UPES
UNIVERSITY OF TOMORROW

RESEARCH
AT UPES

ADDRESSING GLOBAL CHALLENGES FOR A SUSTAINABLE FUTURE

ADVANCED ENGINEERING I COMPUTER SCIENCE I DESIGN I BUSINESS I LAW I HEALTH SCIENCES AND TECHNOLOGY I LIBERAL STUDIES

About UPES

Established in 2003 by the Uttarakhand Legislature Act, UPES is a multidisciplinary, not-for-profit, research-driven university committed to academic excellence, student outcomes and social impact. As the 'University of Tomorrow', it pioneers transformative education, shaping learners into changemakers. With seven schools, including Computer Science, Engineering, Health Science and Technology, Design, Business, Law and Liberal Studies, UPES provides industry-ready education to over 14,000 students.

Fostering a lifelong learning mindset, UPES has global partnerships with institutions like University of California Berkeley, UNSW Sydney, The University of Queensland, University of Gothenburg, University of Bologna, besides several others. Runway, the on-campus business incubator, fuels entrepreneurship and innovation. Recognised nationally, UPES ranks **52nd in the NIRF 2023 University Category,** with notable positions in engineering and management (54th and 39th, respectively) categories.

In **THE World University Rankings 2024,** UPES has achieved a global position in the 801-1000 band, securing 25th place in India, 9th among all private and deemed universities, and 2nd among state private universities. **THE Subject rankings** placed UPES among 501-600 in Engineering and Technology, 601-800 in Business and Economics, and 401-500 in Computer Science categories.

According to **Academic Ranking of World Universities (Shanghai Ranking) by Subjects 2024,** UPES excels globally, ranking among the top 150 for Telecommunication Engineering, top 400 for Electrical and Electronic Engineering, and top 500 for Computer Science and Engineering.

In **QS World Rankings 2024 Asia,** UPES stands at 218th rank, 3rd among private Indian universities, and globally in the 901-950 band. Notable subject-wise rankings include 101-150 for Petroleum Engineering, 501-550 for Computer Science and Information Systems, and 151-175 for International Trade.

UPES is one of the few Indian universities that are ranked among the top 3% institutions globally by all the major rankings systems. Additionally, the university holds an **'A' grade accreditation from National Assessment and Accreditation Council (NAAC) India and 5-star by QS Star Ratings on Employability, Academic Development, Program Strength, and Facilities.**

Embracing a culture of research and innovation, UPES fosters initiatives like internal SEED funding for testing research ideas, developing state-of-the-art in-house synthesis and characterisation facility and high computation facilities. Capacity-building initiative Anusandhan keeps faculty and students updated with the latest developments around the globe, while the dedicated IPR cell focuses on technology transfer opportunities through patents and copyrights. UPES's commitment to cutting-edge research is evident through collaborations with prestigious organisations such as CERN and KEK in Switzerland and Japan, respectively, enabling its partnership in the Future Circular Collider (FCC) and Belle II projects.

UPES is probably the fastest growing university in India by research output with the current publications output being about 4 papers per faculty per year with average citations of the recently published papers similar to top institutions globally such as MIT, NUS, Oxford and Cambridge University and better than top research institutions such as IISc Bangalore, IITs, etc. UPES is one of the best globally, with nearly 52% of its publications having international co-authors. The scholarly output has grown by more than 374% since 2018. The Field-Weighted Citation Impact is 1.68 in 2023, with 28.4% of publications in the top 10% journal percentiles, showcasing UPES's impactful contributions to research.

UPES academic community has leading scholars and researchers such as a Nobel Prize Nominee, Rhodes, Fulbright, Chevening, Commonwealth, Erasmus, Eiffel and DAAD scholars, trained at some of the best institutions in the world such as Harvard, Columbia, Cornell, University of California Berkeley, Oxford, Cambridge, National University of Singapore, Indian Institute of Science, IITs (Indian Institute of Technology) and so on. F**orty-one UPES faculty members** have featured among the **world's top 2% researchers** in their respective fields, according to a research study published by a Stanford University-based research group. UPES is the **13th best among Indian institutions** and the **2nd best private university on this prestigious list.**

CREATING SUSTAINABLE SOLUTIONS THROUGH BIOFUELS AND WASTE MANAGEMENT

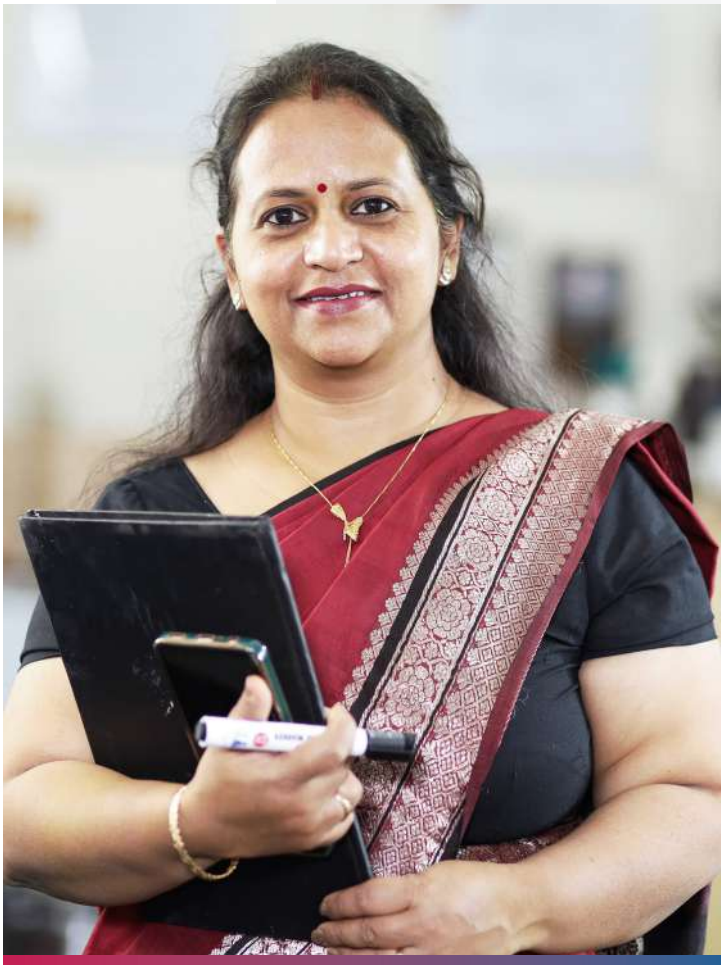
Approach to problem-solving:

Dr. Bhawna Yadav Lamba specialises in biofuels and waste management, with a specific focus on improving the oxidation stability of biofuels for commercialisation. In waste management, her work revolves around converting municipal mixed waste plastic and medical waste (such as PPE kits) into plasto oil, an alternative to diesel fuel. She has successfully completed five externally-funded research projects and is currently working on a DST-ITDD-sponsored project on microalgae-mediated wastewater reclamation, aiming for bio-oil and biogas production. The sanctioned amount for the project is ₹73,01,360.

Practical application:

In her current project, Dr. Bhawna Yadav Lamba focuses on an economical and sustainable approach to sewage water treatment. She utilises microalgae and employs hydrothermal liquefaction and continuous stirred tank reactor methods to treat wastewater, produce bio-oil, and biogas. This integrated process, currently at a TRL (Technology Readiness Level) of 6-7, is being developed at UPES and has the potential to be replicated nationwide in residential complexes, municipal corporations, and industrial areas.

Additionally, she is working on a technologically and environmentally feasible process to convert plastic waste into plasto-oil. This optimised process can be replicated in both rural and urban areas, effectively addressing the problem of plastic disposal.



Dr. Bhawna Yadav Lamba
School of Advanced Engineering

Inspiration behind research:

Increasing industrialisation, dwindling fossil fuel resources, environmental degradation, global warming, and rising energy demand are some of the main inspirations behind Dr. Bhawna Yadav Lamba's research. She aims to develop feasible waste-to-energy sources. The microalgae project was designed with this in mind. Microalgae, which uses sewage water as nutrients, is subjected to hydrothermal liquefaction (HTL) for bio-oil production. Biogas and bio-manure are produced by feeding biomass waste and biochar into a continuous stirred tank reactor (CSTR). This zero-waste technology supports the Swachh Bharat Mission.

ADDRESSING HEALTHCARE DISPARITIES THROUGH INNOVATIVE SENSOR TECHNOLOGIES

Approach to problem-solving:

Dr. Ashish Mathur specialises in microfluidics, nanotechnology, connected health, sensors, and point-of-care devices. With a strong commitment to improving healthcare accessibility and affordability, his research focuses on developing innovative technologies with societal benefits. Dr. Mathur's work encompasses the design and implementation of low-cost, portable sensors for various applications, including healthcare diagnostics and environmental monitoring. By leveraging advancements in microfluidics and nanotechnology, he aims to create practical solutions that bridge the gap between laboratory settings and real-world healthcare scenarios.

Dr. Ashish Mathur
School of Advanced Engineering

Practical application:

Dr. Mathur's research has far-reaching practical implications, particularly in the realm of healthcare. His work in developing low-cost, user-friendly point-of-care devices and sensors empowers healthcare providers and individuals to access rapid and accurate diagnostics, even in resource-limited settings. These technologies have the potential to revolutionise healthcare delivery, enabling early disease detection, personalised treatment strategies, and remote monitoring. Additionally, Dr. Mathur's focus on affordable sensors extends beyond healthcare, with applications in environmental monitoring and other fields where cost-effective solutions are crucial for widespread adoption and sustainability.

Inspiration behind research:

Dr. Mathur draws inspiration from the pressing need for affordable and accessible healthcare worldwide. Witnessing the barriers that hinder optimal healthcare delivery, he is driven to develop practical solutions that address these challenges. By combining his expertise in microfluidics, nanotechnology, and connected health, Dr. Mathur aims to democratise diagnostics and empower individuals and communities with the tools they need to make informed decisions about their health. Furthermore, his commitment to low-cost sensors for environmental monitoring stems from the recognition of the critical role technology plays in safeguarding our planet and promoting sustainable practices.

CREATING HEALTHCARE SOLUTIONS FOR CANCER MANAGEMENT

Approach to problem-solving:

Dr. Parteek Prasher is developing multitargeting agents to address abnormal galactosylation of mucins in adenocarcinoma (cancer of the mucus lining). The goal is to create pharmaceuticals that effectively manage the pathogenesis of adenocarcinoma, particularly in cases like pancreatic ductal cancer, prostate cancer, and breast cancer. The aim is to improve prognosis and offer alternatives to current treatments, such as prostatectomy, ultimately contributing to better outcomes for individuals affected by adenocarcinoma.

Practical application:

Prognosis of adenocarcinoma is extremely challenging, and, in most cases, it is diagnosed at terminal stages. The dearth of novel medications is also aggravating the situation. Therefore, newly-synthesized pharmaceuticals are required to manage the adenocarcinoma pathogenesis which mainly arises from the O-galactosylation of mucins.

Inspiration behind research:

High incidence rate of adenocarcinoma, especially in pancreatic ductal cancer, prostate cancer, and breast cancer, has caused a tremendous spike in the mortality and morbidity rates over the past few years. In some cases, such as prostate adenocarcinoma, the only option left is prostatectomy which hampers the quality of life of the individuals. Therefore, the medications are needed to effectively manage the adenocarcinoma pathogenesis.

Dr. Parteek Prasher
School of Advanced Engineering

ADVANCING SOLUTIONS FOR ENHANCED MENTAL HEALTH AND WELL-BEING

Approach to problem-solving:

Dr. Reneaux's work highlights the significance of histamine and serotonin as crucial biomarkers for understanding and treating inflammation-induced depression. The mathematical model she developed provides a quantifiable approach to assess depression by considering alterations in these neurochemical levels, offering a more reliable method compared to self-reporting questionnaires. Furthermore, her study generates testable predictions on the positive effects of combining histamine-blocking (anti-histaminergic) medication and serotonin-enhancing (antidepressant) medication for clinical depression.

Practical application:

Dr. Reneaux's work highlights the significance of histamine and serotonin as crucial biomarkers for understanding and treating inflammation-induced depression. The mathematical model she developed provides a quantifiable approach to assess depression by considering alterations in these neurochemical levels, offering a more reliable method compared to self-reporting questionnaires. Furthermore, her study generates testable predictions on the positive effects of combining histamine-blocking (anti-histaminergic) medication and serotonin-enhancing (antidepressant) medication for clinical depression.

Inspiration behind research:

Depression is a debilitating mental disorder affecting a significant number of individuals worldwide. The limited efficacy of serotonergic antidepressant drugs prompted the need to deepen our understanding of depression. Driven by the observation that a subset of individuals with depression also experience increased inflammation, our research aims to explore the connection between inflammation and depression and sheds light on the role of histamine in depressive symptoms.

Dr. Melissa Reneaux
School of Liberal Studies

FOSTERING GREEN SOLUTIONS FOR ENERGY AUTONOMY AND ECOLOGICAL BALANCE

Approach to problem-solving:

Dr. Siddharth Jain's research focuses on various aspects of biofuel production techniques using renewable, non-food crops with lower environmental footprints. He employs chemical and thermochemical conversion technologies, along with next-generation and futuristic fuel generation technologies. The aim is to contribute to achieving energy independence in economically fast-growing nations like India. Additionally, Dr. Jain's research includes life cycle assessment (LCA) and improving different waste-to-energy conversion technologies.

Practical application:

Dr. Siddharth Jain's research has identified numerous approaches for future waste-to-energy plants in India. These emerging technologies, though still in their early stages of development, offer potentially cost-effective alternatives that are suitable for the diverse nature and dispersed availability of municipal solid waste (MSW) resources. These methods enable waste-to-energy facilities to generate biofuels and by-products, potentially increasing revenues compared to current facilities that prioritise heat and power production alone.

Inspiration behind research:

While significant efforts have been made in both theoretical and practical research to advance energy production, conversion, and utilisation technologies, there has been relatively less focus on conducting comprehensive systems-level research to understand and assess their interconnectedness with the environment. Implementing such a strategy could play a crucial role in achieving energy independence in rapidly developing countries like India, while simultaneously reducing greenhouse gas (GHG) emissions. This is the inspiration behind Dr. Jain's research.

Dr. Siddharth Jain
School of Advanced Engineering

ADDRESSING CLIMATE CRISIS AND BIODIVERSITY LOSS

Approach to problem-solving:

Dr. Anil Kumar is contributing to environmental monitoring by serving as the Principal Investigator for the L and S Band Airborne Synthetic Aperture Radar (ASAR) part of the NASA-ISRO Synthetic Aperture Radar (NISAR) Mission. His project, funded by ISRO Ahmedabad, focuses on implementing evolutionary computing algorithms for polarimetric SAR data processing and classification. Dr. Kumar is also the council member of National Collaborative Scheme of Forest Fire Management, ICFRE-FRI Dehradun, Ministry of Environment, Forest and Climate Change, Government of India. By advancing technologies in machine learning, computer vision, and remote sensing, Dr. Kumar's work enhances Earth observation capabilities, facilitating a better understanding of environmental changes and supporting solutions to global problems such as climate change, biodiversity loss, multi-hazards like landslides, forest fires, floods, etc.

Dr. Anil Kumar
School of Computer Science

Practical application:

The proposed dual-frequency airborne SAR will provide invaluable data for various land and ocean applications. Some of the major objectives and applications of SAR data include the development of tools, techniques, and methods for SAR data applications, natural resource management, natural disaster management, urban applications, enhanced crop and vegetation monitoring, and geological applications.

Inspiration behind research:

The airborne SAR, similar to NISAR specifications, is expected to prepare the Indian scientific community for optimal utilisation of NISAR data. ISRO, in collaboration with JPL, NASA, is developing the Dual Frequency Synthetic Aperture Radar (NISAR) in L and S band frequencies. The launch is scheduled for January 2024 from SDSC, SHAR, Sriharikota, India. The collaboration between ISRO and NASA on this project aims to improve Earth's observatory system and conduct environment studies.

PROBING COSMIC MYSTERIES AND EVOLUTION OF THE UNIVERSE

Approach to problem-solving:

Dr. Vipin Gaur is contributing to advancing particle physics and global scientific collaboration by participating in the Belle and Belle II experiments at KEK (Japan): Belle II is a successor to the Nobel Prize-winning Belle experiment. His involvement extends to the Future Circular Collider (FCC) experiment at CERN (Switzerland), the world's largest accelerator project. Serving as an institutional representative from UPES, Dr. Gaur facilitates contributions to these mega science and technology projects, fostering international cooperation and knowledge exchange in the pursuit of fundamental discoveries in particle physics.

Practical application:

The upgraded Belle II and FCC experiments aim to search for new physics phenomena that cannot be explained by the particles and forces currently included in the Standard Model, which is the well-tested theory of particle physics. Additionally, the experiments seek to make precise measurements of known phenomena including Higgs boson (whose discovery at LHC led to the 2013 Nobel Prize in physics) at FCC.

Inspiration behind research:

Dr. Gaur's passion for particle physics stems from his recognition of the field's substantial contributions to society. Innovations such as Distributed Computing, the World Wide Web, Computed Tomography (CT) Scans, and advancement in drug delivery through molecular structure analysis with ultra-high precision have inspired his love for particle physics.

Dr. Vipin Gaur
School of Advanced Engineering

FOSTERING CULTURAL IDENTITY AND INTEGRATION FOR AN INCLUSIVE SOCIETY

Approach to problem-solving:

Dr. Roshni Sengupta works on the interstices between media, politics, and transnational cultures, particularly on the process of homemaking of Indian-origin diaspora groups in Europe. The work traces mediatised transnational connections of such communities with their motherland.

Practical application:

Dr. Sengupta hopes to bring forth a robust new methodology for studies in media and culture, particularly with regard to transnational communities. Furthermore, her research valourizes "forgotten Indian-origin communities" and establishes a link between the diasporic groups and their recognition in their country of origin.

Inspiration behind research:

Dr. Sengupta was inspired to study processes of homemaking, diasporization and transnational cultures due to her close contact with members of the Dutch-Hindustani community in the Netherlands. Some of her Hindustani friends often said, "We don't feel accepted by the Indians!" and that drove her to focus her research on the enduring cultural links that the community maintains with India despite the relative anonymity.

Dr. Roshni Sengupta
School of Modern Media

ENHANCING ENERGY RESILIENCE AND SUSTAINABILITY

Approach to problem-solving:

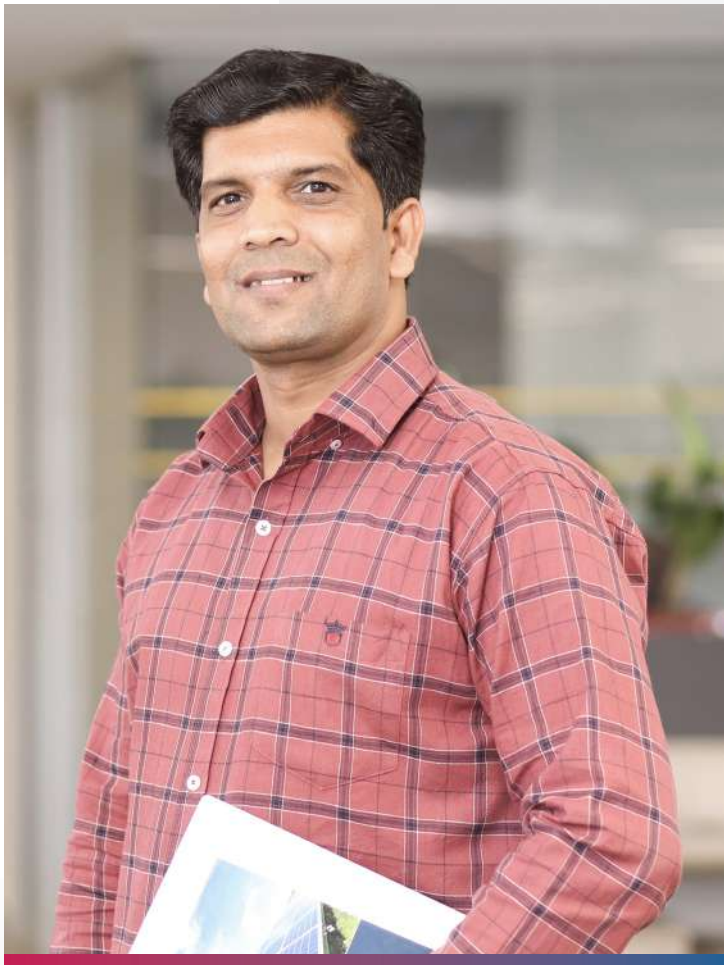
Dr. Rupendra Kumar Pachauri is developing and implementing networked microgrids-based Transactive Energy Systems (TES). This system enables the energy transaction between the networked microgrids with multiple energy vectors, such as photovoltaic systems, wind turbines, and biofuels, which reduces the dependency on the existing main power grid infrastructure in a few instances. The use of networked microgrids enhances the resilience of the overall energy infrastructure, allowing them to operate independently and share power during power outages or disruptions. This solution is particularly valuable in disaster-prone areas and for critical infrastructure, contributing to improved energy reliability, sustainability, and resilience on a global scale.

Practical application:

Networked microgrid topologies play a crucial role in improving grid efficiency and dependability, ensuring continued service during blackouts, and fostering the widespread use of renewable energy sources, thus contributing to a global-scale reduction in carbon footprint.

Inspiration behind research:

Dr. Pachauri says that the huge dependence on the pre-existing grid infrastructure and the huge expenditures involved in it inspired him to start his research work in microgrids-based Transactive Energy System.



Dr. Rupendra Kumar Pachauri
School of Advanced Engineering

ADVANCING SUSTAINABLE AND RESILIENT MATERIALS FOR AERONAUTICAL SECTOR

Approach to problem-solving:

Dr. Sravendra Rana is focusing on the development of a novel self-healable polymer composite. This composite utilises the dynamic bond exchange concept to imbue the material with self-healing abilities. Inspired by the natural healing processes in living species, the goal is to create materials that can autonomously repair microcracks and prevent material failure over time. Additionally, he incorporates bio-based chemical resources and nanofillers to enhance the material's strength, making it a more sustainable and resilient option compared to traditional thermosets. Dr. Rana aims to contribute to the advancement of materials that are not only self-healing, but also environmentally-friendly and durable, addressing global concerns related to material degradation and the environmental impact of traditional materials.

Dr. Sravendra Rana
School of Advanced Engineering

Practical application:

Self-repairing composite materials can reduce the repair costs of airplanes and provide a boost for the aeronautical sector. They will require minimal maintenance and will have the ability to repair their own micro-cracks and breaks, thus providing an alternative to expensive manual testing and repair. This material can also heal aircraft hit by space debris at high speeds.

Inspiration behind research:

An airplane takes off and suffers a crack in one of its parts mid-air. This untreated crack can become deeper with time and cause safety concerns, putting hundreds of lives at risk. The airplane, therefore, must make an emergency landing. What if, in that very moment of damage, the crack not only stops from getting deeper, it also heals itself just like the tissues of living organisms? The researcher is attempting to generate materials that are able to repair autonomically or through external stimuli such as heat, light, or pressure.

ENHANCING REACTOR AND AEROSPACE SAFETY WITH RADIATION-RESISTANT MATERIALS

Approach to problem-solving:

Dr. Parswajit Kalita investigates ways to enhance the resilience of materials against damage caused by radiation. His focus is on materials used in fission/fusion reactors, spacecraft/satellites, which are prone to radiation-induced damage leading to decreased efficiency and potential accidents.

Practical application:

By conducting experiments and considering various factors, Dr. Kalita aims to improve the final product by utilising a combination of materials. Recently, he has been awarded a funded project in collaboration with the Bhabha Atomic Research Centre, by the Department of Atomic Energy, Government of India. This research will contribute to enhancing the efficiency, lifespan, and safety of nuclear reactors and spacecraft by mitigating the damage caused by nuclear and cosmic radiation, respectively.

Inspiration behind research:

Dr. Kalita's passion for physics dates back to his high-school days. During his research journey, his PhD supervisors emphasised the significance of studying radiation damage, and since then, he has been dedicated to advancing research in this field.

Dr. Parswajit Kalita
School of Advanced Engineering

ADVANCING BIOSENSOR TECHNOLOGY FOR HEALTH AND ENVIRONMENT

Approach to problem-solving:

Dr. Nidhi Chauhan and her team are focused on merging nanotechnology and biochemistry to create cutting-edge sensors for various fields including medicine, forensic science, pollution monitoring, and so on. These sensors are capable of selectively identifying crucial molecules that act as markers for the early detection of a range of diseases such as cancer, diabetes, neurological disorders, neonatal sepsis, and others. Additionally, they have developed sensors for detecting illegal drugs, pollutants, and this list will continue to expand.

Practical application:

Dr. Chauhan aims to utilise her research to create sensors that are inexpensive, easy to use, and offer swift and precise detection. Her recent work on sensing anandamide, which is a neurotransmitter, will enable us to analytically measure the happiness level of a person. This is immensely beneficial in objectively accessing and combating depression and other mental health-related problems. Her work on neonatal biosensors offers ideal solutions to solving the problems associated with accurate diagnosis of sepsis in neonates. Similarly, her work on diabetes, polycystic ovary syndrome, gastric cancer and many other biosensors is focused on social welfare.

Dr. Nidhi Chauhan
School of Health Sciences and Technology

Inspiration behind research:

Dr. Chauhan wanted to bring life-saving medical technology to a broader population, particularly to resource-limited communities. The societal benefits of research into biosensors using modern nanotechnology are vast. They promote accessibility, enable timely interventions, empower individuals in self-monitoring, and enhance public health efforts. Continued advancements in biosensors have the potential to transform healthcare, environmental monitoring, and various other domains, positively impacting society. This has been the underlying motivation driving all her endeavors.

PROMOTING HOLISTIC HEALTH SOLUTIONS FOR MARGINALISED COMMUNITIES

Approach to problem-solving:

Dr. Padma Venkat and her team address healthcare challenges in marginalised and vulnerable communities through innovative, sustainable solutions. By combining science, technology and traditional knowledge, she and her team create innovative and affordable healthcare solutions. Her main areas of work focus on drinking water purification, nutrition, anemia and wellness. Dr. Padma Venkat's research showcases the effective use of native herbs and fruits for curing diseases.

Practical application:

Dr. Padma Venkat's research demonstrates the use of simple herbs/fruits like amla, pomegranate, ginger and moringa in the management of anemia. TamRas, a low-cost, copper-based drinking water purification device was the outcome of several years of R&D by her and her team. She established a women technology park to provide training to rural women in green technologies to enhance their livelihood options. She conceptualised a novel student-centric pedagogy called the University Wellness Program for campus sustainability.

Inspiration behind research:

Dr. Padma Venkat is in awe of traditional medical knowledge that looks at living holistically and in synergy with nature. She is convinced that if systematically studied, the philosophy, science and practice can provide affordable and sustainable solutions to current-day health problems.

Dr. Padma Venkat
School of Health Sciences and Technology

EMPLOYING POLLUTION DETECTION FOR A CLEANER ENVIRONMENT

Approach to problem-solving:

Dr. Manish Kumar's research encompasses four main directions: contaminant fate and transport in freshwater; isotope fingerprinting for identifying pollution sources; developing cost-effective and in-situ removal technologies for pollutants; studying antimicrobial resistance through wastewater surveillance with community participation for environmental sustainability. Dr. Kumar achieved a significant milestone by detecting the SARS-CoV-2 gene in wastewater, being the first in the country to do so. His expertise in antiviral resistance led to an invitation from the United Nations Environment Program as an expert in this field.

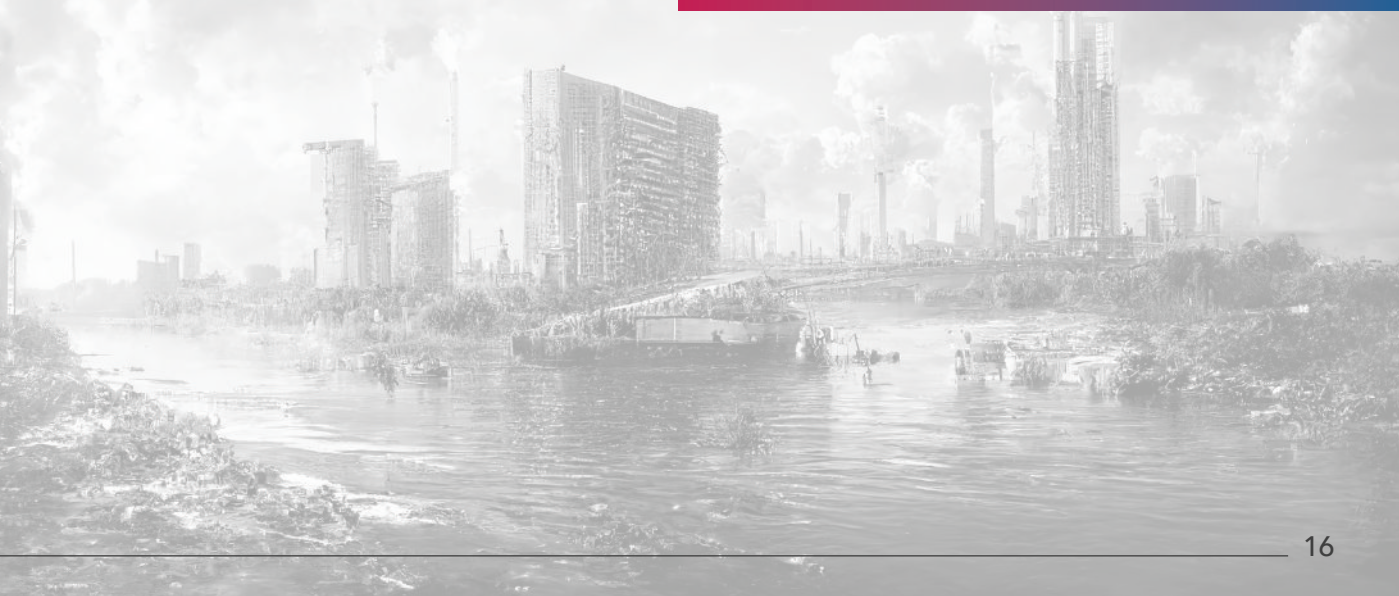
Practical application:

The research focuses on wastewater surveillance and management, remediation techniques for cleaning water bodies and soil, and addressing the issue of antimicrobial resistance.

Inspiration behind research:

Dr. Kumar's fascination with technology began at a young age, nurtured by his father, who was a science teacher. His father always encouraged him to question and understand the "why" behind things, exposing him to various technological innovations. Although his parents initially envisioned him becoming a medical doctor, Dr. Kumar's path led him to pursue a Doctor of Engineering degree.

Dr. Manish Kumar
School of Advanced Engineering



ADVANCING SUSTAINABLE WASTE MANAGEMENT THROUGH BIOREMEDIATION

Approach to problem-solving:

Dr. Sunita Varjani addresses environmental challenges by applying bioremediation and bioprocess technology to waste management and wastewater treatment. Her research aims to devise sustainable solutions, optimising waste treatment processes through microorganisms and bioprocess engineering. The goal is to contribute to a cleaner, healthier environment by promoting sustainable waste management and establishing a circular/closed-loop economy through biorefinery strategies.

Practical application:

Dr. Sunita Varjani's research is significant for the waste management and wastewater treatment industries. Using bioremediation, bioprocess technology, and environmental technology, her team provides cost-effective and sustainable methods for treating contaminated soil, water, and industrial waste. Industries and environmental agencies can readily implement the research outcomes generated by her work to mitigate pollution, reduce environmental impact, and promote the recycling and recovery of valuable resources from waste streams.

Inspiration behind research:

Dr. Sunita Varjani's research stems from the pressing need to address the escalating environmental challenges associated with waste management and wastewater treatment. The adverse consequences of rapid industrialisation and population growth, including heightened pollution levels and resource depletion, have motivated her to seek innovative solutions. She is driven by the potential of integrating bioremediation, waste management, environmental technology, and bioprocess technology to address these issues comprehensively. Her overarching goal is to contribute to sustainable development and positively impact the environment and society by implementing waste (bio)refinery approaches within a circular (bio) economy framework.

Dr. Sunita Varjani
School of Advanced Engineering

ENHANCING ENERGY EFFICIENCY AND GREEN TECHNOLOGY APPLICATIONS THROUGH PHOTONICS

Approach to problem-solving:

Dr. Prasanta Mandal is addressing the issue of long-term sustainable development by researching and developing Plasmonic and Photonic Metamaterials (PPMs). These artificially structured materials are designed for Light Manipulation (LM) and have applications in light scattering measurements, SERS spectroscopy, ultrasensitive molecular detection useful for forensic science, defence and biomedical applications, and solar energy harvesting (SEH). The aim is to contribute to green energy solutions and promote environment-friendly technologies with high societal impact.

Practical application:

PPMs have wide practical applications in designing sensors and actuators for ultrasensitive chemical sensing at the molecular level. Surface-enhanced Raman scattering (SERS) spectroscopy plays a key role in this regard. Chemical/molecular identification using SERS spectroscopy finds applications in health safety measures and standards, forensic science, defence for explosive detection, and medical diagnostics. Additionally, plasmonic and photonic metamaterials are valuable for solar energy harvesting. This technology can enhance the efficiency of solar cells.

Inspiration behind research:

Dr. Mandal has strong research interests in long-term sustainable development for modern civilisation. His research is divided into two parts: chemical sensing using SERS spectroscopy and solar energy harvesting (or radiation sensing). The importance of chemical sensing lies in its applications in food science, health safety measures and standards, molecular fingerprinting in forensic science, and more. The interest in solar energy research stems from the limitations of fossil fuel energy and the ongoing quest for alternative energy sources.

Dr. Prasanta Mandal
School of Advanced Engineering

ANALYSING GENDER DYNAMICS IN DEVELOPMENT-INDUCED DISPLACEMENT

Approach to problem-solving:

Dr. Bitopi Dutta's research focuses on Development Induced Displacement (DID) in tribal societies, specifically in Northeast India and Uttarakhand. The project critically examines global literature on displacement and seeks to understand the lived experiences of displacement in tribal communities. While existing research has explored the general impact of DID on subaltern groups, Dr. Dutta's work aims to address a gap in literature by delving into the politics of displacement and its effect on gender relations within these communities. The research strives to provide valuable insights into the nuanced dynamics of development-induced displacement and its broader societal implications, particularly in the context of tribal societies in India.

Practical application:

Dr. Dutta's research seeks to engage with the standard Resettlement and Rehabilitation policies and offer critical analysis on their applicability across different contexts in tribe societies in India.

Inspiration behind research:

Dr. Dutta was inspired to study how displacement changes gender relations while working as a displacement researcher in the Northeast after her Masters. While her research focused on studying displacement, her activism centred around queer rights.

Dr. Bitopi Dutta
School of Liberal Studies

UNRAVELLING COSMOLOGICAL PRINCIPLES FOR SCIENTIFIC ADVANCEMENT

Approach to problem-solving:

Dr. J.B. Singh is contributing to the understanding of fundamental building blocks of matter and forces in experimental high-energy particle physics. The research advances knowledge of fundamental laws of nature and the formation of the universe. This understanding can have broad implications for various scientific and technological applications, potentially leading to advancements in fields such as energy, materials science, and technology.

Practical application:

The advancements in radiation detectors used in high-energy physics experiments have been adapted for medical imaging techniques such as MRI, CT, CAT, and PET scans. Particle accelerators, including proton and heavy-ion therapy, have been utilised in radiation therapy for cancer treatment. The use of parallel processing and high-speed data processing techniques, such as GRID and cloud computing, which are integral to handling the vast amount of data produced in high-energy physics experiments, has found applications in other domains where fast data processing is required. Superconducting magnets originally developed for particle accelerators have been adapted for medical imaging technologies like MRI. The World-Wide-Web (WWW), originally conceived and developed at CERN for automatic information and data sharing between institutes involved in high-energy physics experiments worldwide, has revolutionised information exchange globally.

Inspiration behind research:

The pursuit of high-energy physics experiments not only leads to scientific discoveries, but also drives advancements in technologies that often find applications in other scientific domains.

Dr. J.B. Singh
School of Advanced Engineering

ENGINEERING LIGHTWEIGHT, HIGH-STRENGTH MATERIALS FOR AEROSPACE INDUSTRY

Approach to problem-solving:

Dr. Goyat's research is about creating lightweight, high-strength polymer composites. He focuses on developing transparent superhydrophobic coatings for the solar industry and anti-corrosion superhydrophobic coatings for the metal industry. Through his research, he aims to meet the increasing demand for advanced materials in the aerospace industry and contribute to sustainable and efficient solutions for various industrial applications.

Dr. Manjeet Singh Goyat
School of Advanced Engineering

Practical application:

Carbon Fiber Reinforced Polymer (CFRP) composites are extensively used in aerospace and aviation industries due to their high strength-to-weight ratio. They are employed in aircraft structures, wings, fuselage components, rotor blades, and interior parts, contributing to weight reduction, fuel efficiency and safety. Superhydrophobic coatings can be applied on solar panels to create self-cleaning surfaces useful for dust removal from the panels to maintain optimal solar panel efficiency. Superhydrophobic coatings can be applied to metal surfaces to provide corrosion resistance.

Inspiration behind research:

The aerospace and automotive industries have a constant drive to reduce the weight of their structures and components. CFRP composites provide a significant weight reduction compared to traditional materials like metals, while improving mechanical strength. This inspires researchers to explore CFRP composites as a solution for achieving lightweight designs without compromising performance. The inspiration behind research on superhydrophobic coatings arises from the intriguing natural phenomenon of water-repellent surfaces, the desire to replicate these properties for practical applications and environmental benefits.

DEVELOPING THERAPEUTIC STRATEGIES FOR CANCER TREATMENT

Approach to problem-solving:

Dr. Dhruv Kumar is addressing the challenge of cancer by investigating the Autophagy-Metabolic axis in cancer cells and the tumor microenvironment. Through this research, he aims to gain insights into the complex interplay between cellular processes, with a specific focus on head and neck, oral, breast, and brain cancers. By understanding the nuances of these interactions, Dr. Dhruv Kumar seeks to develop novel therapeutic approaches for combating cancer. His work contributes to advancing our understanding of cancer biology and facilitates the development of targeted and effective treatments for various types of cancer.

Practical application:

Early cancer detection, drug designing, drug repurposing.

Inspiration behind research:

It is a combined passion for improving healthcare, scientific curiosity, a desire to address current medical challenges, and the potential to contribute to society's well-being. The impact of successful drug design, early cancer detection, and drug repurposing on patient care and well-being is a significant inspiration.

Dr. Dhruv Kumar
School of Health Sciences and Technology

ADVANCING MATERIALS DESIGN THROUGH COMPUTATIONAL SOLUTIONS FOR SUSTAINABLE ENERGY, ENVIRONMENT AND HEALTHCARE

Approach to problem-solving:

Dr. Abhishek Kumar Mishra's research aims to accelerate the development of advanced materials through computational solutions that can revolutionise various industries, including electronics and chemical industries, and improve our everyday lives. He has recently received a research grant from DST-SERB, Government of India, to design materials for effectively capturing CO2 and converting it to fuels and chemicals and also the International Cooperation Division of DST towards formation of nanostructured thin films for energy applications. He is also working on quantum simulations towards designing efficient materials for solar cell applications, water purification, gas sensors, spintronic devices and targeted drug delivery.

Practical application:

Dr. Mishra's research aims to accelerate the development of advanced materials that can revolutionise various industries including electronics and chemical industries and improve our everyday lives. He has recently received a research grant from DST-SERB, Government of India to design materials for effectively capturing CO2 and converting it to fuels and chemicals. He is also working on designing efficient materials for solar cell applications, water purification, gas sensors, and spintronic devices.

Inspiration behind research:

Dr. Mishra's inspiration often stems from the desire to contribute to a sustainable and cleaner future. He is driven by the potential to design materials that can efficiently capture and convert CO2 emissions, renewable energy sources like solar cell materials, and battery electrode materials leading to reduced environmental impact. By exploring diverse areas such as energy, environment, electronic materials, and drug design, the researcher aims to address a wide range of societal needs and push the boundaries of scientific knowledge for the betterment of humanity.

Dr. Abhishek Kumar Mishra
School of Advanced Engineering

EMPOWERING COMMUNITIES WITH USTAINABLE ENERGY FROM FOREST BIO-RESIDUE

Approach to problem-solving:

Dr. Anita Sengar and her team work on developing forest bio-residue-based energy generation and value-added products (pine-briquettes), to generate low-cost, environment-friendly sustainable energy for household and commercial purposes. They are on a mission to create sustained livelihood, effecting widespread socio-economic change in the state of Uttarakhand and subsequently in the North-Western Himalayan region.

Practical application:

Dr. Anita Sengar hopes to use her research work to tap into a vast unutilised forest bio-residue (especially Chir Pine) resource with a community-linked initiative. She proposes the use of bio-briquetting machines and IT enablement of the whole process to bring efficiency to the value-chain.

Inspiration behind research:

Dr. Anita Sengar was pained to see the forest fires caused by dried pine needles in Uttarakhand every year. These fires destroyed vast tracts of forests and resulted in biodiversity loss. She undertook her research in pine briquette-based energy generation as a solution to the problem.

Dr. Anita Sengar
School of Business

ADVANCING MATERIALS FOR IMPROVED TECHNOLOGY AND ENERGY EFFICIENCY

Approach to problem-solving:

Dr. Asokan Kandasami is investigating the impact of ion beams on material properties, particularly focusing on optical, structural, and electrical aspects. This research involves understanding electronic structures to unravel the mechanisms influencing functional properties. The goal is to apply this knowledge to enhance material performance, contributing to advancements in technology, energy efficiency, and various applications that benefit society.

Practical application:

Ion implantation has played an important role in electronic industries. Ion beam studies allow the engineering of new materials that have industry relevance. **Synchrotron-based spectroscopic studies allow us to characterise and understand the charge transfer mechanism.**

Inspiration behind research:

Ion beam interaction in materials results in modification of surface, structure, phase, optical, electrical, and magnetic properties. Synthesis of new compounds is feasible by ion beam assisted mixing which may be difficult to carry out by other means. Apart from this ion beam-based characterisations like RBS are more useful to determine the composition even in dilute concentrations.

Dr. Asokan Kandasami
School of Advanced Engineering

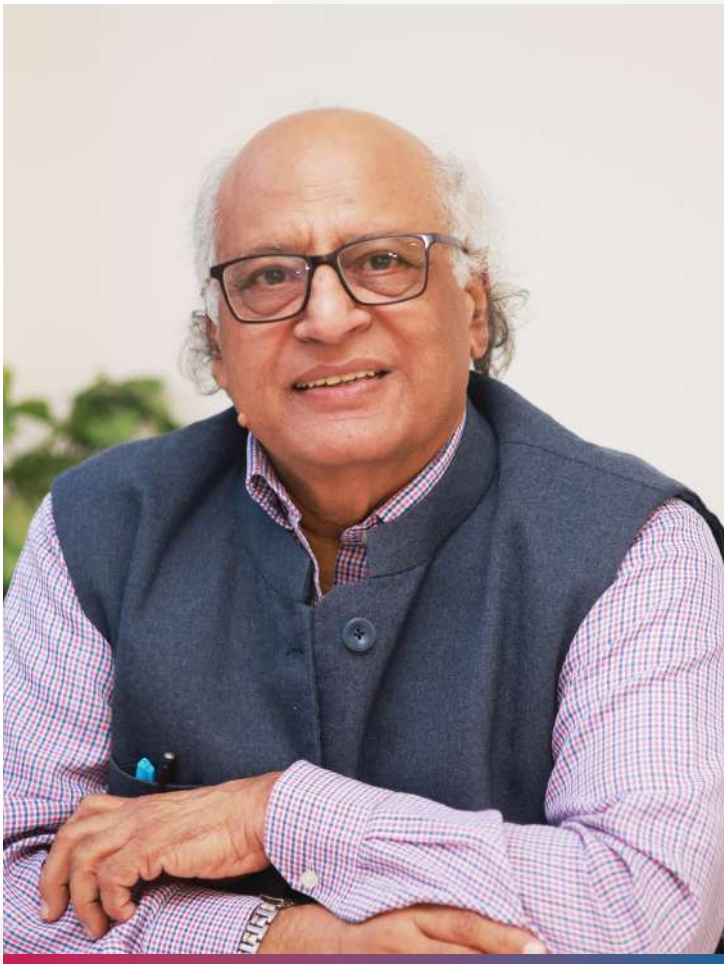
UNLOCKING THE POTENTIAL OF MATHEMATICAL MODELLING TO UNDERSTAND COMPLEX PHENOMENA

Approach to problem-solving:

Dr. Karmeshu has developed mathematical models for a variety of systems with emphasis on their stochastic evolution. Employing analytical, simulation and information theoretic frameworks, he has investigated problems related to the study of performance modelling of computer and communication networks, spiking patterns in computational neuroscience, intraday returns in computational finance and socio-technical systems, including innovation diffusion.

Practical application:

The evolutionary paths of sustainable development goals (SDGs) deal with economic, social and environmental challenges which are generally governed by nonlinear dynamics, yielding coupled stochastic trajectories. The control and optimisation of these trajectories may provide the road map for achieving sustainable development by 2030 as agreed upon by UN Member States. With growing realisation that mathematical modelling has become an essential feature of scientific enquiry, it is imperative to model different systems and study their transient behaviour to gain understanding of evolution of the fluctuations around their mean values. Several emerging applications require study of nonlinear systems viz large-scale communication networks, epidemic modeling, financial modeling and algorithmic trading, role of collaborative/collective learning in the team dynamics and its impact on the software development, evolutionary network dynamics on random graphs, large scale coupling of neurons in noisy brain leading to emergent structures describing mental health, happiness, etc.



Dr. Karmeshu
School of Computer Science

Inspiration behind research:

The real-world problems are nonlinear systems; however, the focus has largely remained to modelling within a linear framework. This has led to missing out of many interesting and crucial features that are observed in nonlinear systems. The emergence of fields like Synergistics and Dissipative structures deal with Complex systems from a unifying point of view. The role of stochasticity, particularly in the vicinity of critical points, becomes crucial, characterising interplay between randomness and determinism in driving the system from old configuration to new configuration.

IMPROVING DATA STORAGE IN SMALLER DEVICES FOR GLOBAL EFFICIENCY

Approach to problem-solving:

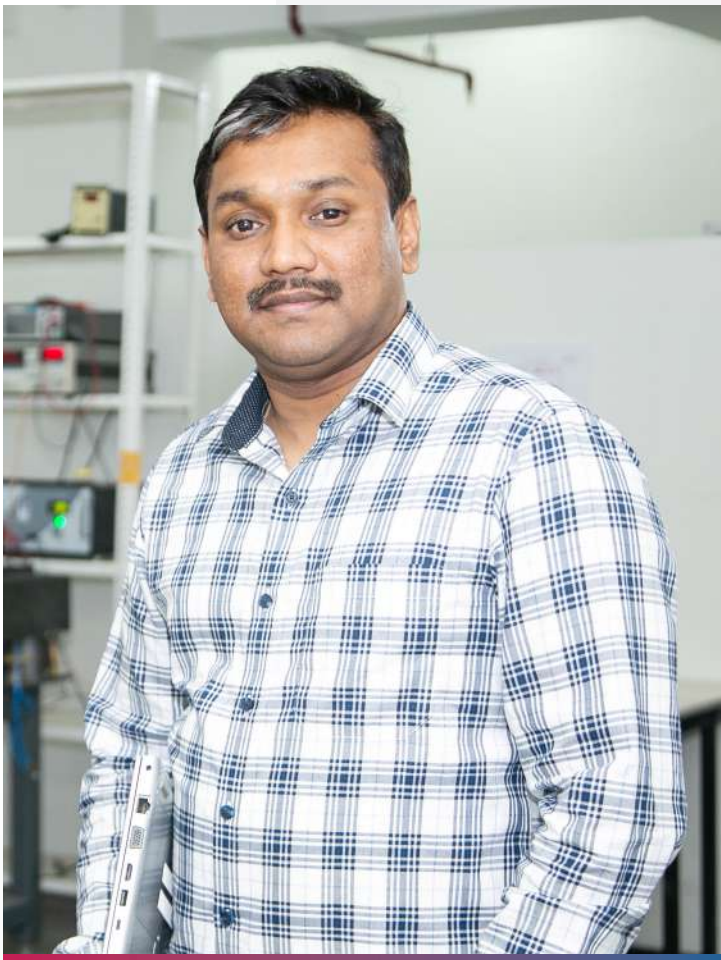
Dr. Sarathlal K V is working on spin-based electronics, trying to manipulate spin interactions to increase data storage. While laptops and mobile devices are getting smaller, the need for data storage is increasing. The research deals with the issue of maintaining data stability under these smaller dimensions.

Practical application:

The research attempts to meet the demand of high data storage across the world by increasing data storage while reducing the size of the device.

Inspiration behind research:

It was his Physics teacher in school who changed Dr. Sarathlal K V's life forever. He encouraged him to pursue academics and go for research. The 2007 Noble Prize in Physics for GMR discovery related to data storage industry enthralled him to pursue his work in this domain. Since then, Dr. Sarathlal K V has devoted his life to the field.



Dr. Sarathlal K V
School of Advanced Engineering

ASSESSING ARCTIC POLLUTION FOR PLANETARY HEALTH AND BIODIVERSITY

Approach to problem-solving:

Dr. Christian Sonne focuses on the pan-Arctic monitoring and assessment of biological effects from exposure to long-range transported pollution by industrial chemicals and mercury in vulnerable Arctic ecosystems, including indigenous people. The research specifically emphasises biodiversity and climate change. Post-2000, some populations and species in the Arctic were found to have organohalogen contaminants (OHCs) and mercury tissue contaminant burdens that exceeded putative risk threshold levels previously estimated for non-target species or populations outside the Arctic.

Practical application:

The ultimate goal is to improve the prediction and estimation of health and well-being in Arctic biodiversity, wildlife, and human societies at the individual, population, and ecosystem levels. The Arctic is undergoing drastic changes due to global warming, and there are significant knowledge gaps regarding the biological effects of exposure to long-range transported chemicals, zoonotic diseases, and climate change in the region. Future assessments should focus on integrating human health, wildlife ecology, and global warming in a multiple-stressors modelling framework to assess biological effects and support nature conservation.

Inspiration behind research:

The research is inspired by the global environmental changes driven by climate change, which are affecting the transport and biomagnification of toxic chemicals associated with industrial activities, such as PFAS and mercury. The vulnerable Arctic environment, exposed to long-range transport of these substances, along with the wildlife and indigenous populations of Northern People relying on country food, makes these societies among the most susceptible worldwide. The research aims to contribute to the activation of Global Goals and address the specific challenges faced by the Arctic region.

Dr. Christian Sonne
School of Advanced Engineering

TAILORING NANOMATERIALS FOR NEXT-GENERATION TECHNOLOGIES

Approach to problem-solving:

Dr. Akarsh Verma is developing atomistic-scale models using classical mechanics-based molecular dynamics and quantum mechanics-based density functional theory environments. His focus is on characterising nanocrystalline materials and 2D nanomaterials (graphene, graphane, graphene-oxide nanomaterials, and their polymer nanocomposites). Through extensive simulation work, he tailors the mechanical, fracture and thermal properties of nanomaterials by incorporating defects (grain boundaries, etc.) and chemical functional groups in their domain. This research contributes to optimising nanomaterial properties for diverse industrial applications, from enhancing mechanical strength to improving thermal conductivity.

Practical application:

Dr. Verma's work assists scientists in designing alloys and related materials that can perform under specific pressures and temperatures. This opens new avenues for the application of miscible alloys in cryogenics and other thermal energy-based technologies.

Inspiration behind research:

The improvement of material properties, such as cracking and corrosion resistance, has been achieved by tailoring interface characteristics, particularly grain boundaries (GBs). Special GBs with desirable properties are crucial for engineering material strength. However, the complex nature and migration mechanisms of GBs make their growth difficult to control and understand. Researchers are currently focusing on enhancing the understanding of boundary plane effects within specific misorientations of GBs, which can refine grain growth control and help in developing desired microstructures in materials. Grain growth at room and elevated temperatures has been known to degrade the mechanical properties of nanocrystalline materials. However, recent ex-situ experiments have confirmed spontaneous grain growth and coarsening occurring at cryogenic temperatures as well. This intrinsic problem of poor thermal stability may hinder potential applications. Dr. Verma's research group is currently addressing this issue.

Dr. Akarsh Verma
School of Advanced Engineering

TACKLING ENVIRONMENTAL CHALLENGES THROUGH WASTE UTILISATION AND POLLUTION MITIGATION

Approach to problem-solving:

Dr. Su Shiung Lam is actively advancing microwave pyrolysis technology, securing research grants and patents. His work, commercialised through licensing, contributes to waste-to-wealth applications and sustainable solutions in energy conversion. Through his startup, Moment Alpha Sdn Bhd, he provides technology know-how and consultation on biorefinery, pyrolysis application, and biomass and waste utilisation to universities and companies, promoting sustainable practices and innovation.

Practical application:

Dr. Lam is active in the development and application of microwave pyrolysis technology. Dr. Lam has secured 33 research grants, both international and in Malaysia, worth nearly RM 4.0 million. His research team has filed 2 patents (PI201701015 and PI2021006617) for a platform technology (Microwave Pyrolyzer) to scale up and commercialize the invention. This technology is licensed to NV Western PLT, and 2 companies and Henan Agricultural University have purchased 4 prototypes, making RM 80,700 as revenue from commercialization. These prototypes are currently used and tested by waste operators for energy conversion and waste-to-wealth applications. Together with his colleagues, he has set up a start-up company called Moment Alpha Sdn Bhd with a team of researchers, providing technology know-how, licensing, and consultation on sustainability analysis, biorefinery and pyrolysis application, and biomass and waste utilization; some services have been provided to universities such as Monash University, Malaysia, Nottingham University, Malaysia and companies such as Sime Darby Berhad and hospitals of KPJ Healthcare Berhad.

Inspiration behind research:

Dr. Lam is active in research on waste recycling and biomass utilisation, particularly the application of thermochemical processes (e.g. pyrolysis, gasification, torrefaction) and microwave heating in transforming waste and biomass into green energy and products applicable to industry and environmental protection.

Dr. Su Shiung Lam
School of Advanced Engineering

PROPAGATING METHODS FOR ALLEVIATING ENVIRONMENTAL POLLUTION

Approach to problem-solving:

Dr. Meththika Vithanage is addressing the global problem of environmental pollution, specifically focusing on geogenic and anthropogenic processes that release various inorganic and organic micropollutants, including microplastics. Her research aims to understand the complex chemical interactions in environmental matrices, study the fate and transport of pollutants, and develop mechanisms for effective remediation. The goal is to contribute to a comprehensive understanding of solid-water interfacial interactions and advance methods for mitigating environmental pollution.

Practical application:

The ultimate goal of monitoring and assessing the micropollutants in environmental samples is to better estimate the distribution and possible exposure paths for biota. Research on pollution monitoring is always geared towards the improvement of living conditions of the general public by focusing on environmental pollution remediation. The core focus of field assessment of hydrogeochemistry is to seek the root causes of kidney diseases prevailing among Sri Lankan farmers in dry zones.

Inspiration behind research:

With the increasing concern about the ubiquitous presence and potential impacts of inorganic and organic micropollutants in various ecosystems, including oceans, rivers, and even human bodies, a better understanding of their presence, distribution, and impacts on soil, water, and air is crucial to sustaining the ecosphere mitigating the pollution to achieve sustainable development goals.

Dr. Meththika Vithanage
School of Advanced Engineering

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