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

Sl. No.	01
Dept.	Electronics and Electrical Engineering
Project Code	JD_EE_RS-SB
Joint Supervisors	Dr. Ramesh Kumar Sonkar, Department of Electronics and Electrical Engineering, IITG; Dr. Somak Bhattacharyya, Department of Electronics Engineering, IIT (BHU)
Title of the Project	Optical Metasurface-based Components
Project Summary	A joint research on Optical Metasurface-based Components has been proposed with IIT (BHU), Varanasi. The student will do the simulation in details under the guidance of Dr. Somak Bhattacharyya in IIT (BHU), Varanasi together with circuit modelling part and carry out the fabrication and experimental characterization in IIT Guwahati under Dr. Ramesh Sonkar.
Sl. No.	02
Dept.	Electronics and Electrical Engineering
Project Code	JD_EE_RJ-JJ
Joint Supervisors	Dr. Ravindra Kumar Jha, Department of Electronics and Electrical Engineering, IITG; Dr. Jaya Jha, Department of Electronics and Electrical Engineering, IIT (BHU)
Title of the Project	A comparative study of Emerging 2D material-based transistors with the AlGaN/GaN HEMTs for Heavy Metal Ion Detection
Project Summary	Heavy metal ions (mercury, lead, arsenic, etc.) are highly toxic for living organisms, especially after bioaccumulation and biomagnification, which possess a serious threat to human health. Various Field effect transistors have been utilized for electrical sensing of heavy metals till now. Currently, a number of research groups worldwide are investigating the sensing abilities of two-dimensional (2D) materials including transition metal dichalcogenides, black phosphorous, MXenes etc. Ultrathin planar structure of these materials allows efficient electrostatics (easier control of channel charge by gate voltage) and high degree of vertical scaling, which are beneficial for designing ultrashort channel FETs. A FET-based sensor are based on the ion movement on the analyte/membrane interface, resulting in a potential difference between target analytes and reference solution, observed with the threshold voltage shift. Unlike conventional FETs, HEMT's conducting channel is fueled by two-dimensional electron gas (2DEG) arising from spontaneous piezoelectric polarization at the [0001] axis of the AlGaN/GaN heterostructure. Even though the 2DEG carrier mobility is incomparable to the mobility of zero-bandgap graphene, HEMT has considerable potential as a highly sensitive sensor device with fast response time attributed to its higher 2DEG density and thinner barrier in the AlGaN/GaN layer, enabling direct detection of molecules or charged particles absorbed on top of its sensing area (gate). In this project, we intend to compare the sensing behavior of AlGaN.GaN-based devices with the 2D material-based devices. This performance analysis of these devices have capability of opening new avenues of heavy metal ion sensors.

Sl. No.	03
Dept.	Mechanical Engineering
Project Code	JD_ME_SJ-PC
Joint Supervisors	Dr. Shrikrishna N. Joshi, Department of Mechanical Engineering, IITG; Dr. Pranjal Chandra, School of Biochemical Engg, IIT (BHU)
Title of the Project	Design and Development of a Novel and Efficient Manufacturing System for Electrodes Required for Bio-Molecular Analysis
Project Summary	This project is aimed at the design and development of electrodes required for manufacturing of electrodes required for bio-molecular analysis. A thorough and systematic study of existing methods and systems will be carried out. Based on this, a novel and simple design methodology for electrode manufacturing will be prepared. The design will be duly verified by carrying out extensive finite element method-based numerical analysis. The set-up will be fabricated and tested for a wide range of process parameters. The optimal and tested set-up parameters are then employed for practical applications. Such a system will be indigenous and highly tuneable for molecular sensing in miniaturized settings. The system will be characterized using various physiochemical process and opto-electrochemical measurements. In the proposed joint research, we explicitly aim to develop carbon as well as other material base electrodes for detection of diverse molecules which includes; free radical, small molecules, macromolecules in highly efficient manner. The project also aims to deliver a personalized device prototype for detecting clinically relevant markers.
Sl. No.	04
Dept.	Civil Engineering
Project Code	JD_CE_TB-MC
Joint Supervisors	Dr. Tadikonda Venkata Bharat, Department of Civil Engineering, IITG; Dr. Manash Chakraborty, Department of Civil Engineering, IIT (BHU)
Title of the Project	Prediction and Mitigation of Rainfall-induced Landslides
Project Summary	Rainfall is an important triggering factor in causing the landslides. The rainwater infiltration into the soil slope decreases the matric suction, eventually resulting in a loss of shear strength in the soil. The prediction of Landslides is currently based on the assumption that the entire rainfall contributes to the infiltration. Nevertheless, the impacts of precipitation (and/or evapotranspiration), which plays an important role in governing the long-term stability of soil slopes, are not duly incorporated in the analysis. The primary reason for this incapability is that most of the analyses are based on conventional geomechanics, which pertain to completely saturated/dry soils. However, in reality, soils remain in partially saturated conditions. Hence, various hydromechanical aspects of unsaturated fluid flow (steady-state and unsteady-state) must be considered in the simulations. This project aims to conduct tests on the slopes at the laboratory and field scale to evaluate the soil characteristics during the wetting-drying cycles. Further, it aims to perform rigorous numerical and analytical slope stability simulations whereby the impact of change in moisture boundary conditions, either by precipitation or by evapotranspiration, will duly get incorporated in the seepage and stability analysis. This study will primarily focus on the slope stability analysis and the bearing capacity of the footings that rest over the slopes. The study will be helpful in modeling rainfall-induced landslides for the prediction and mitigation of these events.