices for next generation computing. The first part involves PVD deposition of oxide seed layer followed by controlled sulfurization to prepare large area thin films. Next, we will use nanofabrication and characterization to demonstrate CMOS compatible logic devices.
Keywords	:	2D Materials, Thin films, CMOS logic, Neuromorphic computing
Background and Motivation	:	Two dimensional materials owing to their superior carrier transport properties are promising candidates for logic devices. The inability to grow high quality large area 2D materials is the key bottleneck for realizing the same. This necessitates a novel approach towards CMOS compatible thin film growth and device processing.
Essential Qualifications	:	BTech/MTech in Materials Science, Nanotechnology, EE/ECE or Semiconductor devices, or Engineering Physics. MSc. in Physics/Material Science/Nanotechnology/Semiconductor Devices
Desirable Qualifications	:	Good knowledge of thin film growth and/or semiconductor devices
Broad Proposal objectives	:	https://drive.google.com/open?id=1R1lVuFvu2LHVZoDzIvjxY1zGD2vf4PEz

Project 30		
Title of the Proposal	:	**Design and Development of Nanostructured High-Entropy Alloys for Hydrogen Storage Applications**
Guide-1	:	**Dr. Sudarsanam Putla**, *Department of Chemistry*
Guide-2	:	**Prof. Pinaki Prasad Bhattacharjee**, *Department of Materials Science and Metallurgical Engineering*
Email	:	sudarsanam.putla@chy.iith.ac.in pinakib@msme.iith.ac.in
Abstract	:	This project focuses on developing efficient high entropy nanoalloys (HEAs) for hydrogen storage at ambient conditions, essential for a future hydrogen-based economy. Both solid-state and wet-chemical methods will be used to synthesize novel HEAs, followed by their characterization to ensure the desired crystal phase, desirable micro/nanostructure, and optimum lattice strain for enhanced hydrogen storage efficiency.
Keywords	:	Solid-state hydrogen storage, HEAs, Wet-chemical synthesis, Solid-state synthesis, Micro/nanostructure and characterization
Background and Motivation	:	Hydrogen storage is currently the bottleneck towards shifting to a hydrogen-based economy, owing to the inherent difficulty in handling hydrogen gas. A potential solution is to employ solid-state hydrogen storage systems, especially emerging multicomponent high entropy alloys (HEAs). The hydrogen storage properties of HEAs can be further enhanced by tailoring their compositions and properties, which can be achieved by employing innovative synthesis strategies.
Essential Qualifications	:	(1) MSc in Chemistry or BTech/MTech in Materials Science and Engineering/Ceramics with min 60% marks; (2) Gate or Net qualification; (3) Knowledge in nanochemistry/physical metallurgy; (4) Sorption/spectroscopy/microscopy characterization
Desirable Qualifications	:	(1) One year of research experience in the relevant field; (2) Expertise in solid/nanomaterials synthesis/physical metallurgy; (3) Analysis of solid materials' properties/microstructural characterization techniques; (4) H2 adsorption-desorption analysis
Broad Proposal objectives	:	https://drive.google.com/open?id=1le9iGx9xcNYm7MtoRcA20e7-k3PZZ7PL

Project 31		
Title of the Proposal	:	**Porous Organic Polymers for CO_2 Capture**
Guide-1	:	**Dr. Venkata Rao Kotagiri**, *Department of Chemistry*
Guide-2	:	**Dr. Deepu J. Babu**, *Dept. of Materials Science and Metallurgical Engineering*, ***Adjunct faculty of*** *Dept. of Climate Change*
Email	:	kvrao@chy.iith.ac.in deepu.babu@msme.iith.ac.in
Abstract	:	The aim of the project is to design and synthesize various porous organic polymers (POPs) with tunable surface areas and functionalities and investigate their adsorption characteristics for relevant carbon capture applications. Post-synthetic modifications will be employed on POPs to tune the porosity and tailor the functionality to enhance CO_2 adsorption.
Keywords	:	Carbon capture, Porous polymers, Gas adsorption, Post-synthetic modifications
Background and Motivation	:	CO_2 gas is one of the major greenhouse gases and a prime contributor to global warming. Compared to the established CO_2 capture technology of amine scrubbing, adsorption based carbon capture offers numerous advantages. Material development is at the heart of adsorption-based carbon capture technology. This project aims to develop low cost, easily scalable materials for practical carbon capture applications.
Essential Qualifications	:	M.Sc Chemistry, M.Sc Materials Science, M.Tech. Materials Science
Desirable Qualifications	:	Experience in organic synthesis, porous Materials, gas adsorption measurements, and characterization techniques like XRD, BET, NMR etc.
Broad Proposal objectives	:	https://drive.google.com/open?id=1WIoPwlPQkwI_GLSbsAF32xAjH_h7FRnu

Project 32		
Title of the Proposal	:	**Point Defect Engineering of Two-(2D) and Three-Dimensional (3D) Materials for Application in Quantum Technologies**
Guide-1	:	**Anuj Goyal**, *Department of Materials Science and Metallurgical Engineering*
Guide-2	:	**Manish K Niranjan**, *Department of Physics*
Email	:	anujgoyal@msme.iith.ac.in manish@phy.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 different host systems (Si, oxides, nitrides, and 2D TMs chalcogenides) for applications in quantum technologies, spintronics and nanoelectronics.
Keywords	:	First-principles quantum mechanical DFT calculations; Point defect engineering; Materials (Semiconductors, 2D materials, Nitrides, Oxides); 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.
Essential Qualifications	:	Physics (MSc); Chemistry (MSc); Electrical engineering (B.Tech, M.Tech); Material Science and Engineering (B.Tech, M.Tech); Chemical Engineering (B.Tech, M.Tech)
Desirable Qualifications	:	Solid-state physics, electronic structure methods, Coding skills (Fortran, Python, C/C++)
Broad Proposal objectives	:	https://drive.google.com/open?id=1Ylf6Fwn1O6x5qWQKTIbg8cWx4-GwItUr

Project 33		
Title of the Proposal	:	**Assembling Rare-Earth Free QDs on Plasmonic Nano-Antenna Hybrid Structures for Visible to infrared Energy Harvesting Applications**
Guide-1	:	**Shinde Satish Laxman**, *Department of Physics*
Guide-2	:	**Ranajit Mondal**, *Department of Chemical Engineering*
Email	:	shindesl@phy.iith.ac.in ranajit@che.iith.ac.in
Abstract	:	Vis-IR energy harvesting converts ambient electromagnetic radiation into electrical power, suitable for hydrogen production, low-power devices, and sensors/detectors. Our project aims to enhance photo-electrical conversion efficiency by self-assembling wet-chemically prepared rare-earth-free quantum dots on non-metallic plasmonic perfect absorbers or nanocavities. Such a strategy can produce active catalysts for hydrogen generation and QDs-based narrow-band IR photodetectors for thermal imaging.
Keywords	:	Photoelectric conversion, Self-assembly, Hot carriers, Quantum dots, Detectors
Background and Motivation	:	Quantum dots (QDs) have unique optoelectronic properties but their efficiency is limited. Combining QDs with plasmonic materials may enhance their efficiency. The project aims to self-assemble QDs with perfect absorbers or nanocavities to enhance energy conversion efficiency and produce active catalysts for hydrogen generation and high-sensitivity QDs-based narrow-band IR photodetectors for thermal imaging. This has implications for renewable energy and sensing applications.
Essential Qualifications	:	M.E/M. Tech. (Nanotechnology, Electrical, Materials, Chemical Engineering) OR M.Sc. (Physics, Applied physics, Electronics, Nanotechnology) with a valid GATE score/CSIR/UGC-NET
Desirable Qualifications	:	Expertise in materials synthesis and characterization and 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=1jvca9idYDNovOiIHA1aU-9k3WPl8JXQh

Project 34		
Title of the Proposal	:	**Computational Modelling of Soft Autonomous Materials**
Guide-1	:	**Sai Sidhardh**, *Department of Mechanical and Aerospace Engineering*
Guide-2	:	**Mohd Suhail Rizvi**, *Department of Bio Medical Engineering*
Email	:	sidhardh@mae.iith.ac.in suhailr@bme.iith.ac.in
Abstract	:	Soft autonomous materials, characterized by the presence of active constituents for intrinsic mechanical force generation, have several applications in soft robotics, sensing, actuation, and bioengineering. This work will involve the development of a computational finite element method-based framework for such materials and explore some specific applications.
Keywords	:	Soft autonomous materials, finite-element method, computational modeling, meshless methods
Background and Motivation	:	Despite wide-ranging applications in several domains, autonomous materials do not yet have a comprehensive continuum theory for their computational modeling. A theoretical and computational modeling framework for such materials will help analyze large-scale systems of soft autonomous materials in different areas of engineering and biology.
Essential Qualifications	:	First class ME/MTech degree in Mechanical/Aerospace/Chemical Engineering or M.Sc. in Physics or Mathematics
Desirable Qualifications	:	Knowledge of C/C++/python programming, FEM tools.
Broad Proposal objectives	:	https://drive.google.com/open?id=18RY46HoJBhikPVmu9sCj8MxnCWZ5LCPJ

Project 35		
Title of the Proposal	:	**Thermo-Mechanical Finite Element Modelling of Fracture in anisotropic Ceramic Matrix Composites Using ABAQUS**
Guide-1	:	**Prof. Amirtham Rajagopal**, *Department of Civil Engineering*
Guide-2	:	**Dr. Viswanath Chinthapenta**, *Department of Mechanical and Aerospace Engineering*
Email	:	rajagopal@ce.iith.ac.in viswanath@mae.iith.ac.in
Abstract	:	Ceramic matrix composites have been widely applied in high-temperature applications in defense, aerospace, and hypersonic vehicles. Fracture is one of the major failure modes in Ceramic matrix composites and computational modeling helps in understanding the crack initiation and propagation. This study focuses on predicting fracture nucleation and growth and its interaction with the interfaces in a thermo-mechanical environment.
Keywords	:	Ceramic matrix composites, thermo- mechanical loading, Fracture, Damage, Hypersonic Glide vehicles
Background and Motivation	:	Phase field model considering the interfacial damage for different configurations of a fiber-reinforced ceramic composite needs to be formulated. The model to be developed in this work along with simulations will allow the user to understand the anisotropic crack growth together with studying the interaction of crack with interfaces
Essential Qualifications	:	B.Tech (Mechanical/Civil/Aerospace); M.Tech(Design/Structural Engineering/Aerospace/Applied Mechanics)
Desirable Qualifications	:	Valid GATE score in Mechanical/CIvil/Aerospace;
Broad Proposal objectives	:	https://drive.google.com/open?id=1cY16--7jY0ae04Us85qjoQzaA7J99P6A

Project 36		
Title of the Proposal	:	**Computational Modelling of Electron Transport Through Transition Metals-Based Chains and Clusters**
Guide-1	:	**Dr. Saurabh Kumar Singh**, *Department of Chemistry*
Guide-2	:	**Dr. Archak Purkayastha**, *Department of Physics*
Email	:	sksingh@chy.iith.ac.in Archak Purkayastha
Abstract	:	Extended metal atom chains (EMACs) are the wide range of transition metals™ of the first second and third transition series, in symmetric and unsymmetric arrangements, shows promising applications in the field of moleuclar electronics. Here by using conventional density functional methods with NEGF formalism we aim to understand how electronic structure, bonding in the TM-complexes generates an assymetric current-voltage response, quantum interference and negative differential resistance. We also aim to develop a more accurate method including so-called many-body interaction terms in the model Hamiltonian.
Keywords	:	Density Functional Theory, Quantum Transport, NEGF, Molecular Electronics, Transition Metal Chains and Clusters
Background and Motivation	:	The 2011 update to the International Technology Roadmap for Semiconductors (ITRS) sets out the need for fundamentally new technologies to replace existing silicon-based device components. Only if this can be achieved will the cost/function ratio of computer components continue to decrease at the rate to which we have become accustomed over the past 30 years (~25-29% per annum, according to the 2011 ITRS). One attractive solution is to develop molecular-scale analogues of key components such as wires, diodes and transistors. The incorporation of such components into realistic devices will face many challenges, not least those related to the manufacture of stable nanoscale arrays with precise and reproducible orientations. The proposal set out herein meets this challenge head on – the aim is to focus valuable synthetic effort in the most promising areas through in silico design.
Essential Qualifications	:	M.Sc (Physics, Chemistry) and B.Tech (Material Sciences)
Desirable Qualifications	:	M.Sc (Physics, Chemistry) and B.Tech (Material Sciences)
Broad Proposal objectives	:	https://drive.google.com/open?id=1MMBXOjqYgVciTQDmVF75jgi36SRiAlpy

Project 37

Title of the Proposal	:	**Self-Assembly, Structure and Rheology of DNA Hydrogels**
Guide-1	:	**Himanshu Joshi**, *Department of Biotechnology*
Guide-2	:	**Mahesh Ganeshan**, *Department of Chemical Engineering*
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Abstract	:	In this project, we propose to synergistically combine experiments with all-atom and coarse-grained MD simulations to study the self-assembly, dynamics, thermodynamic and rheological properties of DNA hydrogels. Our study will help in enabling a rational design of non-canonical DNA hydrogels for their biomedical applications like gene silencing etc.
Keywords	:	DNA hydrogels, Rheology, Molecular dynamics simulations, Programmable self-assembly, Polymers.
Background and Motivation	:	Due to its unique structure and function, deoxyribonucleic acid (DNA) has emerged as an interesting choice of material to create biocompatible hydrogels. These hydrogels have proposed applications in tissue engineering, biosensing and basic biomedical research by mimicking the extracellular matrix. DNA offers several advantages over the synthetic polymers or other biomaterials such as proteins or polysaccharides to create the hydrogels.
Essential Qualifications	:	M.Sc Physics/Chemistry. B.Tech or M.Tech in Chemical engineering,
Desirable Qualifications	:	Background in soft matter, Statistical mechanics, chemical engineering, modeling and simulation, Nanotechnology
Broad Proposal objectives	:	https://drive.google.com/open?id=16JQwmZyNRhivpn2G5kC84uMcQsKbomM5