Interdisciplinary PhD Programme – July 2024

Sl. No.	01
Dept.	Biosciences and Bioengineering
Project Code	ID_BT_SN-SS
Joint Supervisors	Dr. Selvaraju Narayanasamy (BSBE), Dr. Sreedeep Sekharan (CE)
Title of the Project	Production of Microbial Biodiesel using Second Generation feedstock by Consolidated Bioprocessing (CBP) approach
Project Summary	The rapid development and population growth worldwide forced people to depend on the utilization of fossil fuels. This increased the depletion and demand for fossil fuels globally with a continuous rise in greenhouse gases, petroleum-contaminated water, and other environmental concerns. To overcome the aforementioned energy-environmental problems, fossil fuels are being replaced with renewable biofuels. For instance, diesel derived from fossil fuels can be replaced with biodiesel produced from renewable sources (vegetable oil, microbial oil, etc.,) by transesterification to achieve sustainability. Production of third-generation biodiesel using oleaginous microorganisms has been increased recently to achieve high sustainability and demand for energy. This proposed work aims to generate third-generation biodiesel using second-generation feedstock via consolidated bioprocessing (CBP) technology. Second-generation feedstock such as lignocellulosic biomass derived from crop residues and forest residues, is inexpensive, abundant, and environmentally friendly. Lignocellulosic biomass can be utilized by microbes as a carbon source for the production of biofuel to get a circular economy for meeting sustainability globally. Due to its recalcitrant nature, heterogeneity, and structural complexity, the conversion and decomposition of lignocellulosic biomass is a multi-step and difficult process that includes pretreatment, saccharification, and fermentation. In this case, CBP will be a promising technology by combining the process of enzyme production, enzymatic saccharification, and fermentation in a single bioreactor to accumulate maximum lipids using a specific combination of microorganisms. The proposed study includes the following objectives; • Isolation, identification, and development of potential indigenous microbial consortia for biodiesel production. • Selection, characterization and pretreatment of appropriate second-generation feedstock. • Optimization of Process Parameters for efficient lipid production via consolidated bioprocessing (CBP) approach. • Production, Recovery, Purification and Characterization of biodiesel and its blend. • Techno-economical analysis of developed biodiesel production process. • The left-over biomass will be explored as soil amendment.
Sl. No.	02
Dept.	Biosciences and Bioengineering
Project Code	ID_BT_SS-GP
Joint Supervisors	Dr. Senthilkumar Sivaprakasam (BSBE), Dr. G Pugazenthi (CL)
Title of the Project	Enhancing D-lactic acid production in engineered Saccharomyces cerevisiae: A dual approach leveraging reverse engineering and cell recycle membrane integrated bioreactor

Project Summary	This interdisciplinary research (IDP) proposal aims to substantially enhance D-lactic acid (DLA) production using metabolically engineered Saccharomyces cerevisiae, with the goal of sustainably synthesizing biodegradable polylactic acid (PLA) polymers as a viable alternative to petroleum-based plastics. Leveraging the robust metabolic framework of S. cerevisiae and molecular cloning tool availability, this research employs a dual approach that synergizes evolutionary adaptation with precise metabolic engineering techniques. Our objective is to optimize DLA production pathways while significantly improving both substrate uptake rates and the yeast's tolerance to acidic conditions. The proposed methodology encompasses genetic modifications to overexpress heterologous D-lactate dehydrogenase and to eliminate competing metabolic pathways using advanced genome editing tools. Additionally, we plan to integrate mutations identified through adaptive laboratory evolution (ALE) that enhance acid tolerance and substrate uptake rates. This proposal addresses a critical research gap by simultaneously enhancing DLA production and acid tolerance, with the aim of developing an efficient recombinant yeast strain characterized by highly stable DLA biosynthesis for industrial applications. Further, to enhance DLA production, this project will implement process optimization in cell recycle membrane integrated bioreactor system. This system will facilitate continuous fermentation, significantly boosting productivity by mitigating product inhibition and preventing membrane fouling—both are critical parameters in membrane-integrated systems. This comprehensive strategy not only promises to advance DLA production technologies but also contributes to the development of sustainable bioplastics, aligning with global efforts to mitigate consumption of non-renewable source.
Sl. No.	03
Dept.	Chemical Engineering
Project Code	ID_CL_NP-ST
Joint Supervisors	Dr. Nageswara Rao Peela (CL), Dr. Subhash Thota (PH)
Title of the Project	Green Hydrogen Production from Ethanol by Steam Reforming
Project Summary	There is a global urgency to adopt cleaner alternatives to the non-renewable fossil fuels, such as petroleum, natural gas and coal for energy production due to stringent environmental constraints and limited availability of these resources. One of the most promising options to replace fossil fuels is to use hydrogen, derived from biomass-based resources such as ethanol, as energy carrier. Therefore, in this project a special emphasis will be given to probe the catalytic behavior of the bimetallic nanostructures for potential steam reforming of bio-ethanol which will lead to the production of green hydrogen. Bimetallic catalysts based on the transition metal spinel (AB_2O_4) oxides will be explored for the catalytic applications. Especially $MnCo_2O_4$ cubic spinel nanostructures will be synthesized using the sol-gel processing and their structural, morphological and elemental analysis will be performed to thoroughly explore their potential as novel catalyst. Moreover, their electrochemical characteristics will also be explored using the cyclic voltammetry (CV) method for evaluating the electrochemical behaviour of a nanostructures. The catalyst screening experiments, at ambient pressure, will be performed using a continuous fixed bed reactor. The details of the continuous experimental setup are as follows: The required gases (N_2 or H_2) will be passed through mass flow controllers to obtain required flow rates. The liquid reactant (ethanol/water solution) will first be pumped through an evaporator, maintained at approximately 150°C, using a reciprocating pump. The gaseous stream and the vapor stream will be mixed together and passed to a ¼" Inconel reactor. The catalyst to be tested will be placed in the reactor which in turn will be placed in a tubular furnace whose temperature will be maintained at a desired value by using a PID controller. The pressure will be ambient (1 atm). At each experimental condition, the activity and selectivity of a catalyst will be determined using the above-described experimental setup. The physico-chemical properties of the tested catalysts will be correlated with the activity, selectivity and stability of the catalysts.
Sl. No.	04
Dept.	Chemical Engineering
Project Code	ID_CL_PV-SM
Joint Supervisors	Dr. Prabu Vairkannu (CL), Dr. Soumen K. Maiti (BSBE)

Title of the Project	Bio-chemical leaching of critical minerals from ores
Project Summary	Critical minerals including rare earth elements (REEs) are of strategic importance because they find numerous applications in various sectors of the global economy. The concern about the REEs and other critical minerals supply challenge has led to increasing interest and research in the recovery from various sources of ores. Hence, the extraction of critical minerals including REEs from various ores is essential by economical ways without high operational costs, high energy consumption, and other environmental issues. Chemical and bioleaching methods are prominent for the separation of metals from their ores. There are no studies found for the recovery of Indian mineral sources in the overlying stratas of northeast coal seams for the extraction of critical minerals. Northeast coal mines are geographically enriched with many such mineral sources and hence the objective targets the overburden minerals (OBM) of these mines. Leaching and bio-leaching process will be conducted under laboratory scale using various soils and stones of OBM. Microorganism's dissolute specific metals from ores. Hence, employing appropriate fungi and bacteria in the leaching process is beneficial to separate valuable metals. The process parameters for the optimum conditions will be evaluated by using various solvents and appropriate microbes in the leaching process. Optimization of solid particle size, solvent to solid ratio, temperature, pH, and residence time will be performed. Initially, preliminary experiments will be performed to identify the suitable solvents for the recovery of REE from chemical methods. A batch reactor will be used for treating the OBM slurry for the leaching process. Raw OBM, coal and ash, leachate liquor will be characterized by using inductively coupled plasma – mass spectroscopy (ICP-MS) to identify and quantify the critical minerals with REE present in it. Suitable and efficient microorganism will be identified in the biochemical method for the extraction of critical minerals. Optimization for the extraction of these minerals using microorganism will also be studied. Further, a techno-economic analysis will be performed to examine the feasibility of the process for commercialization.
Sl. No.	05
Dept.	Chemistry
Project Code	ID_CH_DM-RT
Joint Supervisors	Dr. Debasis Manna (CH), Dr. Rajkumar P. Thummer (BSBE)
Title of the Project	Harnessing Ion Transport Mechanisms for Antibacterial Innovation: Strategies Against Multidrug Resistance
Project Summary	Traditional antibacterial development strategies often cause rapid antibiotic resistance. Henceforth, we need to address this major challenge by developing innovative approaches that are more effective and selective towards pathogenic bacteria. Contrary to targeting the explicit protein, enzyme, or genetic material of the bacterial cells, the hydrophobic ion transporters remain within the membrane and support ions in crossing the hydrophobic core of the membrane, which leads to the stimulation of bacterial cell death. The ion transporter-assisted alternation of ionic homeostasis can potentially disrupt the ionic balance and overcome the multidrug resistance related to the proteins or enzymes' overexpression or mutation(s). Several synthetic ion transporters have recently been reported, and few have shown the ability to enhance ion transport-mediated antibacterial activities. The current proposal highlights the potential of ionophores as possible leads and emphasizes the complexities related to their mode of action against bacterial cells. Ionophores with new scaffolds, which are highly specific to the bacterial cells and manifest toxicity almost exclusively towards them (or at least have a higher selectivity for bacterial cells compared to the host cells), will be designed, synthesized, and their ion recognition, ion transport properties will be extensively studied. Our group already demonstrated that, in most of the cases, either due to the transport of the Zn2+/Cl—, disruption in ionic homeostasis takes place or when Cl— is transported with H+, because of a change in the pH gradient triggered the death of cancer or bacterial cells. In addition to this, it has been recently shown by other groups that the productive transport efficiencies of the ionophores coupled with their non-detrimental nature towards the normal cells can be exploited to restore the defective endogenous anion channels, which led to various channelopathies. Another area that has not been thoroughly explored is the bactericidal properties of these ionophores, which result from the ability of this ionophore to upset the existing ionic homeostasis.

Sl. No.	06
Dept.	Chemistry
Project Code	ID_CH_KR-AK
Joint Supervisors	Dr. Kalyan Raidongia (CH), Dr. Abhijit Kakati (CL)
Title of the Project	Synthesis and Characterization of Nanomaterials for Developing High-Performance Oil Field Chemical Products
Project Summary	Oil and gas production is among the most challenging but essential industrial operations of the present time. Across the entire value chain, the petroleum industry encounters numerous operational problems. For example, wax and asphaltene deposition in facilities and pipelines drastically increases the operating cost and risk to surrounding environments. Similarly, efficiently separating oil and water from the produced well stream is another challenging and expensive process. Along with mechanical and thermal measures, the oil industry globally uses chemical methods or chemical additives to improve crude oil flow behavior and de-emulsify oil and water. However, the majority of these chemical additives are environmentally hazardous and cost-intensive. Due to their very high surface-to-volume ratio, nanomaterials and their polymer composites exhibit remarkable properties far beyond the expectations of simple molecule polymers. The recent trend in the literature suggests that nanomaterials and their composites can revolutionize the industry processes of the oil and gas-based energy sector. Therefore, all the major oil and gas businesses are investing significantly in the nanotechnology sector. In this project, we proposed to address these two operational problems by utilizing nano-materials as an alternative solution to chemical additives. Different nano-materials will be designed, synthesized, and tested as flow improvers and de-emulsifiers using crude oil and emulsion. Similarly, the applicability of nanomaterials will also be explored in areas such as – drilling fluids, improved oil recovery, and formation water treatment. Moreover, nanomaterials will be used to reduce energy losses during production, develop high-performance products, and contribute to more efficient, less expensive, and environmentally friendly products. In conclusion, we propose to work on the fundamental research areas of nanomaterials/nanocomposites – their synthesis and characterization- and explore potential applications to improve the existing oil and gas operations. Processes and Techniques to be used/learned during Ph.D.: 1. Synthesis of various nanomaterials and nanocomposeits; 2. Characterisation of the synthesized nanoparticles and nanocomposites; 3. Evaluate the performance of the nanoparticles on different oil industry applications.
Sl. No.	07
Dept.	Chemistry
Project Code	ID_CH_TP-VT
Joint Supervisors	Dr. T Punniyamurthy (CH), Dr. Vishal Trivedi (BSBE)
Title of the Project	Synthesis and Biological Studies of Heterocyclic Compounds
Project Summary	• Designing of elegant strategies that enable for the enantioselective C(sp3)-H functionalization using a chiral transient directing group strategy. • Performing atroposelective C-H activation/annulation strategy towards accessing axially chiral frameworks. • Late-stage functionalization and further study of their therapeutic applications to depict biological activities.
Sl. No.	08
Dept.	Chemistry
Project Code	ID_CH_KB-TM

Joint Supervisors	Dr. Krishna Pada Bhabak (CH), Dr. Tapas K. Mandal (CL)
Title of the Project	Bioanalyte-triggered Prodrugs for the Co-delivery of Anti-Cancer or Anti-inflammatory Drugs and Hydrogen Sulfide with Turn-On Fluorescence
Project Summary	Off-target side-effects of the commercially available anti-cancer drugs (chemotherapeutic drugs) are major concerns for the effective treatment of cancer. The lack of targeting behavior of most of the commonly used chemotherapeutic drugs leads to the circulation of active drug not only to the cancer microenvironment but to healthy normal tissues. As a result, homeostasis of healthy normal cells gets hampered. Therefore, in the present proposal, we propose the development of stimuli-responsive conjugate prodrug systems for the targeted delivery of the anticancer drug to the desired tumor microenvironment or into the important intracellular organelles such as mitochondria or lysosomes, which are implicated in most of the cancer development and progression due to their importance in cellular metabolism, signaling cascades and apoptosis. Moreover, a co-delivery of the anti-cancer drugs with hydrogen sulfide (H2S) will be considered with the turn-on fluorogenic events for minimizing the off-target side effects and the convenience of efficient monitoring of drug delivery processes. It should be noted here that H2S exhibits various pharmacological effects, including anticancer, antioxidant, anti-inflammatory, cytoprotective, cardioprotective, and chemopreventive activities. Therefore, rational conjugation of H2S with the marketed anticancer drugs/enzyme inhibitors might be an effective strategy for enhancing the therapeutic potential of the chemotherapeutic drugs while reducing off-target side effects The level of reactive oxygen species (ROS) in cancer cells is generally higher than in normal cells, and the overproduction of ROS in cancer cells is caused primarily by the dysregulation of multiple metabolic enzymes. For example, the expression levels of thymidylate synthase (TS), aldose reductase (AR), cyclooxygenase-2 (COX-2), and glutathione-S-transferase pi (GSTP1) are reported to be up-regulated in many organ-specific cancer cells.1 Furthermore, it is well-established that cyclooxygenases (COX-1 and COX-2) induce and elevate the inflammatory signals with the generation of prostaglandin, leading to the overproduction of ROS. Another primary concern of the chemotherapeutic drug effectiveness is associated with chemoresistance, which is triggered by the over-expression of GSTP1. It has been shown that the higher level of glutathione (GSH) in tumor cells is reported to be risky in specific cancer types, such as head and neck carcinoma, as it helps in many chemotherapeutic drug inactivation catalyzed by GSTP1. The overproduction of GSTP1 in the tumor microenvironment is quite common, and GSTP1 mainly induces resistance to chemotherapeutic drug activity via GSH conjugation. Therefore, selective and potent inhibitors of one or more of these overexpressed enzymes are used for the treatment of cancer.1b, 2 However, the existing strategies of such inhibition processes have drawbacks/limitations such as (a) direct administration of chemotherapeutic drugs/enzyme inhibitors can be non-selective towards cancer cells over non-malignant normal cells; (b) direct administration of the drugs/inhibitors to the cells invites more side-effects by sudden increase in the drug concentration in the plasma level; (c) most of the inhibitors targeting these enzymes or receptors are not fluorogenic, rendering the real-time monitoring difficult. In the present research plan, we plan to design and synthesize turn-on fluorescent prodrugs for the targeted delivery and/or selective inhibition of the above-overexpressed enzymes using the specific stimuli-triggered sustained release strategy. The development of turn-on fluorescent prodrugs would involve several steps of organic synthesis. Additionally, an adjuvant delivery of an anti-cancer drug or an enzyme inhibitor with H2S will also be considered to minimize the drug resistance and the drug-induced side effects.
Sl. No.	09
Dept.	Chemistry
Project Code	ID_CH_KM-AK
Joint Supervisors	Dr. Kingsuk Mahata (CH), Dr. Ajaikumar B. Kunnumakkara (BSBE)
Title of the Project	Development of novel drug molecules targeting ATP-Citrate Lyase for the treatment of Triple Negative Breast Cancer
Project Summary	Breast cancer stands as the most prevalent malignancy affecting women globally. Among its subtypes, triple-negative breast cancer (TNBC), notably prevalent in younger age groups, emerges as the most aggressive variant. In this project, various drugs will be designed using computer aided drug design methods. The drugs will be synthesized, and finally investigated against the TNBC.

Sl. No.	10
Dept.	Chemistry
Project Code	ID_CH_DS-UM
Joint Supervisors	Dr. Dipankar Srimani (CH), Dr. Uday Narayan Maiti (PH)
Title of the Project	Development of transitional metal/N-doped nano/micro-structured material for catalysis
Project Summary	Revolutionary developments in organic synthesis for the synthesis of bulk and fine compounds have been made possible by organometallic catalysis. Noble metal complexes are mostly used for this purpose. However, there is considerable interest in catalysis using earth-abundant alternatives due to its high cost. Various well-defined 3d-transition metal complexes have recently been developed for catalysis. The difficulty of reusing the catalyst and removing metal contaminants from the intended product is the primary disadvantage of homogeneous catalysis. Thus, the development of 3d-metal-based heterogeneous catalyst, which can perform various types of catalytic processes under milder conditions, would be extremely advantageous. To achieve this Well-designed metal fabrication on heterogeneous support would be crucial. Recently, thermal decomposition metal complexes on carbon support were used to synthesize Fe- and Co-based catalysts encapsulated in N-doped graphitic carbon. However, the field is in a nascent stage and has the potential to open up a new avenue in the area of heterogeneous catalysis. Thus, the synthesis of various metal-fabricated catalysts with varied composition/microstructure, and study of their influence on catalysis would be highly significant. The relative reactivities Mn, Co, and Fe, as well as modifications to ligand motifs, support characteristics, and reaction parameters, may alter the microstructure and final composition of the catalyst, which will help to fine-tune the catalytic process.
Sl. No.	11
Dept.	Chemistry
Project Code	ID_CH_CM-SP
Joint Supervisors	Dr. Chandan Mukherjee (CH), Dr. Subrata Pramanik (HT)
Title of the Project	Development of “Smart” MRI Contrast Agents Based on Mn and Fe Nutritional Elements
Project Summary	Magnetic resonance imaging (MRI) is a noninvasive imaging modality that has found its extensive use for recording high-resolution images of soft tissues. The prior administration of a paramagnetic species, known as a contrast agent (CA), can boost image quality, organ specificity, and functionality of the organs. Herein, the plan is to develop some CAs for the application of angiography, pancreatic beta-cell imaging, and thereafter, the diagnosis of diabetes, and early-stage detection of cancer by targeting folic acid receptors. The current challenge of the existing Gd(III) ion-based CAs is that these are not bio-friendly, and leaching of free Gd(III) ions in vivo is known to engender nephrogenic systemic fibrosis in patients with renal impairment. Hence, we plan to overcome this challenge by developing Mn(II) and Fe(III) ions-based CAs, which will be characterized using in vitro and in vivo models. The ions are essential nutrients for intracellular activities, and human physiology has specific metabolic pathways to excrete excess Mn and Fe ions from the body. Therefore, toxicity due to excess metal ions deposition is less for the ions.
Sl. No.	12
Dept.	Chemistry
Project Code	ID_CH_CJ-SK

Joint Supervisors	Dr. Chandan K Jana (CH), Dr. Sachin Kumar (BSBE)
Title of the Project	Synthesis of arylated N-heterocycles via C-H arylation of N-heterocycles for the development of antiviral agents
Project Summary	RNA-dependent RNA polymerase (RdRp)plays crucial role to make multiple copies of viral genomic RNA. Thus RNA polymerase inhibitor that disrupts the process of viral replication is an important target for the development of antiviral drugs. Various anti-viral drugs(shown in figure I), which block the viral RNA synthesis by RdRp, have been developed forthe treatment of SARS-CoV, hepatitis C, Ebola, MERS, HIV, etc. The common structural features of these drugs include a pentose sugar decorated with the heterocycles. The heterocycles attached either via heteroatom or carbon atom remain syn to the hydroxymethyl group at 5-position. Deoxy derivative in larnivudine was also found to have effective anti -viral activity. The recently identi fied betacoronavirus, SARS-CoV-2, has a genetic sequence and viral structure which are similar (70% similarity) to severe acute respiratory syndrome coronavirus (SARS-CoV). The anti-viral drugs such as ribavirin and remdesivir, which were developed for SARS, MERS, etc. were found to be effective for SARS-CoV-2.
Sl. No.	13
Dept.	Chemistry
Project Code	ID_CH_AD-SG
Joint Supervisors	Dr. Animesh Das (CH), Dr. Subhradip Ghosh (PH)
Title of the Project	Exploring the Synthesis and Catalytic Studies of Immobilized Triazine-Based Metal-Pincer Complexes in Cross-Coupling Reactions
Project Summary	Pincer ligands are extensively used in many diverse areas of chemistry primarily as a means to direct and modulate the properties of a metal center to which it is bonded. An important characteristic of the pincer platforms is the fact that its three ligating sites are well organized by the backbone of the ligand which leads to the possible formation of five- or six-membered chelate rings in which the central metal-heteroatom bond is in common. Moreover, in some cases, the pincer platform is suitable for executing metal-ligand cooperative (MLC) behavior in catalytic processes. The challenges in homogenous catalysis such as the recovery of catalysts and the use of costly methods for purification of the products, encourage the researchers to design and use heterogeneous catalysts instead to overcome such problems. But even with heterogeneous catalysis, there are still some issues to be considered such as low activity and selectivity, turnover number (TON), and leaching of the metals into the reaction media. The immobilization of the homogenous catalyst onto the solid supports via covalent or non-covalent interactions is considered a beneficial approach to combine the advantages of homogeneous and heterogeneous reactions such as high reactivity, selectivity, rational design, efficient recovery, and recyclability.1 The choice of solid supports plays an important role in the immobilization methods. Given these considerations and continuing our previous works,2 we would like to investigate herein the immobilization of 2,4,6-trichloro-1,3,5-triazine (cyanuric chloride, TCT)-derived metal pincer complex with MLC motif onto the large surface area of highly dispersed magnetic nanoparticles, graphene oxide and also examine onto the hydroxy-functionalized microporous polymer network using the concepts of surface organometallic chemistry.3 The catalytic activity of the resulting NNN-pincer metal catalyst will be investigated in a synthetically challenging cross-coupling reaction of lignocellulose biomass-derived substrates to commodity chemicals in a sustainable manner. A detailed mechanistic study will be performed with the help of theoretical calculations.
Sl. No.	14
Dept.	Chemistry
Project Code	ID_CH_UM-PP
Joint Supervisors	Dr. Uttam Manna (CH), Dr. Partho Sarathi Gooh Pattader (CL)
Title of the Project	Design of adaptable and flexible coatings to develop efficient microfluidic platform for unit operations

Project Summary	The surface modification of flexible polymeric platforms for microfluidic applications represents a cutting-edge research topic at the intersection of material science and microengineering. This initiative aims to enhance the performance and versatility of polymeric materials commonly used in microfluidic devices. By applying advanced surface chemistry and modification techniques, such as chemical grafting, plasma treatment, or nano-coating, the project seeks to optimize the surface properties of flexible polymers, thereby improving their wettability, biocompatibility, and chemical stability. We also aim to explore the versatility of hydrogel as a potential platform for microfluidics. These modifications target to address challenges related to sample handling, fluid flow control, and device compatibility in microfluidic applications such as extraction, separations, micro-reactions, etc. The ultimate goal is to develop a highly adaptable and efficient platform that can find widespread use in various fields, including medical diagnostics, point-of-care testing, environmental monitoring, etc.
Sl. No.	15
Dept.	Civil Engineering
Project Code	ID_CE_TV-AN
Joint Supervisors	Dr. T V Bharat (CE), Dr. Arup Nandy (ME)
Title of the Project	Mitigation of Rainfall-induced Landslides by Capillary-barrier System
Project Summary	The North-Eastern region of India receives the highest rainfall in the country. This region is prone to rainfall-induced landslides, which caused several deaths in the recent past. The recent rise in the number of landslide events is attributed to changes in the climatic conditions. Rainwater infiltration into an initially stable, unsaturated slope has the potential to decrease the shear strength and reduce the factor of safety against the slip. Mitigation techniques for rainfall-induced landslides can be adopted in the landslide susceptible regions to save lives and property. Capillary barrier systems (CBS) have been studied as an effective tool to reduce rain-water infiltration into native slopes, thereby reducing the chances of slope failure. A hydraulic barrier against the flow is developed at the interface of finer-grained soil placed above unsaturated coarser-grained soil. Recent past studies used the combinations of silty sand-pea gravel, silty sand-concrete sand, etc., as finer-grained – coarser-grained soils to invoke the capillary barrier mechanism. The capillary barrier mechanism to arrest the slope failure under field conditions still requires further experimentation and numerical analysis. This study will conduct lab- and field-scale studies to evaluate the CBS using different materials in the field conditions.
Sl. No.	16
Dept.	Chemistry
Project Code	ID_CH_KB-CS
Joint Supervisors	Dr. Kalishankar Bhattacharyya (CH), Dr. Chiranjib Sur (DSAI)
Title of the Project	Predicting Oxygen Evolution Activity in Transition Metal Hydroxide Electrocatalysts Using Machine Learning
Project Summary	In this project, we propose a ML-based method for predicting the OER activity of hydroxide catalysts across a wide range of doping scenarios. Our approach involves creating a dense feature representation of the chemical space, which is used to train a model to predict the overpotential (OP) of different catalyst candidates. By screening potential catalysts using our ML model, we aim to identify superior OER catalysts more efficiently, especially in the evaluation of complex multi-transition oxide compounds. This project has the potential to significantly advance the field of electrocatalysis and contribute to the development of sustainable energy technologies.
Sl. No.	17

Dept.	Design
Project Code	ID_DD_PK-DS
Joint Supervisors	Dr. Pratul Ch. Kalita (DD), Dr. Deepak Sharma (ME)
Title of the Project	Change Management: Strategic Framework for Government Service System Design
Project Summary	The prime focus of this study is to investigate the new service and system design issues in Indian government organizations. Change management in the context of design and implementation of new service and systems, technology acceptance and adoption, organization restructuring, human capital development for innovation in government sector is the motivation of this study. The study will cover a systematic literature review of new service and system development issues and challenges in the government sector in global and Indian context. The study will have a special emphasis on measuring the social impact of the new service and system design interventions in Indian public administration. There are many different interpretations of the current developments and changes taking place in India, in technology acceptance and user behavior in government service and systems. Design Thinking may be very effective in this context, as it effectively deals with change and innovation management. The study intends to result in development of a service system design framework for Indian public administration, inspired by design and technology management in government process reengineering. Methodology: We will start with the study of the 'Service System Design Frameworks' with special reference to design and technology management. We will try to understand how the established service system designs frameworks work in Indian public administration. We will design experiments to study models viz. Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), Unified Theory of Acceptance and Use of Technology (UTAUT) in service system design projects in some of the government process reengineering initiatives in India. We may select any service system design case viz. land revenue and land record portals, real estate regulatory authority portal, power distribution company portals, municipality administration portal etc. We may also consider other service-system design cases from India railway service, Indian police service, Indian revenue service etc. We will follow structured qualitative and quantitative methods to study the challenges of all the stakeholders in the selected system(s). We will design experiments to test the effectiveness of existing service-system design solution(s) with special emphasis to usability, impact, and design and technology acceptance. We will develop service-system design strategy and framework based on theoretical and practical understanding of the service system of the selected case(s). The strategic service-system design framework developed may be further experimented for generalization in a particular type of public service in India. Tentative Research Contribution: Empirical research findings of experiments with Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), Unified Theory of Acceptance and Use of Technology (UTAUT) in service-system design initiatives in Indian public administration. Strategic framework for service and systems design in Indian public administration with special emphasis to change management. Research methodology approach in the interdisciplinary research area of design, operations management, technology management, governance and public administration. Ideal candidate Educational Background: Master's degree in Business Administration, Social Science, Economics, Design and Technology Professional Background: Experience in public administration, government establishment.
Sl. No.	18
Dept.	Mechanical Enggineering
Project Code	ID_ME_SJ-SK

Joint Supervisors	Dr. Shrikrishna N. Joshi (ME), Dr. Sougata Karmakar (DD)
Title of the Project	Design and Development of Toys for Physical activity and dexterity with due consideration to Human Factors
Project Summary	The current project deals with the design and development of innovative toys for physical activity and the dexterity of the kids (Nursery to 4th Standards). The innovative features would include innovative product form and its corresponding appropriate manufacturing techniques and assembly. Physical characteristics of the toys, e.g., dimension, weight, 2D or 3D structure, volume, location of CG, colour, texture, etc., will be considered. As the targeted users of the toys are kids, their physiological, anthropometric, and biomechanical capabilities/ limitations will be considered during the product conceptualization process. Here, it is worth mentioning that the current project will also put due importance on safety issues to mitigate risk from hazardous consequences during interaction of the kids with their toys.
Sl. No.	19
Dept.	Electronics and Electrical Engineering
Project Code	ID_BT_SN-SS
Joint Supervisors	Dr. Shabari Nath (EE), Dr. Rashmi Dutta Baruah (CSE)
Title of the Project	Control of SIMO DC-DC power electronic converters using AI (artificial intelligence)
Project Summary	Various applications of power electronics like portable electronics, electric vehicles, IoT, and renewable energy sources require different regulated DC voltages and most of them are moving towards miniaturization. The power management unit of these applications operating from single voltage source demand better efficiency, compactness, longer battery life, and multiple regulated voltages. To achieve these requirements, single-input multiple-output (SIMO) DC-DC converters are a promising solution. The SIMO converters can generate multiple different DC voltage levels from only one available DC voltage level with reduced component count, reduced losses, reduced physical size and increased efficiency. Although SIMO converters offer many advantages, their control is more complex than simple DC-DC converters. In simple DC-DC converters, there are two modes – continuous conduction mode (CCM) and discontinuous conduction mode (DCM). Most of the simple DC-DC converters can be controlled using simple compensators. However, analysis of SIMO converters shows that these converters have various sub-modes in both CCM and DCM. Further, they have problems of cross-regulation and cross-coupling. Cross-regulation is the problem of disturbance in different outputs when any one load is changed. Cross-coupling is the problem of disturbance in different outputs when any one output voltage is changed. Due to the above problems, advanced controllers are required for control of SIMO converters. Artificial intelligence (AI) is a promising solution for control of complex problems like SIMO converters. AI can be used conveniently for highly non-linear systems without rigorous mathematical modeling of the power electronic converter. There are various AI methods. For power electronics applications, usually artificial neural networks (ANN) are used. ANN is one of the AI methods. For control of SIMO DC-DC converters, first ANN needs to be trained by collecting huge amounts of data offline. After that, the trained ANN is used for control of the converter in real-time. In the offline mode of AI, different data sensed for voltages, currents, and temperatures of the SIMO power electronic converter are sent by IoT transmitter to a cloud server. The cloud server collects thousands of data and trains the ANN model. The trained ANN model is then implemented in a microcontroller/DSP/FPGA control platform. The ANN model generates the gate pulses for the gate drivers and controls the switches of the converter in real-time. While applying for PhD on this topic, candidate requires to have basic knowledge of power electronics and circuit theory. During the course of PhD, student will need to acquire the knowledge of AI, if not known at the time of application.

Sl. No.	20
Dept.	Mechanical Enggineering
Project Code	ID_ME_SB-PT
Joint Supervisors	Dr. Swarup Bag (ME), Dr. Pankaj Tiwari (CL)
Title of the Project	Design and development of rotocasting mould and functional components through modelling, simulation and experiments
Project Summary	The current project deals with the design and development of rotocasting components using polymeric materials that are functional. The complete system consists of three parts. First one is the design and development of the permanent molds made of steel or cast iron used for rotocasting operation. The second one is the rotocasting process development such that the mold are seamless and rotates with its axis to produce symmetric components. The third one is the design of the process to produce functional components that may be the part of integrated process or can be done as a post-processing component. The permanent mould is proposed to develop using metal printing technology and the analysis of the same from the perspective of distortion and residual stress associated with developed metallic mould. In rotocasting, the molten material (mainly polymer) is pulled towards the center and there is a difference in cooling rate from wall to the inner part. The impurities are also driven to the inner part of the mold. Therefore, it is necessary to follow post processing opreration to remove impurities. Even for a functional component, there is a difference in curing time (different in densities and physical propertis) for different types of polymer used. Hence, a thermo-mechanical simulation will help to reduce the experimental trials to develop the process. Finally, the system design of the complete process through optimization of process parameters and optimization of production rate of a predefined component for a number of polymeric materials is targeted. The broad objectives are defined as · Experimental and numerical simulation of permanent metallic mould using 3D printing process · Design and development of rotocasting system for polymeric materials · Modelling and simulation of rotocasting process
Sl. No.	21
Dept.	Mechanical Enggineering
Project Code	ID_ME_SK-BM
Joint Supervisors	Dr. Sajan Kapil (ME), Dr. Biman B Mandal (BSBE)
Title of the Project	Indigenous Design and Development of a Novel 3D Printing System for Processing Non-toxic, Biocompatible Materials
Project Summary	Additive Manufacturing (AM), popularly known as 3D Printing (3DP), is one of the key enablers for Industry 4.0. An appropriate AM process can realize the parts with high geometrical and material complexity. Nowadays, it is essential to explore the possibilities of utilizing the bio-compatible materials for an AM process (particularly for the Material Extrusion process) in different industrial applications (such as Toys and biomedical industries). In this project, an AM process will be indigenously designed and developed for fabricating the objects of a biocompatible material. Further, the developed materials would be critically assessed for their biocompatibility, toxicity, and degradability in vitro under various conditions to determine their safe applications in humans.
Sl. No.	22
Dept.	School of Energy Science and Engineering
Project Code	ID_EN_RT-RV

Joint Supervisors	Dr Ranjith Thangavel (ESE), Dr. R. Prasanna Venkatesh (CL)
Title of the Project	Development of Functional Materials for Na-ion Batteries and Na-ion Hybrid Capacitors
Project Summary	The global drive for decarbonizing the energy economy has pushed our dependency on renewable resources like solar, wind, and hydro energy. However, the highly intermittent renewable resources demand an installation of high energy density, safer and cheaper energy storage devices for the grid storage applications. The grid storage applications require a sustainable battery storage system with low energy cost which cannot be met by state-of-the-art Li-ion batteries due to high energy cost. Sodium-ion batteries are the most eminent candidate for ESS application due to the abundant availability of Na-ion resources (>1200 times than that of Li resources) and the energy cost. However, developing a Na-ion battery with energy density equivalent to Li-ion batteries remains as the major obstacle in commercialization. This is mainly attributed to poor stability of high voltage cathode, and low capacity anode, sluggish Na+ ion kinetics from larger sized Na ion, rapid capacity loss, and poor temperature adaptability. Therefore, the global objective of the project is to design and develop next-generation sodium-ion batteries with high energy density. The current research will address the aforementioned by developing high capacity alloy type anodes based on metal sulfides, metal selenides, and NASICONs with superior cyclic stability. The interface of the anode particles will be engineered with coatings and ion dopants to improve the Na-ion kinetics to favor fast charging behavior. Several top-down and bottom-up approach approaches to realize anode materials constituting core–shell, hollow matrix, and multichannel heterostructure will also be employed to enhance facile charge storage. In addition, hybrid capacitors bridge the energy and power gap between a battery and supercapacitor by combining reactions from a battery-type electrode and a capacitor-type electrode. Sodium-ion hybrid capacitors (NICs) can combine the benefits of high-power capacitors and high energy batteries at a cost potentially lower than that of Li analogues. However, research on NICs is in the nascent stage and requires significant attention to enable their use in practical applications. The project will direct the utilization of functional materials for sodium hybrid capacitor application also. At the end of the project, a pouch-cell prototype of the sodium-ion battery/capacitor will be studied by coupling newly engineered anode materials and the newly developed sodium-ion based energy storage system will also be an alternate to the commercial lithium-ion analogues.
Sl. No.	23
Dept.	Energy Science and Engineering
Project Code	ID_EN_PK-PB
Joint Supervisors	Dr. Pankaj Kalita (ESE), Dr. Prabir Barooah (EE)
Title of the Project	Development of a solar thermal absorption refrigeration system with optimal control
Project Summary	Absorption refrigeration (AR) is an attractive alternate to the more widely used vapor compression refrigeration due its much lower electricity demand. The work needed for refrigeration in AR comes from a heat source, and using solar thermal systems for the heat source in AR has become an intense topic of research. The two main bottlenecks in the current AR technology are (1) low COP under nominal conditions when hot water from a solar thermal system is used, and (2) lack of appropriate real-time control techniques to dynamically change various set points to extract the most performance. This PhD research topic is to develop a AR system with a focus on the latter challenge. We plan to use an optimal control technique to update set points in real time based on measurements. A calibrated dynamic model will also be needed to design and test the control technique and overall performance. The research will involve significant experimental component as well via prototype system development and testing. Because of the intersection of thermal science, mechanical design, and advanced control and computation, the research topic is a perfect example of interdisciplinary research. The advisors bring complementary expertise to the table: thermal science (Kalita) and Control (Barooah).