Interdisciplinary-PhD Admissions, 2022 at CIP@IITH	
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
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=1px1Dg80RIDSy-0v_RAf3QrWk3OtTx8Ot
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.

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
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
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
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

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
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
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-Z4TDyPho0WgUyI24
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

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
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	MTech in Chemical Engineering or Biotechnology or Biomedical Engineering or Polymer Engineering or allied areas
Desirable Qualifications	Motivated/Sincere, Willingness to learn, English fluency, Cell culture
Broad Proposal Objectives	https://drive.google.com/open?id=1lM6akBeC4ywJWoiE6ei9MbUzlZd83wZF
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
Project Code	**12**
Title of the Proposal	**Ultrasound Initiated Cavitation for Medical Applications**
Guide I and Department	Avinash Eranki

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

Interdisciplinary-PhD Admissions, 2022 at CIP@IITH	
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=1kR8IdFuv4sSYSKwRGFevVhRaegwN8Uu6
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	1.M.E./M.Tech in Metallurgical Engineering/Metallurgical and Material Science/Chemical Engineering or any related fields. 2.Valid Gate Score in the relevant disciplines.
Desirable Qualifications	Publication/M.Tech Thesis in steelmaking/CRE/reactor design/modeling/
Broad Proposal Objectives	https://drive.google.com/open?id=1ZujA-VXPTbMdruoOpxw-eJHpI53YIAM1
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.

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
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. Sasata 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
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

Interdisciplinary-PhD Admissions, 2022 at CIP@IITH	
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
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
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

Desirable Qualifications	M.Tech in Environmental Engineering, MSc in Chemistry
Broad Proposal Objectives	https://drive.google.com/open?id=1X93B68MffuPztTfCynzBLDTveLMh1XZ4
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
Project Code	**22**
Title of the Proposal	**3DCP Applications for Functional Structures using Parametric Design**
Guide I and Department	Srikar AVR, Department of Design
Guide 2 and Department	KVL Subramaniam, Department of Civil Engineering
Email Address	srikaravr@des.iith.ac.in
Abstract	3DCP (3D Concrete Printing) holds great promise in the construction industry with potential to mass customize and add aesthetic value to the construction components at scale. It will also be a catalyst to heritage preservation efforts, sustainability and smart quotient to construction.The concepts of parametric design can be extended to produce 3D printed elements for use in non-conventional structures with enhanced functionality. IITH 3DCP activity adds to the growth of 3DCP landscape in India.
Keywords	3DCP, IITH, Parametric, Applications, Sustainabili
Background and Motivation	Prof. KVLS and Prof. Srikar came together with a common interest to foster the 3DCP community in IIT Hyderabad. Prof.KVLS has worked with IITH from its inception, and is responsible for the majority of campus construction and development activities. Prof.Srikar is an architect and an industrial designer with diverse industry experience in construction applications with leading global and Indian construction companies.
Essential Qualifications	Concrete Processing and Rheology Control, Industrial Design, Architecture, Concrete Technology
Desirable Qualifications	As above, 3DP Machine operations and tech
Broad Proposal Objectives	https://drive.google.com/open?id=16FPAZqAZg6QXer6wW5R2K8VdxdfuN5m0
Project Code	**23**
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
Project Code	**24**
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
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_LI6xgjP9LsdOtyzirA5YgY93A
Project Code	**25**
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	
AREA: ARTIFICIAL INTELLIGENCE, COMMUNICATIONS & NETWORKS	
Project Code	**26**
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-_
Project Code	**27**
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
Project Code	**28**
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
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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

Desirable Qualifications	background/experience in machine/deep learning, statistics, astronomy
Broad Proposal Objectives	https://drive.google.com/open?id=1DTvOE88Cb5VhD1Cw2jGjJy6JQcmiT_uJ
Project Code	**29**
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=1jWcloC1HZax6eQkEcJ9ypSzoFKHIBPVe