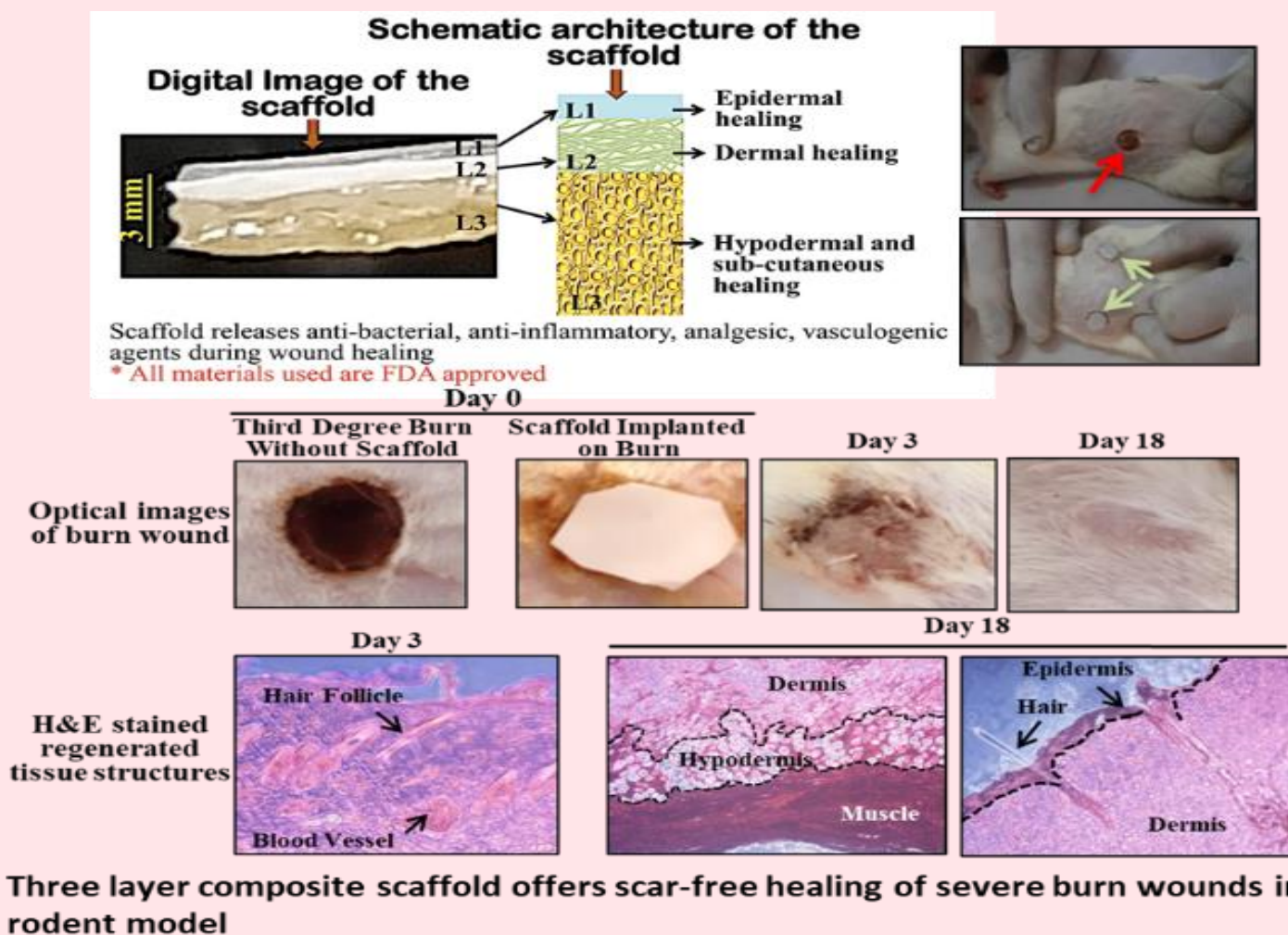


R&D NEWSLETTER

Indian Institute of Technology Roorkee

Vol.16

June 2021



3D Scaffolds in Tissue Engineering

3D scaffolds are biodegradable templates that support healthy and functional regeneration of damaged and/or lost tissue when implanted in-vivo. Using an appropriate fabrication process to reproduce the microarchitecture and biochemical constitution of the native tissue, the scaffolds are capable of mimicking the extracellular matrix of the native tissue. The research groups of Prof. Debrupa Lahiri from the Department of Metallurgical and Materials Engineering and Prof. Partha Roy from the Department of Biosciences and Bioengineering, along with clinicians, have developed 3D scaffolds for neural, skin (deep and burn wounds) and bone regeneration. The scaffolds have been tested in animals and are in the process of undergoing clinical trials.

Recently Registered Research Projects

Development of Ultrasensitive MEMs Magnetic Sensors for Flexible Electronics

Sponsor: Science & Engineering Research Board

Prof. Davinder Kaur

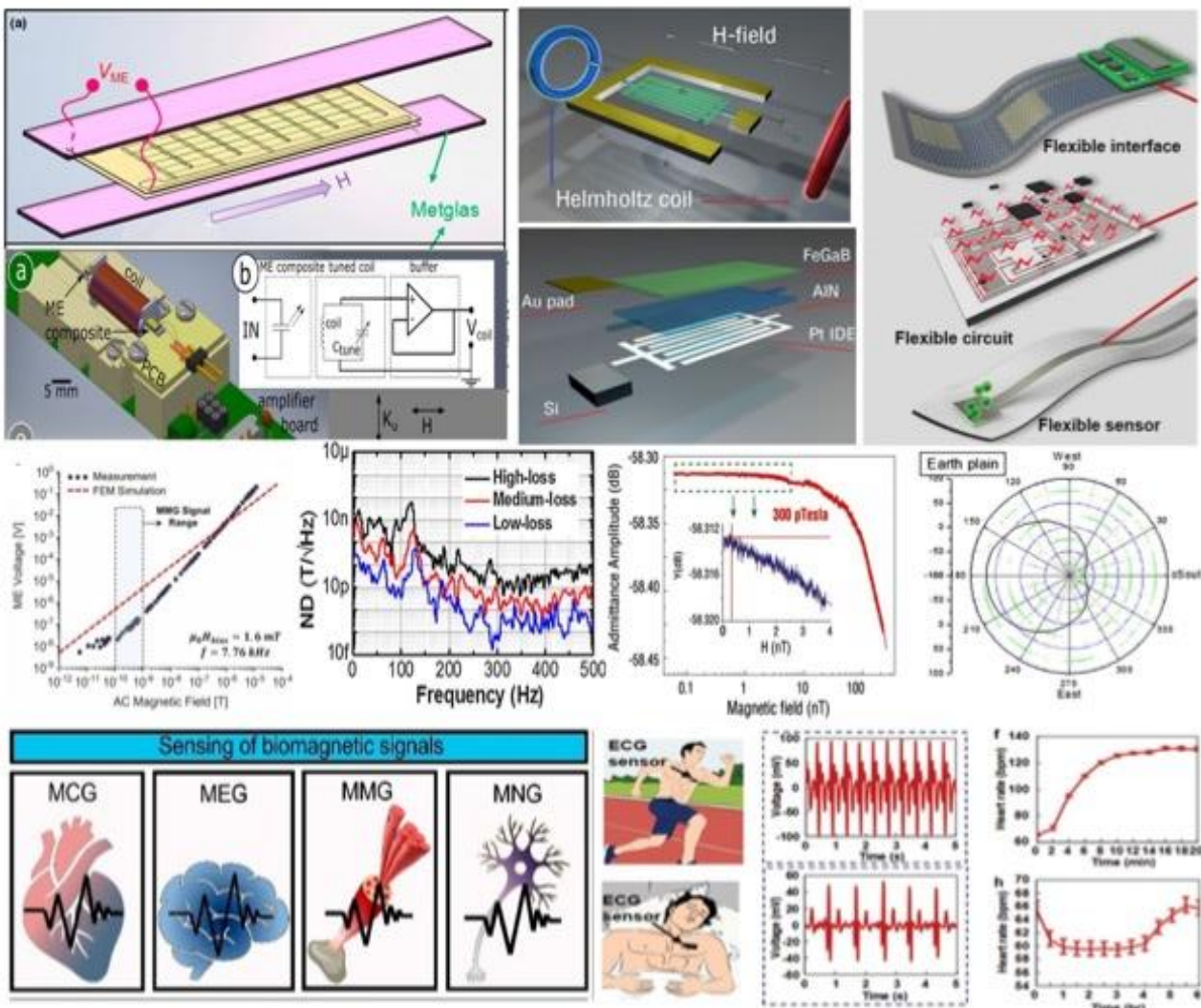
Department of Physics

Email: davinder.kaur@ph.iitr.ac.in

Homepage: <https://ph.iitr.ac.in/~PH/dkaurfph>



Recent years have witnessed a paradigm shift in the electronics industry towards the development of flexible and stretchable electronics. Many applications have benefited and numerous new applications will arise from electronics that can bend and conform to three dimensional curvilinear shapes.



MEMs Magnetic Sensors

For example, vital medical devices (e.g. retinal implants, pacemakers, and prostheses), intelligent clothing, flexible displays, and numerous wearable gadgets, which are needed to enable advances in emerging fields such as Internet of Things, robotics, and healthcare, will all require bendable and conformable electronics. The integration of magnetic elements into electronic devices, is essential for widening up the application area of flexible electronics. Magnetoception is a sense, which allows bacteria, insects and even vertebrates such as birds and sharks, to detect magnetic fields for orientation and navigation. Humans are however unable to perceive magnetic fields naturally, but electronic skin (e-skin) could soon help to bridge this gap. Soft, flexible and transient smart sensorics to monitor physiological conditions are at the forefront of multidisciplinary research efforts bridging materials science, electrical engineering and medicine. Therefore, the aim of the present proposal is development of magnetic field sensors which offer the possibility to sense and respond to external magnetic fields, which when integrated into electronic skin will bring new novelty to e-skin concept.

Development of Indigenous Simulation Model for Design Validation of Power Supply of High-Speed Railways

Sponsor: National High-Speed Rail Corporation Limited

Prof. Biswarup Das

Department of Electrical Engineering

Email: biswarup.das@ee.iitr.ac.in

Homepage: <https://ee.iitr.ac.in/~EE/biswafee>



For validating the design of the power supply system of an electric traction corridor, extensive software simulation studies are required. Till now, Indian Railways used to take help from foreign agencies for conducting these studies. Due to various reasons (high fees charged by the foreign agencies is one of them), it was felt by Indian Railways to develop this software indigenously in collaboration with the academic institutes. The envisaged simulation software would address all relevant aspects of the power supply system such as required rating of transformers and conductors, voltage profile in the traction corridor, temperature rise in the conductor, induced voltage in the nearby communication lines, generation of harmonics etc. Towards this goal, the developed software will have several major modules such as load flow analysis, harmonic power flow study, short circuit analysis, calculation of the temperature rise in the conductor and calculation of induced voltage in the nearby conductors.

Halting the Release of AntiMicrobial Resistance and PaThogens into the Environment from Indian Dairies (AMRIT)

Sponsor: Science & Engineering Research Board

Prof. Gargi Singh

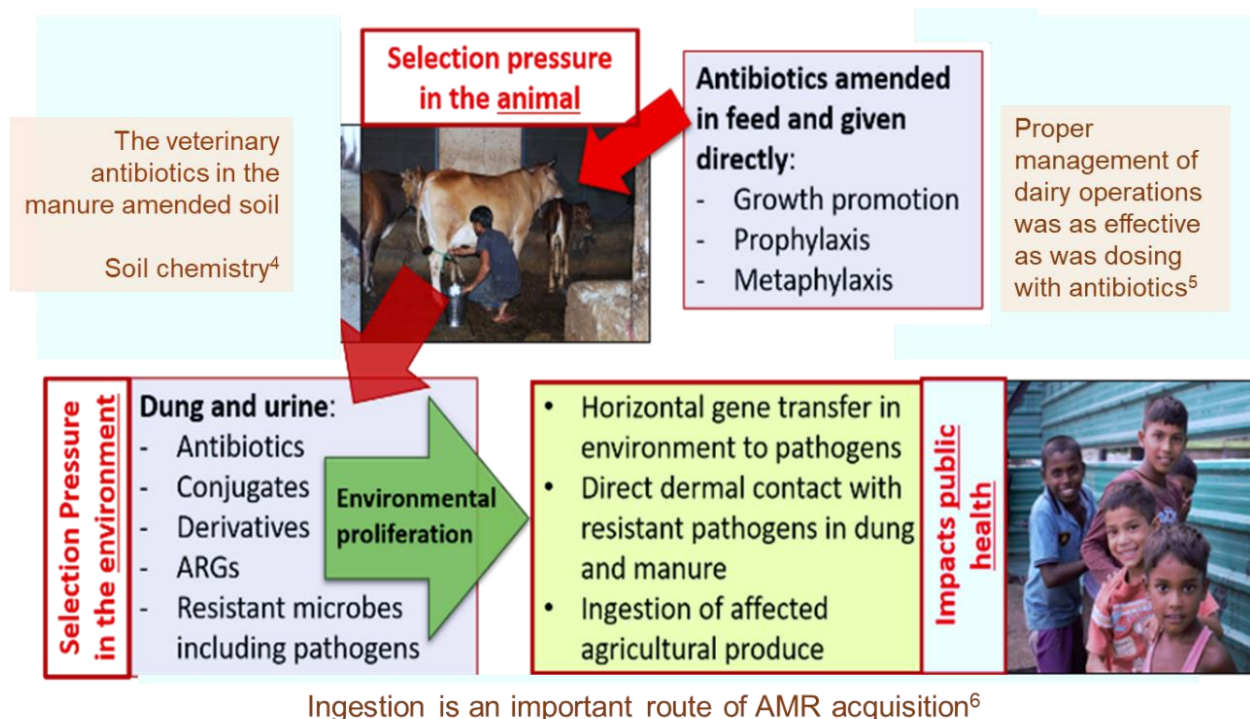
Department of Civil Engineering

Email: gargi.singh@ce.iitr.ac.in

Homepage: <https://civil.iitr.ac.in/CE?Uid=gargifce>



An alarming and unintended consequence of the rise of our Indian dairy industry has been release of antibiotics, antimicrobial resistance, and pathogens into the environment. The bridge between the release of antibiotics, ARGs, and antibiotics resistant microbes into the environment from Indian dairies and its impact on public health is little understood.



The effect of prevalent practices such as piling dung and dung cakes, letting the urine and washwater into agricultural farms or drains or surface water bodies, etc. on environmental resistome is not known. Thus, we proposed a three-pronged approach to address the knowledge gaps: **A.** quantify the flux of antibiotic resistance and its selectors; **B.** determine the risk of ingesting antibiotics, ARGs, and resistant pathogens from dairy produce and agricultural produce from manure impacted farms; and **C.**

minimize the need and use of antibiotics in dairy farms through increased awareness, better animal care, nutrition and farm management.

Mesoscale Modelling of Amorphous Solids for Large Scale Simulations

Sponsor: DST (National Supercomputing Mission)

Prof. Shiladitya Sengupta

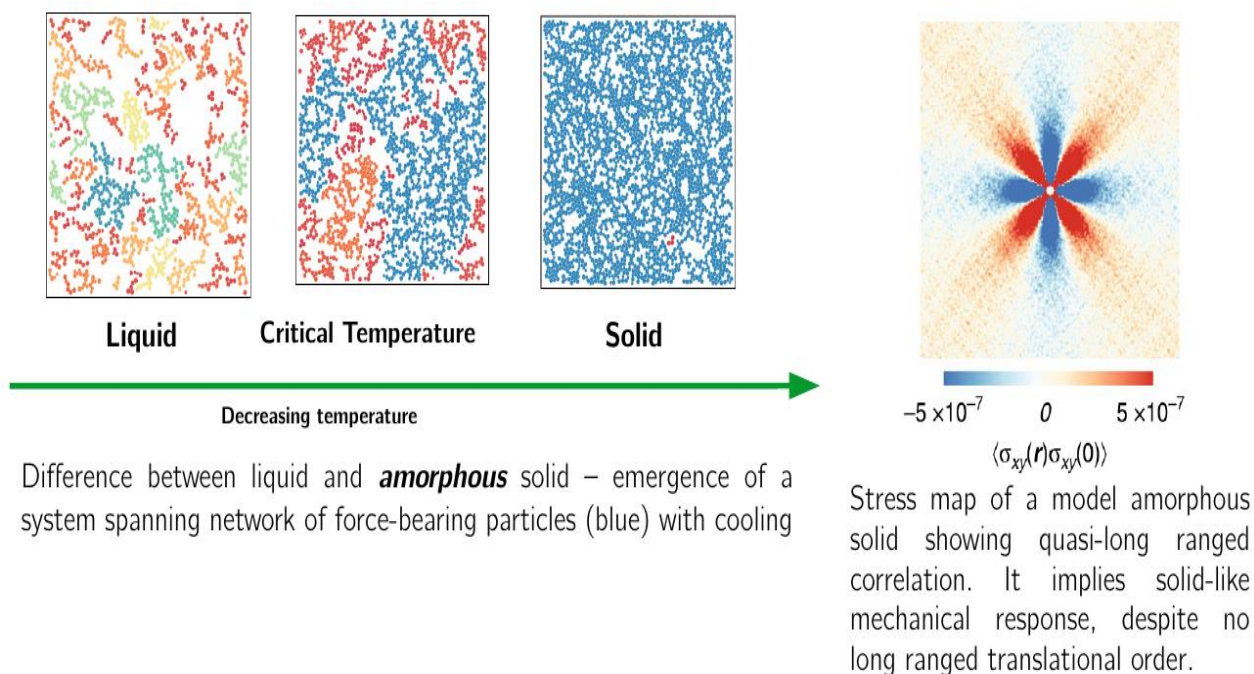
Department of Physics

Email: shiladityasg@ph.iitr.ac.in

Homepage: https://ph.iitr.ac.in/~PH/Shiladitya_Sengupta



Amorphous solids have peculiar properties distinct from crystals. One fundamental mystery is the emergence of solidity in such nonequilibrium, disordered state without the protection by long-range translational order.



A jammed system at zero temperature, although marginally stable, has solidity stemming from the space-spanning force network, which gives rise to the long-range stress correlation. Here, we show that such nonlocal correlation already appears at the nonequilibrium glass transition upon cooling. This is surprising since we also find that the system suffers from giant anharmonic fluctuations originated from fractal-like potential energy landscape. We reveal that it is the percolation of the force-bearing network that allows long-range stress transmission. Thus, the emergent solidity of

amorphous materials is a consequence of nontrivial self-organisation of the disordered mechanical architecture. Our findings point to the significance of understanding amorphous solid and nonequilibrium glass transition from a mechanical perspective.

Mercury: Constraints on the Thermochemical Evolution and Internal Differentiation from Meteorites, Experiments and Geochemical Modelling

Sponsor: Science & Engineering Research Board

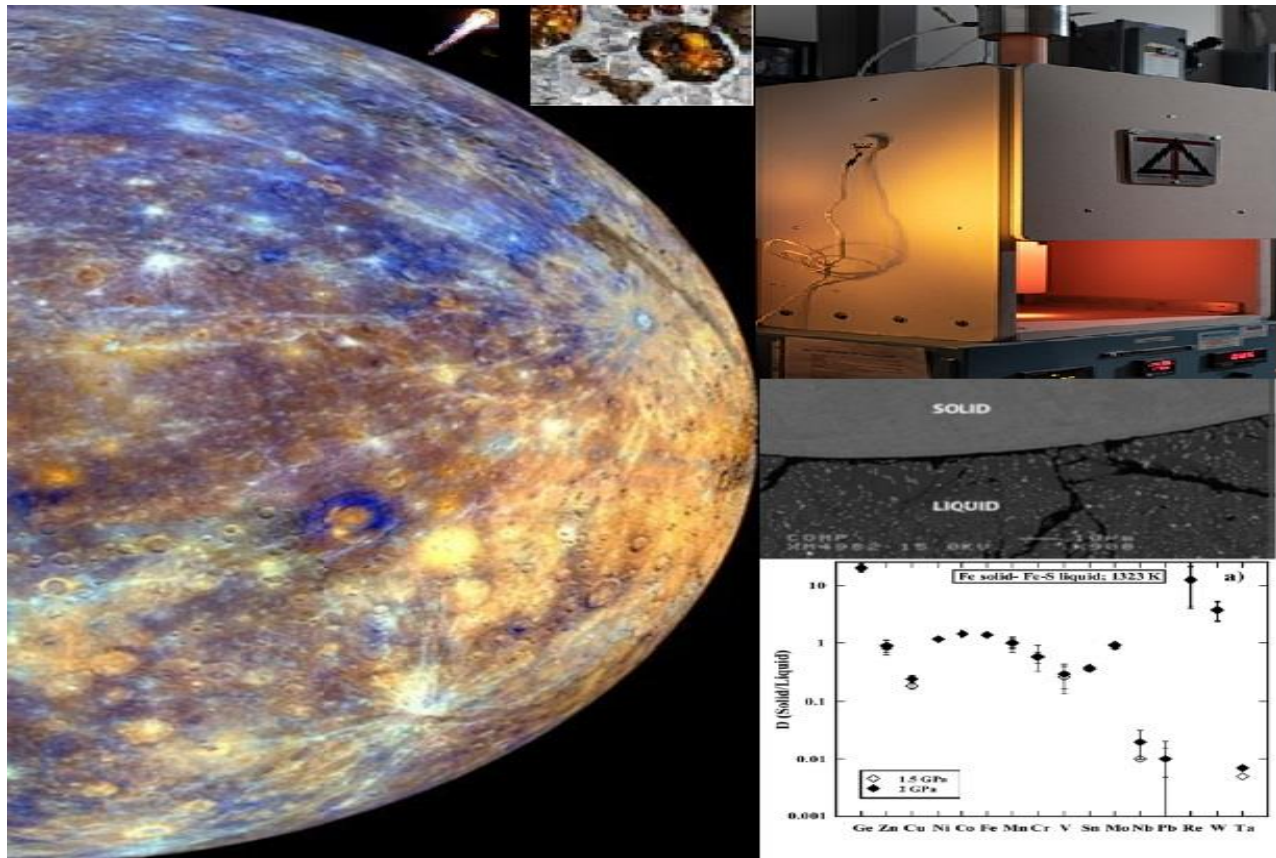
Prof. Nachiketa Rai

Department of Earth Science

Email: n.ra@es.iitr.ac.in

Homepage: https://es.iitr.ac.in/~ES/Nachiketa_Rai

With the success of the Chandrayaan I & II lunar missions, the Mars Orbiter Mission (MOM/ Mangalyaan), and upcoming ISRO missions (Chandrayaan-III, Aditya), India's



From crust to core: Constraining MERCURY through meteoritics, and High-Pressure High Temperature (HPHT) experimental geochemistry

Space program for exploration of terrestrial planets, and solar system continues to successfully grow by leaps and bounds. Considering its close proximity to the Sun, and the very high metal: silicate ratio compared to other rocky bodies, Mercury represents a critical end-member among terrestrial planets, but still remains one of the least explored terrestrial planetary bodies. The primary objective of this research project is to constrain the thermochemical evolution of Mercury by employing an integrated approach involving geochemical investigation of extra-terrestrial rocks, High-Temperature experiments, and numerical modelling of the magmatic evolution of the Mercurian mantle, in the context of the observational data available for Mercury.

Development of Encryption and Secret Sharing Schemes for Quantum Images

Sponsor: Science and Engineering Research Board

Prof. Sanjeev Kumar

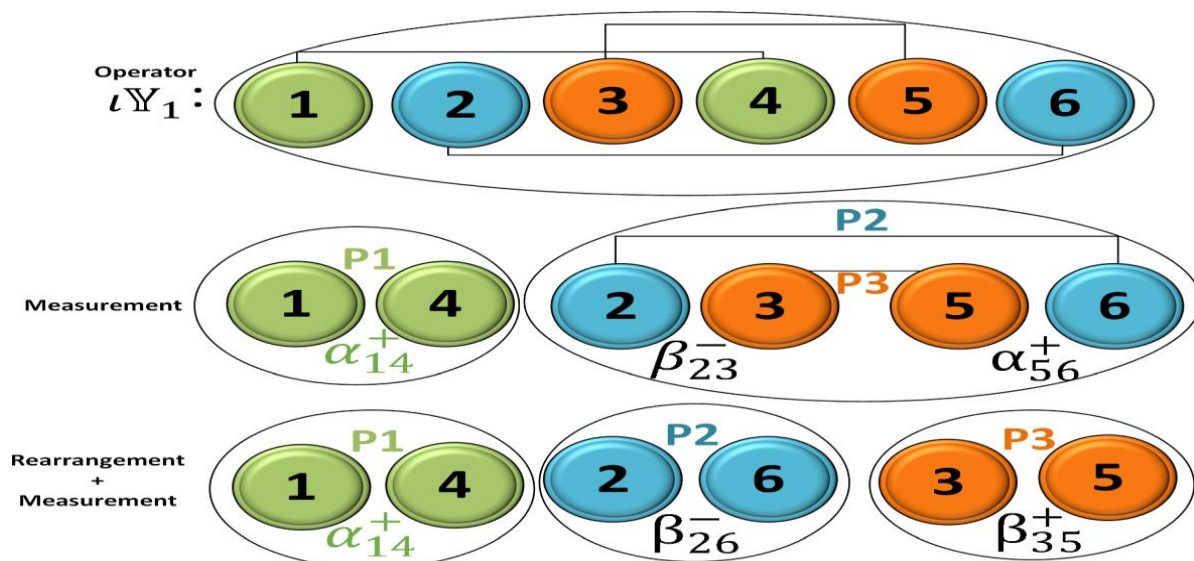
Department of Mathematics

Email: sanjeev.kumar@ma.iitr.ac.in

Homepage: <https://ma.iitr.ac.in/~MA/Malikfma>



Nowadays, most image encryption and security algorithms, including visual secret sharing schemes, are pretty impressive in the case of digital computers.



Schematic of a protocol of a (3,3) QSS using Bell States and Sequential Projective Measurement

However, in the coming era of quantum computing, these algorithms would be susceptible to attacks due to the high computational efficiency possessed by quantum computers. There is a need to develop advanced encryption and security algorithms for images that can withstand in the era of quantum computing. This project is related to the development of quantum algorithms for images and visual data that can withstand post-quantum cryptanalysis. More specifically, the manifestation of this project is a result of the effort put in to propose secure quantum cryptosystems without the use of classical means whose incorporation in the schemes would have diluted the whole purpose. These developments include designing the protocols, theoretical analysis, and experimental validation using the available quantum hardware on various clouds.

Synthesis of π -Extended Corroles, Chlorins and Porphyrins for Anion Sensing, Catalysis, Nonlinear Optical and Solar Cell Applications

Sponsor: Science and Engineering Research Board

Prof. Muniappan Sankar

Department of Chemistry

Email: m.sankar@cy.iitr.ac.in

Homepage: <https://cy.iitr.ac.in/~CY/sankafcy>



Energy sustainability is a prime global economic, societal and environmental issue of modern era that demands clean and renewable energy resources. In this regard, π -extended porphyrins and their analogues (corroles and chlorins) have been gaining remarkable attention due to their versatile attributes, such as diverse π -delocalization pathways owing to flexible macrocyclic structures, UV-Vis and NIR absorption and emission, facile interconversion between multiple redox states and provides coordination cavities for large number metal ions. However, one has to be specialized in the synthesis of these challenging porphyrinoids during the course of multistep synthesis which limits their wide range of material applications and their commercialization. Herein, we designed to synthesize π -extended dendritic porphyrinoids in one or two steps which are expected to show good film formation (through supramolecular interactions), charge injection efficiency and charge mobility and hence the fabricated perovskite solar cells (PSCs) with porphyrinoids as hole transporting materials (HTMs) may show greater power conversion efficiency. Further, the synthesized '*push-pull*' π -extended porphyrinoids will be utilized as naked-eye

sensors for the selective detection of toxic anions in environmental samples, catalyst for various organic transformations and also as optical limiters.

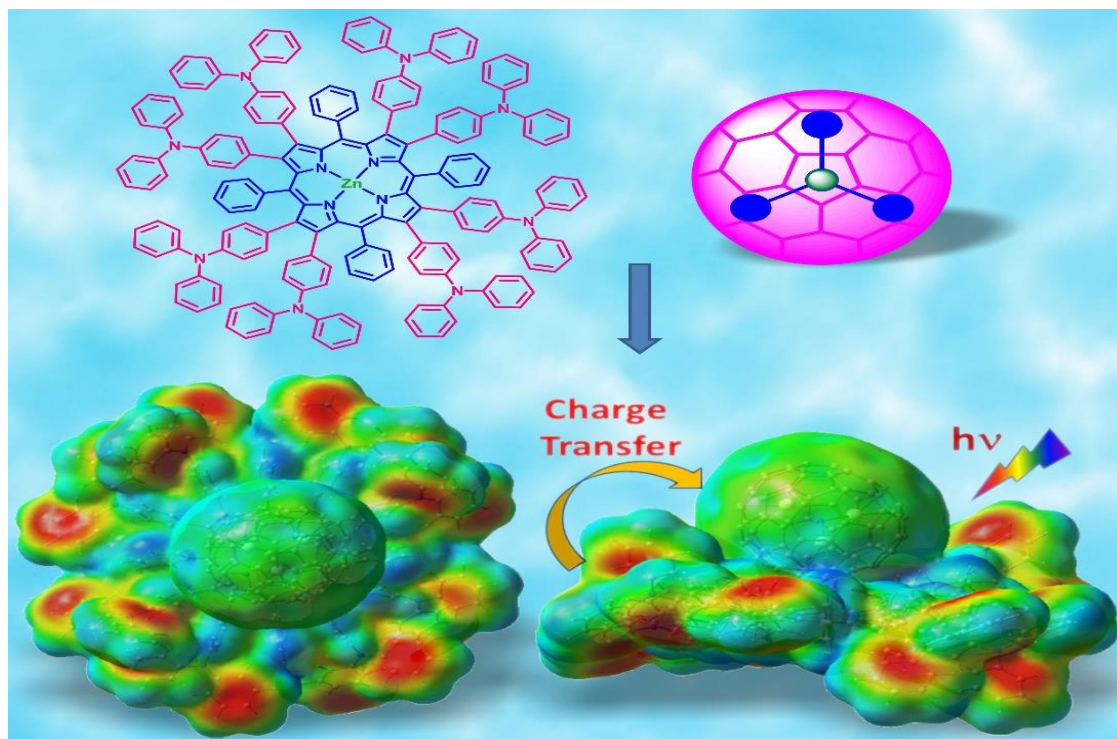


Photo-induced Charge Separation in Donor-Acceptor (D-A) Complex Comprising of Dendritic Porphyrin (D) and Endohedral Fullerene (A)

Non-Invasive Early Sensing of Soft Rot and Dry Rot in Stored Potato Tubers by Analysis of Volatile Organic Compound Emission

Sponsor: Science and Engineering Research Board

Prof. Debabrata Sircar

Department of Biosciences & Bioengineering

Email: debabrata.sircar@bt.iitr.ac.in

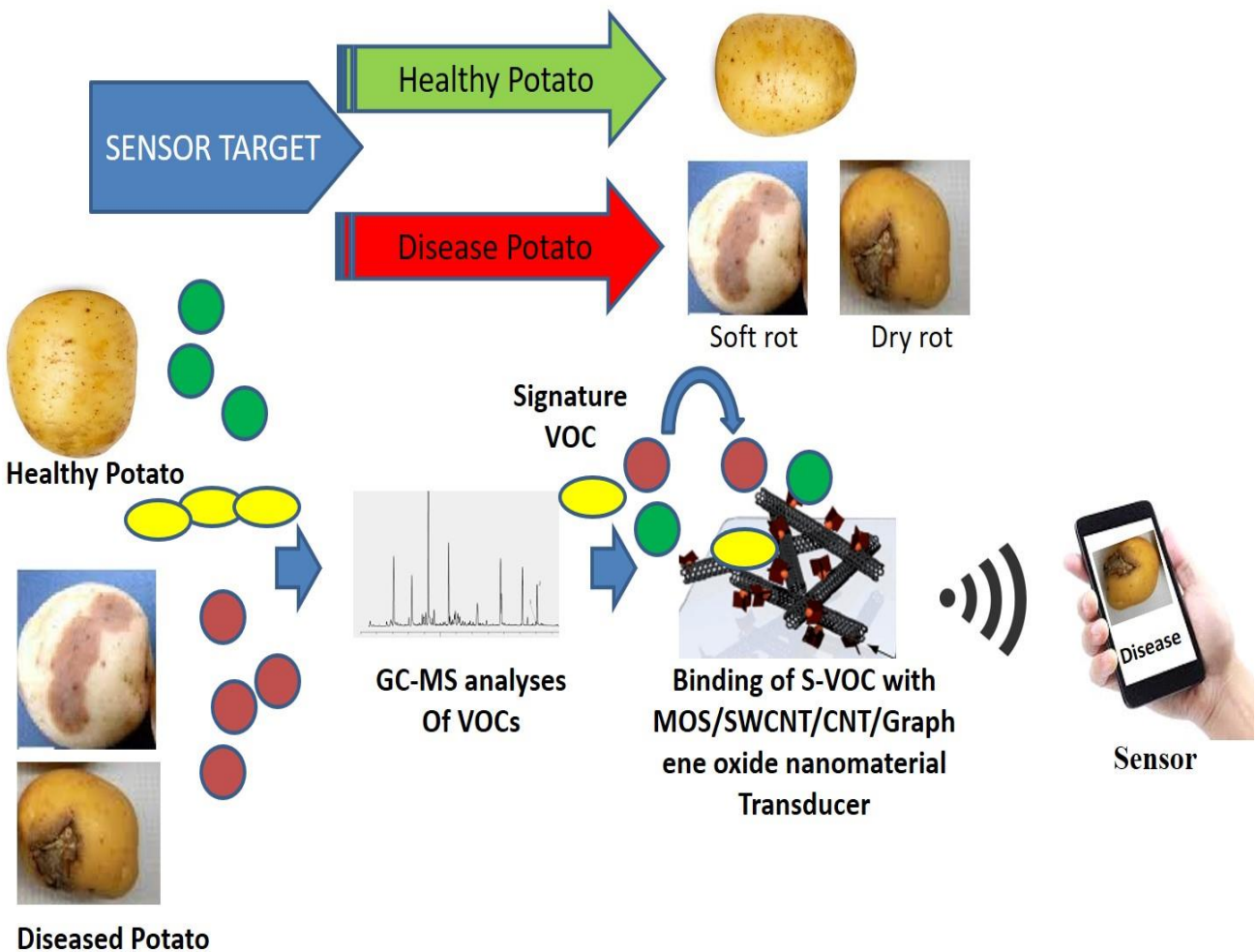
Homepage: <https://bt.iitr.ac.in/~BT/debsrftb>



Potato (*Solanum tuberosum* L.) is an important tuberous food crop consumed in Indian and around the world. India is the second largest world producer of Potato. During postharvest storage, potatoes are highly prone to a number of post-harvest diseases, mainly, soft rot and dry rot disease which together accounts approximately 20-30% losses in potato production every year. In general, farmers separate/ grade the diseased

Potatoes before putting them under storage to separate. However, these manual/ visual methods often fail to completely separate the infected Potatoes from the lot due to a lack of visual symptoms. This project aims to develop a technology for low cost non-invasive early sensing of onset of soft rot and dry rot disease in potatoes. This project is based on the hypothesis that during soft or dry rot disease, potatoes will emit some signature volatile organic compounds (S-VOCs) which are unique to that particular disease conditions. First, this project aims to identify those S-VOCs using SPME-gas chromatography mass spectrometry. Once S-VOCs would identified, we would develop corresponding specific transducer. A low-cost sensor prototype will be developed and sensor outputs will be visualized in SMART phones using interface mobile app. The proposed solution has economic significance.

Low-cost non-invasive early sensing of selected potato diseases



Automated Cognitive Metrics Classification Framework to Improve Human Machine Collaboration

Sponsor: Defence Research & Development Organisation

Prof. Partha Pratim Roy

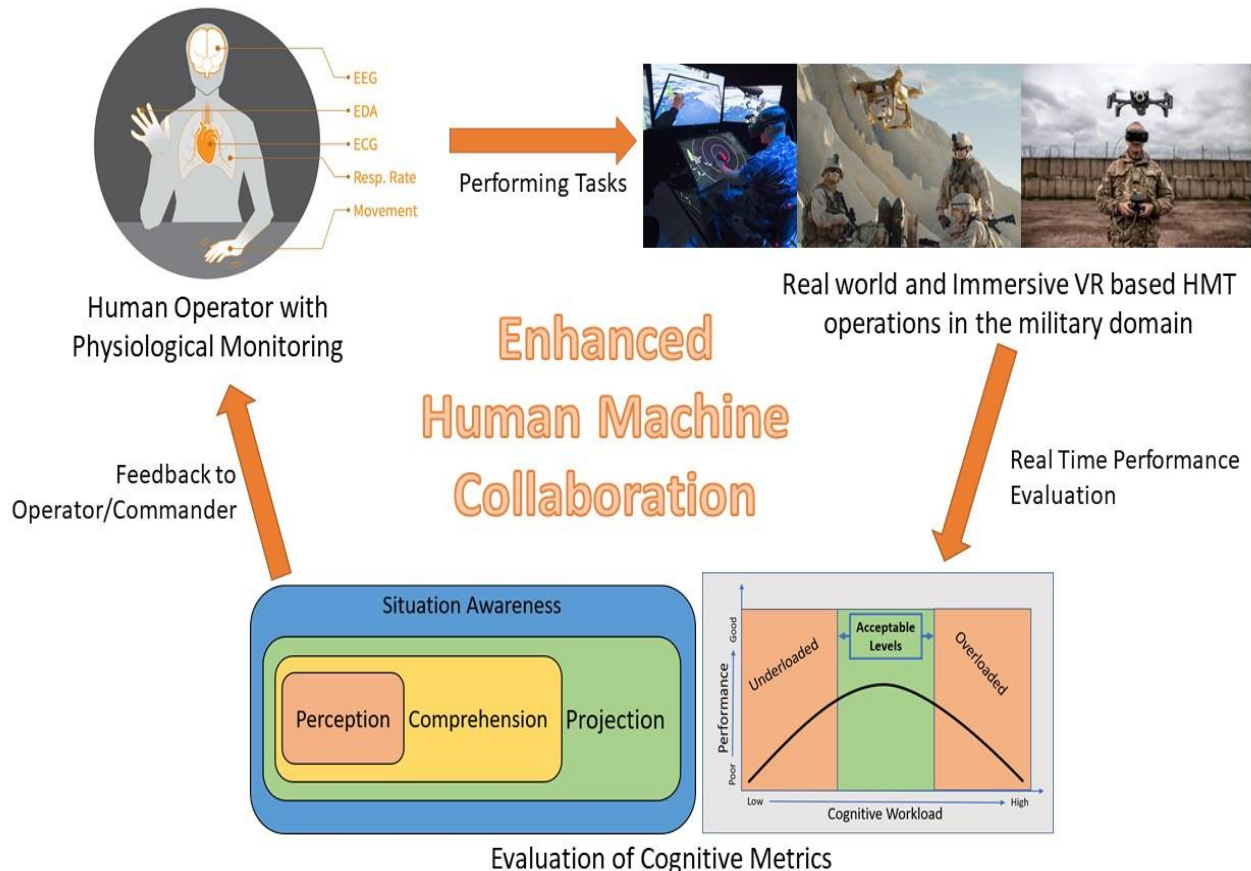
Department of Computer Science & Engineering

Email: partha@cs.iitr.ac.in

Homepage: https://cse.iitr.ac.in/~CSE/proy_fcs



The world around us is evolving at an exponential rate with the rise of technology and intelligent machines. On the one hand, the machines are becoming more advanced and sophisticated, while on the other hand, the human side remains the same. A balance needs to be strived between the two.



Research in Human-Machine teaming examines the key drivers, opportunities, and challenges for defence forces in developing future human-machine teams. Contemplating the impact of human machine teaming research, the main idea of this project is to build a framework which can help assess the cognitive state, especially mental workload (MWL) and situational awareness (SA). of an HMT system and create a

perfect mix of human and machine collaboration. MWL is defined as the amount of mental or cognitive resources required by task demands. Estimating an individual's workload would be useful in monitoring and assisting people at work, as well as in evaluating and designing systems. SA is the perception of the elements in the environment within a volume of time and space, the comprehension of the environment, and the projection of their status in the environment. Degraded SA has been linked to poor interaction between humans and machines. Thus, for development of an effective HMT system SA will play a crucial role. The project will include a confluence of different technologies and fields of research like cognitive neuroscience, artificial intelligence, neuro-physiology, virtual reality, etc. Virtual Reality will be used to immerse the participant or user in a close to real world scenario simulating various human machine teaming operations. EEG and other physiological tools will be used to monitor and evaluate the performance of the user in the simulated scenarios. The fruitful completion of this project will result in a prototype framework to assess and map MWL and SA in human machine collaboration scenarios in the military context.

Indo-South Korea Joint Network Center for Environmental Cyber Physical Systems

Sponsor:

Prof. Sachin Kumar Srivastava

Department of Physics

Email: sachin.srivastava@ph.iitr.ac.in

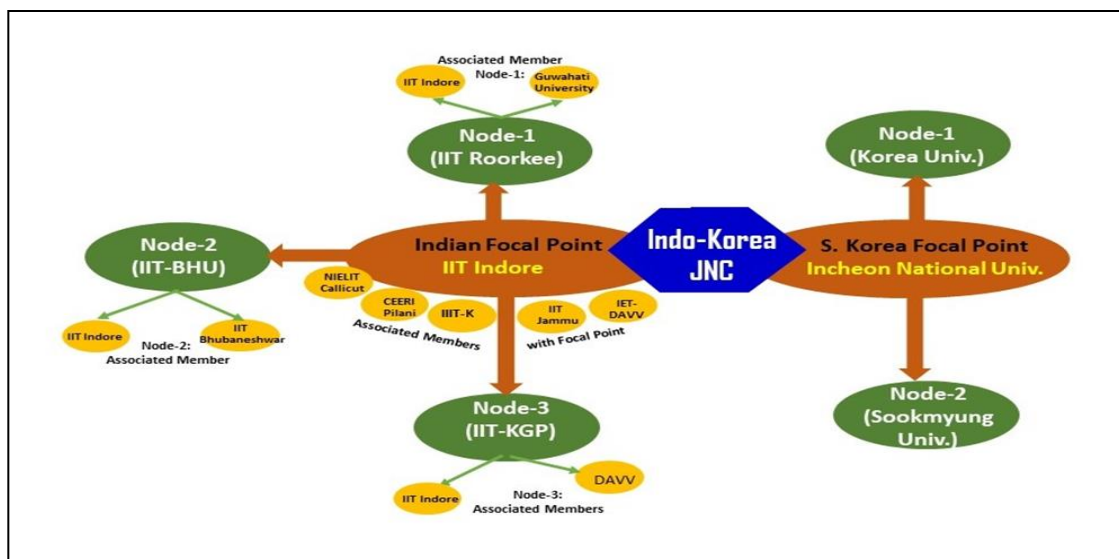
Homepage:

https://ph.iitr.ac.in/~PH/Sachin_Kumar_Srivastava



This is a multi-institutional networking project, led by Indian Focal point IIT Indore. The PI from IIT Roorkee will lead one of the nodes (Node-1) of this joint network center (JNC) towards the development of sensors aligned to the theme of the project. Key Approaches:

1. Joint supervision of PhD students
2. Annual workshops with invited international speakers at both focal centers to facilitate collaboration and networking. When the workshops are conducted in India, a minimum of 70 students (at least 15 from each node and their affiliate institutions) will be fully supported to attend the annual workshops.
3. Faculty and students from India and Korea will be hosted at the focal centres and nodal institutes to develop long term networking and professional collaboration opportunities. Students and faculty will be hosted for a minimum of 10 days respectively.



Other Recently Registered Projects

Principal Investigator	Title of the project	Sponsoring Agency
Prof. Pushpa Chaudhary Civil Engineering pushpa@ce.iitr.ac.in	Pedestrian safety in mixed traffic conditions probing executable solutions to enhance vulnerable road users safety using a pedestrian simulator	SERB
Prof. Vidit Gaur Mechanical & Industrial Engineering vidit.gaur@me.iitr.ac.in	A study on fatigue damage in additively manufactured IN718 alloy	SERB
Prof. Ameeya Kumar Nayak Mathematics ameeya.nayak@ma.iitr.ac.in	Implementation of multi-fluid population balance method for the nonlinear coupled Maxwellian averaged transport equations	SERB
Prof. Millie Pant Applied Science & Engineering milliept@iitr.ac.in	Metaheuristics Framework for Multi-objective Combinatorial optimization Problems (META-MoCop)	DST (Indo-Czech)
Prof. Hari Prakash Veluswamy Chemical Engineering hariprakashv@ch.iitr.ac.in	ECO-EXCHANGE : Investigation of eco-friendly compounds that the substitution of methane with carbon dioxide during energy recovery from hydrate deposits	SERB
Prof. Maheshanand Mathematics maheshanand@ma.iitr.ac.in	Construction and analysis of Locally Recoverable Codes	SERB
Prof. Premananda Bera Mathematics p.bera@ma.iitr.ac.in	Non-Linear stability theory of non-isothermal parallel flow in a vertical annulus filled with high permeable porous medium	SERB

Prof. Anand Bulusu Electronics & Communication Engineering anand.bulusu@ece.iitr.ac.in	Smart Contactless technology development for smart fencing	DST (Indo-Czech)
Prof. Partha Roy Biosciences & Bioengineering partha.roy@bt.iitr.ac.in	Assess the role of Indian mustard honey towards management and cure of drugs resistance colon cancer and its metastasis singly or in combination with potent drugs	National Bee Board
Prof. Varun Sharma Mechanical & Industrial Engineering varun.sharma@me.iitr.ac.in	Experimental investigations on FDM and SLA printed personalized drug delivery systems	DST (Indo-Egypt)
Prof. Nikhil Dhawan Metallurgical & Materials Engineering nikhil.dhawan@mt.iitr.ac.in	Recovery of lithium and cobalt values from discarded lithium-ion batteries	SERB
Prof. Pradeep Kumar Jha Mechanical & Industrial Engineering pradeep.jha@me.iitr.ac.in	Multiphase Analysis of Inclusion Transport and removal in continuous casting products with use of electromagnetic stirrer	SERB
Prof. Alok Bhardwaj Civil Engineering alok.bhardwaj@ce.iitr.ac.in	Satellite Imagery Computer Vision Modeling for Land use/cover	National Geographic Foundation for science and Exploration
Prof. Dharmendra Singh Electronics & Communication Engineering, Computer Science & Engineering dharmfec@ece.iitr.ac.in	Design and Development of MIMO based microwave Imaging system for target detection and identification behind the wall	Ministry of Electronics & Information Technology
Prof. Ajay Physics ajay@ph.iitr.ac.in	Josephson transport across coupled quantum dots	SERB
Prof. Pranita P. Sarangi Biosciences & Bioengineering pranita.sarangi@bt.iitr.ac.in	Role of integrin and GTPases associated signaling cascades in innate immune cell activation and migration during sepsis	SERB
Prof. Pradip Kumar Maji Polymer & Process Engineering predip@pe.iitr.ac.in	Towards a policy for a sustainable industry in PET-based triboelectric nanogenerator	New Castle Research and Innovation Institute (NewRITS), Singapore
Prof. Shailly Tomar Biosciences & Bioengineering shailly.tomar@bt.iitr.ac.in	Protein nanoparticles based development of universal influenza vaccine	SERB

Prof. Durga Toshniwal Computer Science & Engineering durga.toshniwal@cs.iitr.ac.in	Intelligent data placement using AI&ML	Huawei Technologies India Private Limited
Prof. Pranita P. Sarangi Biosciences & Bioengineering pranita.sarangi@bt.iitr.ac.in	Investigating the effects of yoga and meditation in combating anxieties and possible stress induced immunosuppression in students' post-lockdown	DST
Prof. Shailly Tomar Biosciences & Bioengineering shailly.tomar@bt.iitr.ac.in	Antivirals against chikungunya virus targeting RNA Viral Capping Machinery	ICMR
Prof. Naveen Kumar Navani Biosciences & Bioengineering naveen.navani@bt.iitr.ac.in	Characterization of a Herbo-mineral ayurvedic preparation-based Rasa-Shastra-Special reference to mahayogaraj guggulu	Uttarakhand State Council for Science & Technology
Prof. Sanjeev Kumar Hydro & Renewable Energy sanjukec@hre.iitr.ac.in	Development of microalgal biofilm reactor coupled constructed wetland (MBR-CW) system for decentralized waste water treatment	Uttarakhand State Council for Science & Technology
Prof. Ram Jiwari Mathematics ram.jiwari@ma.iitr.ac.in	Lie symmetry analysis, simulation and Lyapunov stability analysis of the hyperbolic systems	DST (Indo-Uzbek)
Prof. Amit Kumar Dhiman Chemical Engineering amit.dhiman@ch.iitr.ac.in	Computational fluid dynamics studies on streamlined/non-streamlined lips of a sluice gate: lip selection and flow structures	Uttarakhand State Council for Science & Technology
Prof. Shiv Kumar Gupta Mathematics s.gupta@ma.iitr.ac.in	Formulation and developing solution methodologies of various optimization models under uncertainty with applications in environmental managements	Uttarakhand State Council for Science & Technology
Prof. Sonal K. Thengane Hydro and Renewable Energy sonalt@hre.iitr.ac.in	Stubble management using decentralized torrefaction systems for biochar-based fertilizers	DST
Prof. Anuj Sharma Chemistry anuj.sharma@cy.iitr.ac.in	Conversion of biomass from flora of Uttarakhand into high valued products like biofuels using green and sustainable methods	Uttarakhand State Council for Science & Technology
Prof. Dharmendra Singh Electronics & Communication Engineering, Computer Science & Engineering dharmfec@ece.iitr.ac.in	Creating a Centre of Excellence for Drone Research	IITR Alumni of 1994 Batch

Correspondence

Dean, Sponsored Research & Industrial Consultancy

Tel: +91-1332-28-5245

Email: dsric@iitr.ac.in

Dr. Rona Banerjee, SRIC

Tel: +91-1332-28-4256

Email: ronab.adm@iitr.ac.in