Joint PhD Programme of IIT Guwahati and IIT (BHU) Varanasi – July 2023

Sl. No.	01
Dept.	Chemistry
Project Code	JD_CH_SB-AI
Joint Supervisors	Dr. Shyam P. Biswas, Department of Chemistry, IITG; Dr. Arindam Indra, Department of Chemistry, IIT (BHU)
Title of the Project	Development of Self-Supported Metal-Organic Framework Electrodes for Electrochemical Hydrogen Evolution at Industrial Scale Current Density
Project Summary	The increasing global energy demand leads to the excessive use of fossil fuels, resulting in the release of a huge amount of greenhouse gases in the atmosphere. These gases have a significant impact on global warming and climate change. In this respect, hydrogen production by electrocatalytic water-splitting can fulfill the increasing energy demand. The Government of India has launched National Hydrogen Mission to rectify the dependency on fossil fuels as well as to take a leading role to fight against global warming. Although a significant development has been achieved in electrocatalytic hydrogen evolution using transition metal-based catalysts, the current density, attained by these catalysts, is not high enough for the industrial-scale application. Therefore, the extensive research is required to fulfill the demand of the industry like the design of low cost and non-toxic materials, high current density (> 400 mA cm^{-2}) at low overpotential (<100 mV) and durability of the catalysts. Looking at the above requirements, in this project, we will develop self-supported metal-organic framework (MOF) electrodes which can catalyze the cathodic hydrogen evolution reaction to reach more than 1 A cm^{-2} current density at a low overpotential. To attain this goal, we have chosen a self-supported approach, which ensures a strong contact between the solid-support and the catalyst and enhances the charge transfer process. In addition, the strong catalyst-support interaction increases the stability of the catalyst system. Further, the electronic and coordination structure of the MOFs will be fine-tuned to attain an optimized activity and stability of the catalyst system. Finally, a structure-activity relationship will be established based on the in situ and ex situ characterization techniques including X-ray absorption and Raman spectroscopic studies.
Sl. No.	02
Dept.	Civil Engineering
Project Code	JD_CE_AM-AP
Joint Supervisors	Dr. Akhilesh Kumar Maurya, Department of Civil Engineering, IITG; Dr. Agnivesh P., Department of Civil Engineering, IIT (BHU)
Title of the Project	Truck Traffic Impacts of Multi-modal Logistics Parks in India
Project Summary	The overarching goal of this research is to develop data-driven solutions for assisting the urban consolidation initiatives centered at multi-modal logistics parks (MMLPs). This involves the Quantification of the barriers for the modal shift to multimodal logistics parks, Analysis of the safety and efficiency impacts of heavy trucks on traffic streams, development of novel approaches to solving the multi-depot vehicle routing problem and examining the business models, infrastructural changes and policy incentives required for the modal shift towards multimodal logistics parks.
Sl. No.	03
Dept.	Electronics and Electrical Engineering
Project Code	JD_EE_AD-PM
Joint Supervisors	Dr. Anirban Dasgupta, Department of Electronics and Electrical Engineering, IITG; Dr. Priya Ranjan Muduli, Department of Electrical Engineering, IIT (BHU)

Title of the Project	Diagnosis of Asthma and Chronic Obstructive Pulmonary Disease
Project Summary	The COVID-19 pandemic seriously affected respiratory health, with chronic obstructive pulmonary disease (COPD) and asthma being the most common. There is a rush among patients for diagnosis at medical centres, potentially overloading doctors. Some individuals are unaware of these disorders until they witness a severe threat. These diseases have common symptoms, such as cough, sputum expectancy, wheezing, and chest pain. As such, standalone AI-enabled systems must be developed to perform preliminary diagnosis and reduce the burden on doctors and paramedical staff. The solution to this problem is developing an Internet-of-Things (IoT)-based smart pulmonary health kiosk (SPHK) system. The system will contain specific sensors that will capture the necessary signals. Specific signal processing algorithms and machine learning models will be applied to these signals to estimate specific parameters that will inform the patient's respiratory health and allied illness. Some non-parametric diagnostic results will be provided solely based on the raw data, using pre-trained deep learning models. All these analytics will be displayed locally on the kiosk and available in the cloud, with access via proper authentication from anywhere.
Sl. No.	04
Dept.	Mechanical Engineering
Project Code	JD_ME_PM-BP
Joint Supervisors	Dr. Pranab K. Mondal, Department of Mechanical Engineering, IITG; Dr. Binita Pathak, Department of Mechanical Engineering, IIT (BHU)
Title of the Project	Investigation of liquid flows in flexible microchannels
Project Summary	In this project, we will study the flow behavior of visco-elastic fluids in flexible microchannels. Flexible channels are widely applicable in mixing, cooling, drug delivery, etc. Visco-elastic fluids in channels also mimic physiological flows. This project aims to investigate the combined effects of the fluid's viscoelasticity and deformation of the channel wall on the underlying transport. We would investigate the interaction between rheological properties and deformable walls and their impact on the flow dynamics.
Sl. No.	05
School	School of Energy Science and Engineering
Project Code	JD_EN_PA-AM
Joint Supervisors	Dr. Pratima Agarwal, School of Energy Science and Engineering, IITG; Dr. Ashish Kumar Mishra, School of Materials Science and Technology, IIT (BHU)
Title of the Project	Transition metal dichalcogenides nanostructures for optoelectronics and energy applications
Project Summary	In last decade, two-dimensional (2D) transition metal dichalcogenides (TMDS) have shown great promise among 2D materials family for the development of next generation technology due to their unique physical properties like layer dependent bandgap, optical transparency, good thermal transport behaviour along with high absorption coefficient and mechanically flexible nature. The semiconducting TMDs like MoS2, MoSe2, WS2, WSe2 are stable materials with bandgap in the visible range and NIR region and suitable for use in next generation optoelectronic and energy devices such as photodetectors, solar cells etc. In the joint PhD programme with IIT(BHU), we aim to synthesize different transition metal diselenides nanomaterials like MoSe2, WSe2 etc. and their heterostructures using physical/chemical techniques like sputtering, CVD and hydrothermal techniques. These nanomaterials will be synthesized on different substrates like Si, SiO2/Si, quartz, conducting glass etc. We look to identify the design of suitable morphology of these semiconducting nanomaterials and their heterostructures on certain substrates, which shows excellent light absorption, good carrier transport and excellent stability. Based on these physical properties, appropriate transition metal diselenides and their heterostructures will be examined for their photodetection and solar cells applications.

Sl. No.	06
School	Jyoti and Bhupat Mehta School of Health Sciences and Technology
Project Code	JD_HT_RK-AP
Joint Supervisors	Dr. Rajiv Kumar Kar, Jyoti and Bhupat Mehta School of Health Sciences and Technology, IITG; Dr. Aditya Kumar Padhi, School of Biochemical Engineering, IIT (BHU)
Title of the Project	Design of nanoparticle-conjugated peptides targeting key biomarkers as point-of-care diagnostics
Project Summary	In this joint Ph.D. program, we propose designing and developing (Gold and Metal-oxide) nanoparticle-tagged peptides for developing sensors to sense biomarkers appearing in body fluid. We will utilize high-throughput computational protein design approaches to construct stable point-of-care diagnostics. The designed prototypes will be characterized and tuned for specificity and sensitivity for the spectroscopic and electrochemical-based detection methods.