| Interdisciplinary-PhD Admissions, 2022 at CIP@IITH | |
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| **AREA: BIOENGINEERING & HEALTHCARE** | |
| **Project Code** | **1** |
| **Title of the Proposal** | **A patch-clamp microfluidic chip for measurement of ion-channel activity in live biological cells** |
| **Guide I and** | Shishir Kumar, Electrical Engineering |
| **Guide 2 and Department** | Anamika Bhargava, Biotechnology |
| **Email Address** | shishirk@ee.iith.ac.in |
| **Abstract** | We propose to demonstrate a low cost, accurate microfluidic chip based ion channel recording system that is highly automated, can be scaled and requires little skill to use. We use new materials, existing hardware and software techniques from our laboratories, to build the system. Validation will be done by live cell recording and comparison to the existing systems. |
| **Keywords** | Ion-channels, microfluidics, automation |
| **Background and Motivation** | Cellular Ion channels play a definitive role in many common diseases and are important drug targets for them. The development in this area has been slow and restricted due to low volume custom fabrication, leading to costly equipment. The key challenges are the fabrication of micron sized through holes in strong insulating substrates and manipulation of cells on the devices, in a scalable manner. We believe the use of ultra thin glasses and microfluidics respectively can tackle these issues. |
| **Essential Qualifications** | Msc with GATE/Mtech/Btech in electrical enggineering/biomedical enggineering/electronics/instrumentation/ or related discipline |
| **Desirable Qualifications** | Semiconductor fabrication, Cell culture, Microfluidics |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1-KCIEQwu6IZ4cuGGsLVgU4gfeYXzMOcM |
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| **Project Code** | **2** |
| **Title of the Proposal** | **Biodegradable hybrid nanoprobes for cancer and anti-microbial theranostics** |
| **Guide I and Department** | Dr. Aravind Kumar Rengan, Dept of BME |
| **Guide 2 and Department** | Prof. Prabu Sankar Ganesan, Dept of CHY |
| **Email Address** | aravind@bme.iith.ac.in |
| **Abstract** | Nanotheranostics involves integration of both diagnostic and imaging within a single nanoplatform to overcome the delay in detection and subsequent treatment. In this proposal, we intend to develop biodegradable hybrid nanosystems for cancer and anti-microbial theranostics, which enables real-time monitoring of the treatment efficacy. The developed nanosystem will be tested for its in vitro and in vivo efficacy. |
| **Keywords** | Nanomedicine, Anti-cancer/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. |
| **Essential Qualifications** | Master’s degree in Biotech/ Nanomedical sciences/ Pharma/ Bio-chemistry |
| **Desirable Qualifications** | Qualified CSIR-JRF/UGC-JRF/DBT-JRF/ICMR-JRF/GATE/INSPIRE. |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1px1Dg80RlDSy-0v_RAf3QrWk3OtTx8Ot |
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| **Project Code** | **3** |
| **Title of the Proposal** | **Development of high-density EEG system for automated diagnosis of neurological disorders** |
| **Guide I and Department** | Dr. Kousik Sarathy Sridharan - BM |
| **Guide 2 and Department** | Dr. Rupesh Wandhare - EE |
| **Email Address** | kousiksarathy@bme.iith.ac.in |
| **Abstract** | The project aims to build an end-to-end AI-driven cloud based platform to diagnose, track and manage neurological disorders such as epilepsy. The work will involve building a scalable high-density EEG system, interfacing firmware, AI-driven algorithm frameworks, deployed on a secure cloud to enable reach of the platform to underserviced regions of the country. |
| **Keywords** | HD-EEG, epilepsy, artificial intelligence, cloud |
| **Background and Motivation** | Neurological disorders such as epilepsy and several other diseases needs high-density EEG setups, trained manpower to deploy the system, acquire data, analyze, interpret and prognosticate to ensure good outcomes. Several above-mentioned components are not yet available to large cohorts of people in the country. The proposed project aims to cater to this need to improve access to under-serviced populace in the country. |

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| **Essential Qualifications** | MTech - Embedded systems, Power electronics, Communication engg or related disciplines |
| **Desirable Qualifications** | Embedded software, FPGA implementation, PCB design |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1oBX5C1I1-eTuD12nR4_4dEQZZSog4ofn |
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| **Project Code** | **4** |
| **Title of the Proposal** | **Study of Biomolecular Docking Using Velocity Map Imaging Technology** |
| **Guide I and Department** | Dr. Surajit Maity, Chemistry |
| **Guide 2 and Department** | Dr. Vandana Sharma, Department of Physics |
| **Email Address** | surajitmaity@chy.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, VMI |
| **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** | Understanding physical chemistry, optical spectroscopy |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1dGv8WDimMIy-HL1ngLQi3F-wX7BFseOY |
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| **Project Code** | **5** |
| **Title of the Proposal** | **Novel Nano-micro-macro system to overcome protein delivery challenges for biomedical applications** |
| **Guide I and Department** | Jyotsnendu Giri, BME |
| **Guide 2 and Department** | Rajkumara Eerappa |
| **Email Address** | jgiri@bme.iith.ac.in |
| **Abstract** | Protein depot formulations (Microparticulate or scaffold) for long-term controlled release of active therapeutic protein have immense clinical importance for the treatment of many diseases, conditions, and regeneration of specific tissues. Objective of this projects to develop novel protein nanoencapsulation platform and their use for sustain release "protein depot" and 'smart biomaterials' for therapeutic protein delivery and potential functional tissue regeneration. |
| **Keywords** | Therapeutics protein stabilization and delivery |
| **Background and Motivation** | Proteins being labile in physiological environment the current protein therapy standard of care requires frequent subcutaneous injection. Resulting protein therapy to have poor patient compliance, and expensive. Thus clinical success of protein depot has been limited mainly due to the presence of critical several barriers. There is an unmet clinical need to develop sustained release formulation to improve patient compliance and efficacy and make the protein therapy affective and cost-effective. |
| **Essential Qualifications** | MTech/MSc in materials science, Pharmacy, Biochemistry, Nanotechnology |
| **Desirable Qualifications** | Interested in interdisciplinary work; protein, cells, materials |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1sYoUqR2yYcWO2BXgzZib4IFNhK00VADi |
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| **Project Code** | **6** |
| **Title of the Proposal** | **Development of in-vitro artificial pancreas model for diabetes by 3D organoid strategy with real-time control of insulin release** |
| **Guide I and Department** | Subha Narayan Rath, Dept. of biomedical engineering |
| **Guide 2 and Department** | Shourya Dutta Gupta, Dept. of Materials science and Metallurgical engineering |
| **Email Address** | subharath@bme.iith.ac.in |
| **Abstract** | A 3D model of artificial pancreas exhibiting controlled release of insulin based on organoid strategy in a bioreactor system integrated with plasmonic nanosensors will be developed. The organoid will consist of insulin-releasing cells whose release will be controlled via feedback from the nanosensors. |
| **Keywords** | Electrospinning, 3D organoid, diabetes, nanosensor |

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| **Background and Motivation** | In India, diabetes is a highly prevalent non-communicable disease. Currently, studies involve insulin-releasing 2D cell lines or drug-induced diabetic rat models for anti-diabetic drugs. These can't exhibit diurnal variation in glucose load and insulin release. We aim to provide an electrospun device with measuring insulin release with allogenic cell therapy. |
| **Essential Qualifications** | Masters in Materials Science, Biomedical engineering, Mechanical eng, Chemical eng, Biotechnology. |
| **Desirable Qualifications** | Prior experience in electrospinning or Microfluidic devices |
| **Broad Proposal Objectives** | https://drive.google.com/file/d/1er39AGB57rrOUJu2GKunwy_FPbXh4F4-/view?usp=sharing |
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| **Project Code** | **7** |
| **Title of the Proposal** | **Theory of active elasticity and its application in biomechanics** |
| **Guide I and Department** | Mohd Suhail Rizvi (BME) |
| **Guide 2 and Department** | Sai Sidhardh (MAE) |
| **Email Address** | suhailr@bme.iith.ac.in |
| **Abstract** | Biological materials are fundamentally different from engineering materials thanks to their non-equilibrium nature resulting in internal mechanical forces at the expense of biochemical energy. This work will involve development of elasticity theory for bioactive materials, and the study of the mechanics of specific physiological processes using the developed model. |
| **Keywords** | constitutive model, active materials, elasticity |
| **Background and Motivation** | Active materials are characterized by being far from the thermodynamic equilibrium. Active fluids, an example of active matter, have been studied quite extensively but active solids, such as cell-seeded polymer-gels, have been remained relatively less explored. This work seeks to fill this gap by developing constituve models of active solids. |
| **Essential Qualifications** | Mechanical Engineering, Mathematics, Physics |
| **Desirable Qualifications** | Mechanical Engineering, Mathematics, Physics |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=18UWQJPbkg0Q8JHvrbefoXlB8wvKcMQNp |
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| **Project Code** | **8** |
| **Title of the Proposal** | **Microstructure property relationship in biological fluids** |
| **Guide I and Department** | Renu John, Biomedical Engineering |
| **Guide 2 and Department** | Alan Ranjit Jacob, Chemical Engineering |
| **Email Address** | arjacob@che.iith.ac.in |
| **Abstract** | This project envisions developing unique microrheological techniques to elucidate microstructure-viscoelastic property relationships for biological fluids. Optical, magnetic and acoustic probes will be leveraged to test extremely small volumes of biological fluids which is expected to lay the groundwork to develop cheap in-situ biomedical tests for the future. |
| **Keywords** | Microrheology, Microstructure, Viscoelasticity |
| **Background and Motivation** | The overarching theme of this proposal is investigating viscoelastic properties and relating it to microstructure in biological fluids. Fluids like blood, sweat and even cellular matrix and cell wall are inherently viscoelastic in nature. The project will focus on developing very unique optical, magnetic and acoustic techniques to probe viscoelasticity of fluids which are available only at extremely low volumes (10-6l - 10-12l). |
| **Essential Qualifications** | Btech and/or Mtech Biomedical Engg, Chemical Engg, Mechanical Engg, BTech in Applied/Eng. Physics, MSc Physics with GATE/ UGC CSIR |
| **Desirable Qualifications** | valid GATE score for BTech/MTech Engg Graduates |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1Zoktfmdq5h-I80g-Z4TDyPho0WgUyl24 |
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| **Project Code** | **9** |
| **Title of the Proposal** | **Cooperative Chemotaxis in a Turbulent Environment** |
| **Guide I and Department** | Dr. Anupam Gupta, Department of Physics |
| **Guide 2 and Department** | Dr. Ranabir Dey, Department of Mechanical Engineering |
| **Email Address** | agupta@phy.iith.ac.in |

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| **Abstract** | This study will investigate the problem of cooperative chemotactic search for an ensemble of microorganisms and combines ideas from active matter, turbulent transport, and reinforcement learning. It will examine the nontrivial correlations between the flow and microorganism dynamics that are essential for the microorganisms to perform tasks collectively. |
| **Keywords** | Chemotaxis, Active Soft Matter, Microswimmers |
| **Background and Motivation** | This study will lead to a better understanding of the behaviour of the Marine ecosystem. The findings of the proposed work can help to develop artificial microswimmers, which can be utilized to detect the source of harmful compounds in a marine environment and harmful volatile compounds in our atmosphere. |
| **Essential Qualifications** | MSc in Physics or BTech/MTech in Mechanical Engineering or Chemical Engineering |
| **Desirable Qualifications** | Computational methods, fluid mechanics, statistical mechanics. |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1o5ISHTH1BTQ2Z_Rz1Gn_CrgzUxzNgMHF |
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| **Project Code** | **10** |
| **Title of the Proposal** | **Functionalized nanofibrous polymeric matrices as cancer immuno-therapeutics** |
| **Guide I and Department** | Satyavrata Samavedi, Department of Chemical Engineering |
| **Guide 2 and Department** | Ashish Misra, Department of Biotechnology |
| **Email Address** | samavedi@che.iith.ac.in |
| **Abstract** | This project employs a bioengineering approach to develop functionalized polymeric biomaterials to arrest cancer metastasis by modulating the immune milieu. In building tunable nanofibrous vehicles and testing their efficacies within 3D cell culture platforms, we aim to better understand immunomodulatory cell-matrix interactions and develop robust immunotherapies with translation potential. |
| **Keywords** | Nanofibrous biomaterials, Cancer, Immunomodulation |
| **Background and Motivation** | Dysfunctional immune responses actively drive the progression/metastasis of malignant tumors, and are correlated with poor patient prognosis. This project develops a new approach to cancer vaccines using implantable biomaterials that can program host immune cells to provide long-term therapeutic benefits without the adverse side-effects associated with conventional treatment modalities. |
| **Essential Qualifications** | Applicants with a BTech or MTech in Chemical Engineering or Biotechnology or Biomedical Engineering or Polymer Engineering or allied areas may apply; Applicants with BPharm or MPharm may also apply |
| **Desirable Qualifications** | Motivated/Sincere, Willingness to learn, English fluency, Cell culture |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1lM6akBeC4ywJWoiE6ei9MbUzlZd83wZF |
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| **Project Code** | **11** |
| **Title of the Proposal** | **Self-assembly, structure and rheology of DNA hydrogels** |
| **Guide I and Department** | Himanshu Joshi, Department of Biotechnology |
| **Guide 2 and Department** | Mahesh Ganesan, Department of Chemical Engineering |
| **Email Address** | hjoshi@bt.iith.ac.in |
| **Abstract** | In this Ph.D. 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 DNA hydrogels with tunable material properties for their biomedical applications. |
| **Keywords** | DNA hydrogels, MD simulations, Light Scattering |
| **Background and Motivation** | Due to its unique structure, function and bonding specificity, deoxyribonucleic acid (DNA) has emerged as a versatile choice of material to create biocompatible hydrogels compared to other bio/synthetic polymers. DNA hydrogels have proposed wide ranging applications in tissue engineering, biosensing and basic biomedical research. There is hence a strong interest to fundamentally understand how their microscale features inform macroscopic material functions. |
| **Essential Qualifications** | Background in soft matter, Quantum mechanics, Statistical mechanics, chemical engineering, modeling and simulation, Nanotechnology |
| **Desirable Qualifications** | UNIX Programming, molecular dynamics, wet-lab experience |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1p0wMZj8lUukb8Co93LsEgdkatJXby2Th |
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| **Project Code** | **12** |
| **Title of the Proposal** | **Ultrasound Initiated Cavitation for Medical Applications** |
| **Guide I and Department** | Avinash Eranki |

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| **Guide 2 and Department** | Badarinath Karri |
| **Email Address** | aeranki@bme.iith.ac.in |
| **Abstract** | Cavitation-based mechanical disruption of tumor tissue using ultrasound has been shown to precisely fractionate solid tumors. Generation of cavitation using ultrasound can be done with varying pulsing regimes and could lead to vastly different effects in tissues. This project proposes to develop an effective and spatially precise approach to treating solid tumors. The project objectives include wave-tissue simulations, experimental validation, and device development for clinical translation. |
| **Keywords** | Ultrasound, Imaging, Cavitation, Device Dev. |
| **Background and Motivation** | Refractory and relapsed solid tumors have seen increased incidence worldwide with a high fatality rate. Thermal ablation is commonly used but denatures tumor antigens, and may not penetrate deep. We propose to develop a novel technique to treat tumors using cavitation-based ultrasound to effectively treat solid tumors in vivo using novel pulsing techniques. These novel techniques could efficiently treat deeper organs and bone tumors that otherwise go untreated with ablative technologies. |
| **Essential Qualifications** | 1.Engineering background (Electrical Engineering, Mechanical Engineering, Biomedical Engineering) 2.Interest in Biomedical 3.Interest in experiments (prior experience preferred) |
| **Desirable Qualifications** | Engineering background , Interest in Biomedical with experimental exp. |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1UOKbivodT-cXn_IpynRjdfhR4AGfYzWv |

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| **AREA: NOVEL MATERIALS & TECHNIQUES** | |
| **Project Code** | **13** |
| **Title of the Proposal** | **Large area 2D materials for CMOS digital logic and spintronic applications** |
| **Guide I and** | Chandrasekhar Murapaka, MSME |
| **Guide 2 and Department** | Shubhadeep Bhattacharjee, EE |
| **Email Address** | 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 and spintronic devices. |
| **Keywords** | 2D Materials, Thin films, CMOS logic, Spintronics |
| **Background and Motivation** | Two dimensional materials owing to their superior carrier transport properties are promising candidates for logic and spintronic 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 or Nanotechnology or EE/ECE or Semiconductor devices or Engineering Physics. MSc. in Physics/Material Science/Nanotechnology/Semiconductor Devices |
| **Desirable Qualifications** | Sputtering, nanofabrication, lithography, electrical characterization |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1kR8ldFuv4sSYSKwRGFevVhRaegwN8Uu6 |
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| **Project Code** | **14** |
| **Title of the Proposal** | **Design and Development of Next-Generation Steelmaking Reactor** |
| **Guide I and Department** | Dr. Ashok Kamaraj, Dept. of MSME, IITH |
| **Guide 2 and Department** | Dr. Ramkarn Patne, Dept. of Chemical Engineering, IITH |
| **Email Address** | ashokk@msme.iith.ac.in |
| **Abstract** | This proposal aims to design and develop a novel reactor lance for ladle-based steelmaking process thorough physical and mathematical/numerical modeling approach. The envisaged reactor lance design will overcome some of the persistent problems in LRF/ARS/OLP. This technique also expected to replace the CAS-OB process, KR desulphurizer, and provides novel solution for dephosphorization in induction melting units. |
| **Keywords** | steelmaking, reactor design, physical modeling |
| **Background and Motivation** | The major drawback of ladle-based steelmaking operations is formation of unavoidable slag eye. Also, the extent of slag metal reaction is limited to the vicinity of the slag eye/plume. The consequences of these drawbacks in production practice are poor alloy recovery, sluggish kinetics, slag crust formation, improper slag killing, reoxidation and difficulty in inclusion control. Therefore, revisiting the design of an existing steelmaking reactor is essential to improve process efficiency. |
| **Essential Qualifications** | M.Tech in Chemical Engineering/Metallurgy or B.Tech in Chemical Engineering/Metallurgy with a valid Gate Score |
| **Desirable Qualifications** | Publication/M.Tech Thesis in steelmaking/CRE/reactor design/modeling/ |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1ZujA-VXPTbMdruoOpxw-eJHpI53YIAM1 |
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| **Project Code** | **15** |
| **Title of the Proposal** | **Development of constitutive model for determining mechanical properties of spin coated polymer films using scanning probe microscopy (SPM)** |
| **Guide I and Department** | Balaji Iyer V S and Chemical Engineering |
| **Guide 2 and Department** | Ranjith Ramdurai and MSME |
| **Email Address** | balaji@che.iith.ac.in |
| **Abstract** | We propose to develop a constitutive model for understanding mechanical properties of thin polymer films and simulate the indentation test using the constitutive model. Both elastic and plastic deformation models will be examined and numerical simulations of indentation test will be carried out based on the constitutive models. The development of the models will be informed by experiments performed on thin films coated on magnetostrictive material. |
| **Keywords** | polymer thin films, scanning probe microscopy |
| **Background and Motivation** | Polymer thin films are utilized for a wide range of applications in design of sensors, protective and functional coatings and tissue engineering. The design of improved films for these applications requires a good understanding of the mechanical properties of such thin films. Here, we propose to examine mechanical properties of thin films by using a combination of simulations and design of a novel experimental setup based on use of magnetostrictive thin films. |

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| **Essential Qualifications** | M.Sc in Physics with CSIR-NET and/or GATE qualified, M.Tech in Chemical engineering, Materials Engineering and Applied physics and allied fields |
| **Desirable Qualifications** | Polymer Technology, Soft Condensed Matter, Computational Physics |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1T_GQpFfNscqZjQy-VLjZL8xryXytvtMX |
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| **Project Code** | **16** |
| **Title of the Proposal** | **Computational Modeling of Fracture induced Phase transformations in Ferroelectric Materials using a Peridynamic Phase field approach** |
| **Guide I and Department** | Prof. Amirtham Rajagopal, Department of Civil Engineering |
| **Guide 2 and Department** | Dr. Saswata Bhattacharya, Department of Material Science and Metallurgical Engineering |
| **Email Address** | rajagopal@ce.iith.ac.in |
| **Abstract** | Ferroelectric ceramics have strong electromechanical coupling and are used in actuation and sensing applications. These materials show pronounced nonlinear behavior at high loading scales. We propose to develop nonlinear micromechanical models and understand the coupling between fracture and phase transformations in such materials using a peridynamic phase field approach. |
| **Keywords** | Peridynamic phase field, Ferroelectrics, Fracture |
| **Background and Motivation** | Ferroelectrics in certain applications are subjected to large deformations/forces thereby exhibiting nonlinear behaviour resulting in damage/fracture. Under thermo-electro-mechanical loading cubic to tetragonal/rhombohedral transformations are possible together with a strain build up that is released by fracture. Nonlocal peridynamic phase field approaches help in understanding coupled structural transformation and fracture. |
| **Essential Qualifications** | B.Tech ( Civil/Mechanical/Material Science ), M.Tech ( Structural/ Mechanical Design/ Aerospace/Applied Mechanics), First Class with Distinction, |
| **Desirable Qualifications** | Programming Using MATLAB/C, Working Knowledge ANSYS/ABAQUS |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1yPKsefOkE-EQbAVWBWFA2Maj29lU7V1T |
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| **Project Code** | **17** |
| **Title of the Proposal** | **Oxidation behaviour and diffusion properties of high entropy alloys: Experimental analysis and ab-initio computations** |
| **Guide I and Department** | Dr. Mayur Vaidya, MSME |
| **Guide 2 and Department** | Dr. Shelaka Gupta, Chemical Engineering |
| **Email Address** | vaidyam@msme.iith.ac.in |
| **Abstract** | The proposed project aims to explore oxidation resistance and diffusion behaviour of high entropy alloys (HEAs). Isothermal tests and tracer diffusion techniques will be used to measure oxidation and diffusion properties, respectively. DFT calculations will be utilised to evaluate migration barriers and unearth the underlying mechanism of diffusion in HEAs. |
| **Keywords** | High entropy alloys, oxidation, diffusion, DFT |
| **Background and Motivation** | HEAs have shown potential for high temperature applications, for which oxidation (a diffusion-controlled phenomenon) resistance is critical. We aim to understand oxidation kinetics of HEAs, particularly with respect to the effect of composition. Diffusion behaviour, examined through experiments and ab-initio computations, will be integral to develop correlations with oxidation properties |
| **Essential Qualifications** | M.Tech Metallurgy/Materials Science, MSc. Physics, MSc. Chemistry |
| **Desirable Qualifications** | Materials Science, Metallurgy, Computational Tools, Physics, Chemistry |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1SfTcAanh3bCS2ylp7xQJuhPLdLISblrs |
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| **AREA: ENERGY, ENVIRONMENT & CREATIVE DESIGN** | |
| **Project Code** | **18** |
| **Title of the Proposal** | **Fabrication of 2D nanomaterials based flexible devices for sensing and energy harvesting applications** |
| **Guide I and** | Dr. Sushmee Badhulika, Electrical Engineering Department |
| **Guide 2 and Department** | Prof. Ashok Pandey, Mechanical and Aerospace Engineering Department |
| **Email Address** | sbadh@ee.iith.ac.in |
| **Abstract** | The project aims at synthesis of various types of 2D nanomaterials and their composites; fabrication of flexible devices based on them using flexible substrates; and exploring these devices in multi functional sensing (i.e. more than 1 application) for environmental monitoring, gas sensors, tactile sensing, or for energy harvesting in form of nanogenerators (for self powering various wearable devices). |
| **Keywords** | Nanomaterials, Sensors, flexible devices |
| **Background and Motivation** | Nanomaterials have superior chemical, mechanical and electronics properties which makes them best suited for sensing and energy harvesting applications. We aim to develop flexible nanomaterials based devices using low cost techniques to demonstrate a wide range of multifunctionalities such as pressure,strain, gas sensing as well as fabricate nanogenerators. These devices have wide applications in medical diagnostics, environmental monitoring as well as self powering wearable gadgets. |
| **Essential Qualifications** | B.Tech/M.Sc/M.Tech in Nanotechnology/Materials science and engineering/Physics/Electrical with hands-on experience in synthesis of nanomaterials |
| **Desirable Qualifications** | Nanotechnology, Materials sciences and engineering, Electrical, Mech |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=15BLJrO5KeETGjWnimah1ryxO2e_MHmMV |
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| **Project Code** | **19** |
| **Title of the Proposal** | **High entropy oxide (HEO) based catalyst for biofuel production** |
| **Guide I and Department** | Dr. Atul Suresh Deshpande, materials Science and Metallurgical Engineering |
| **Guide 2 and Department** | Prof. Sunil Kumar Maity, Chemical Engineering |
| **Email Address** | atuldeshpande@msme.iith.ac.in |
| **Abstract** | We propose the synthesis of novel high entropy (HEO) rutile oxides consisting of transition group elements, such as Ti, Sn, Mo, Mn, Nb, V, etc. These oxides will be used as solid-acid catalysts for biofuels production via hydrodeoxygenation, dehydration, and hydroxyalkylation-alkylation reactions |
| **Keywords** | HEO, Biofuels, Solid-acid catalyst |
| **Background and Motivation** | HEOs are the newest class of materials consisting of the solid solution of five or more metal oxides. Lewis acidity of rutile oxides can be enhanced by high lattice strain which is a characteristic of HEO. HEOs can be used as the catalyst for hydrodeoxygenation of biofuel precursors, alcohol dehydration, and hydroxyalkylation-alkylation reactions. |
| **Essential Qualifications** | M.E/M.Tech in Chemical Engineering, Materials Science, Nanoscience and Technology or related area. |
| **Desirable Qualifications** | synthesis of oxides,characterization, catalytic studies. |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1U_eMcgNnKKrlBO7-Ds4tbpFSu_Jw_3or |
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| **Project Code** | **20** |
| **Title of the Proposal** | **Green Synthesis of Nanocomposites from Waste Activated Sludge and their use in the Removal of Micropollutants from Wastewater** |
| **Guide I and Department** | Dr. Debraj Bhattacharyya, Department of Civil Engineering |
| **Guide 2 and Department** | Prof. Tarun K Panda, Department of Chemistry |
| **Email Address** | debrajb@ce.iith.ac.in |
| **Abstract** | Waste Activated Sludge is the microorganisms that grow in excess quantity in biological wastewater treatment plants. Along with water recycle, emphasis is also given on proper sludge management and reuse. This research will explore ways to generate values-added products like nanocomposites from sludge and reuse these materials for removing harmful micropollutants from wastewater. |
| **Keywords** | Wastewater, sludge, nanocomposites, treatment.. |
| **Background and Motivation** | A significant quantity of sludge is generated as byproducts during wastewater treatment. This sludge needs to be properly managed in order to prevent secondary environmental pollution. Moreover, for sustainable wastewater treatment, recycle of treated water and resource recovery from sludge, or converting sludge into a value-added product, are mandatory. |
| **Essential Qualifications** | M.Tech in Environmental Engineering, MSc in Chemistry |

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| **Desirable Qualifications** | M.Tech in Environmental Engineering, MSc in Chemistry |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1X93B68MffuPztTfCynzBLDTveLMh1XZ4 |
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| **Project Code** | **21** |
| **Title of the Proposal** | **Development of Functional Two-Dimensional (2D) Nanomaterials for Energy and Environmental Applications** |
| **Guide I and Department** | Dr. S. Ambika and Civil Engineering |
| **Guide 2 and Department** | Dr. Narendra Kurra and Chemistry |
| **Email Address** | narendra@chy.iith.ac.in |
| **Abstract** | Development of new materials, architectures and efficient interfaces are required for addressing current global issues related to efficient energy storage and clean water supply. Two-dimensional (2D) nanomaterials are considered as atomistic building blocks for the design of efficient devices for sustainable energy storage and water treatment applications. |
| **Keywords** | 2D Nanomaterials, Water treatment, Energy Recovery |
| **Background and Motivation** | The present global energy requirements are highly dependent on fossil fuels which are non-sustainable. Water contamination and water scaricity is yet another global issue. Therefore, nanotechnology-based strategies should be developed for producing energy and clean water supply in economic and efficient way |
| **Essential Qualifications** | MTech Environmental/Chemical/nanotechnology MSC Chemistry/environmental science/nanotechnology |
| **Desirable Qualifications** | Nanomaterials' synthesis & characterization, Environmental and energy |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1io0OcZQc3F8w7-vXAOcnLZmk0-QqJfrW |
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| **Project Code** | **22** |
| **Title of the Proposal** | **Developing AI Enabled H2/NH3 Turbulent Combustion CFD Model for Gas Turbine Applications** |
| **Guide I and Department** | Raja Banerjee, Department of Mechanical & Aerospace Engineering |
| **Guide 2 and Department** | Kishalay Mitra, Department of Chemical Engineering |
| **Email Address** | rajabanerjee@mae.iith.ac.in |
| **Abstract** | Concerns due to greenhouse gas emission are leading to a rapid decarbonization of the power generation section. There is considerable interest in using carbon neutral fuels like hydrogen and ammonia. However, several engineering challenges remain before these fuels can be effectively used for engineering applications like gas turbine combustion. This work will develop an AI/ML enabled CFD model to simulate combustion of these fuels and address some of these challenges. |
| **Keywords** | Combustion, CFD, AI/ML, Chemical Kinetics |
| **Background and Motivation** | Natural gas based gas turbines are extensively used for electricity generation. Concerns due to greenhouse gas emission are leading to a rapid decarbonization of the power generation sector. Hydrogen and ammonia are ideal carbon neutral fuels that produce only water vapour as exhaust. Computer modelling backed with AI & Machine Learning techniques is expected to accelerate modelling speed and help find the optimal operating envelope of these combustors with such new generation fuels. |
| **Essential Qualifications** | First class ME/MTech degree in Mechanical/Aerospace/Chemical Engineering |
| **Desirable Qualifications** | MTech/ME from CFTI; thesis in CFD, combustion, AI/ML; Publications |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1nsZRbP-8sWJUyilTtwT4bYCWnLiKJ91i |
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| **Project Code** | **23** |
| **Title of the Proposal** | **Development of multi-functional high entropy alloy nanostructured catalysts for hydrogen evolution reaction** |
| **Guide I and Department** | Prof. Suhash Ranjan Dey, Department of Materials Science and Metallurgical Engineering |
| **Guide 2 and Department** | Dr. Debaprasad Shee, Department of Chemical Engineering |
| **Email Address** | suhash@msme.iith.ac.in |
| **Abstract** | This Ph.D. study shall consist of design and development of Pt-based nanosized high entropy alloy tuneable electronic and physico-chemical properties on a suitable substrate, followed by detailed catalytic reactions of hydrogen evolution reaction. Moreover, for designing of HEAs theoretically, initial d-band theory based electronic structure calculations shall also be carried out. |
| **Keywords** | High entropy alloys, Water splitting, HER |

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| **Background and Motivation** | Pt is an efficient catalyst for electrolysis of water (a green method of hydrogen generation) with fast kinetics in acidic medium. But Pt is very expensive, available in less amount in nature and shows poor long time electrocatalytic durability. Therefore, there is a need of new designing of low cost and novel catalysts having high stability and superior electrocatalytic performance which can act as electrocatalysis for hydrogen evolution reaction in various acidic and alkaline electrolytes. |
| **Essential Qualifications** | M.Sc. Chemistry/Nanotechnology/Materials Science/Industrial Chemistry; B.E./B.Tech./M.Tech. Materials Science/Materials Eng./Nanotechnology/Chemical Eng./Industrial Chemistry/Applied Chemistry |
| **Desirable Qualifications** | Knowledge on Chemistry, Chemical and/or Materials Science related |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=13fLtXk_Ll6xgjP9LsdOtyzirA5YgY93A |
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| **Project Code** | **24** |
| **Title of the Proposal** | **Modelling of bed sediment entrainment by a turbulent flow** |
| **Guide I and Department** | Dr. Sk Zeeshan Ali, Assistant Professor, Department of Civil Engineering, IIT Hyderabad |
| **Guide 2 and Department** | Dr. Niranjan S. Ghaisas, Assistant Professor, Department of Mechanical & Aerospace Engineering, IIT Hyderabad |
| **Email Address** | zeeshan@ce.iith.ac.in |
| **Abstract** | The bed sediment entrainment by a turbulent flow remains a challenging problem of applied hydrodynamics. In this project proposal, particular emphasis is given in modelling of bed sediment entrainment from both analytical and numerical perspectives. The developed model would be crucial not only for the scientific rationales, but also for advancing the performance of riverine structures. |
| **Keywords** | Sediment transport, turbulent flow, hydraulics |
| **Background and Motivation** | The bed sediment entrainment by a turbulent flow is an important problem of river engineering. The subject has fascinated Albert Einstein, who himself wrote a letter to Meyer-Peter, an eminent researcher of ETH Zürich, asking him for a doctoral research position for his son, Hans A. Einstein, who later became a leading scientist in the field of sediment transport. |
| **Essential Qualifications** | Masters in Civil/Mechanical Engg/allied areas; Strong mathematical background; Experience/interest in C/C++/Fortran; Hydraulic & water resources engineering, applied mathematics, CFD; English fluency |
| **Desirable Qualifications** | Parallel programming, postprocessing tools, Linux; Mathematical tools |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1SIkRGFzWVzXZk6EfJoNDO1NhJBC9cTSg |

| Interdisciplinary-PhD Admissions, 2022 at CIP@IITH | |
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| AREA: ARTIFICIAL INTELLIGENCE, COMMUNICATIONS & NETWORKS | |
| **Project Code** | **25** |
| **Title of the Proposal** | **Development of passive microwave components for miniaturized RF devices** |
| **Guide I and** | Prof. Shiv Govind Singh, EE |
| **Guide 2 and Department** | Dr. Arabinda Haldar, Phys |
| **Email Address** | arabinda@phy.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, RF |
| **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) |
| **Desirable Qualifications** | BTech/Mtech (EE), MSc (Electronics), Radio Physics, Instrumentation |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1EY41fG6-PJLDG8PFzICxSpRAyiIPHn-_ |
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| **Project Code** | **26** |
| **Title of the Proposal** | **Addressing Security and Privacy in V2X (Vehicle-to-everything) Networks** |
| **Guide I and Department** | Antony Franklin / CSE |
| **Guide 2 and Department** | Abhinav Kumar / EE |
| **Email Address** | antony.franklin@cse.iith.ac.in |
| **Abstract** | The biggest challenge in V2X communication is to design lightweight credentials that can work with low network bandwidth requirements of V2X messages such as CAM (Cooperative Awareness Messages). Need to look at different combinations of symmetric key encryption schemes and anonymous credentials for V2X data with strong privacy guarantees. |
| **Keywords** | Vehicle to Everything (V2X), Privacy, Security |
| **Background and Motivation** | In vehicle-to-everything (V2X), vehicles have a cooperative exchange of messages with other vehicles or roadway infrastructure to issue alerts and warnings to drivers about road safety, traffic and weather updates, etc. Therefore, it is critical to ensure that the communicating devices can trust the integrity of the message and the authenticity of the source of the messages. Further, we should ensure the privacy of user (vehicle) data such as location and driving behavior. |
| **Essential Qualifications** | B.Tech in CS/ECE/AI/IT. |
| **Desirable Qualifications** | M.Tech / GATE |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1Uq0USQ6kwhbtl0PzP0uPVh0lvIDGVGqz |
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| **Project Code** | **27** |
| **Title of the Proposal** | **Advancing Machine learning and deep learning for Astronomy** |
| **Guide I and Department** | Shantanu Desai, Department of Physics |
| **Guide 2 and Department** | Srijith P K, Department of Computer Science |
| **Email Address** | srijith@cse.iith.ac.in |
| **Abstract** | The traditional approaches of studying Astronomical objects does not scale with the unprecedented data growth. Therefore, astronomers have turned their attention to automated techniques based on machine learning. In this proposal, we intend to advance the machine learning and deep learning techniques for Astrophysical data analysis through the lens of explainability, domain adaptation and continual learning. |
| **Keywords** | Astrophysics, deep learning, continual learning |
| **Background and Motivation** | Due to the evolution of detectors, astronomy has become an immensely data rich, triggering the birth of Astroinformatics. Astroinformatics aims at providing a new generation of accurate and reliable methods needed to analyze and learn from massive and complex data sets, requiring the use of modern machine learning (ML) and deep learning (DL) techniques. |
| **Essential Qualifications** | Bachelors/Masters in any of these disciplines CSE/AI/EE/Physics/Astronomy or related areas |

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| **Desirable Qualifications** | background/experience in machine/deep learning, statistics, astronomy |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1DTvOE88Cb5VhD1Cw2jGjJy6JQcmiT_uJ |
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| **Project Code** | **28** |
| **Title of the Proposal** | **Application of machine learning in a photonic system to investigate the ultrafast nonlinear dynamics** |
| **Guide I and Department** | Dr. K. Nithyanandan, Assistant Professor, Dept. of Physics. IIT H |
| **Guide 2 and Department** | Dr. Vikas Krishnamurthy, Assistant Professor, Dept. of Mathematics, IIT H |
| **Email Address** | nithyan@phy.iith.ac.in |
| **Abstract** | Ultrafast photonics become an enabling technology, thanks to its widespread applications. Particularly, fiber laser is at the heart of Photonic Technology, exhibiting complex dynamics in multi-parameter space. This proposal aims at developing analytical models and incorporating machine principles like the Physics Informed Neural Network(PINN), to explore and predict novel nonlinear dynamics. |
| **Keywords** | Photonics, Nonlinear Dynamics, Machine Learning |
| **Background and Motivation** | Real-world problems such as predicting the weather, forecasting the Stock Market, and other challenging stochastic processes are hard to model, predict and investigate. Ultrafast Fiber laser is among the most sought experimental setup to mimic and explore such complex nonlinear dynamical problems. Beyond fundamental interest, exploring the dynamics brings useful insight into the development of next-generation laser sources. |
| **Essential Qualifications** | Physics, Electrical Engineering, Photonics, Applied Physics/Mathematics |
| **Desirable Qualifications** | Experience in Machine Learning, Background in Electrical Engineering, |
| **Broad Proposal Objectives** | https://drive.google.com/open?id=1jWcIoC1HZax6eQkEcJ9ypSzoFKHIBPVe |
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