



## Department of Electrical Engineering

### **Ph.D. Admissions 2026-27 (Autumn Semester)**

#### **Abstracts of Projects (only for TAP/RAP category)**

**Note:**

- 1) These positions are other than TA positions.
- 2) Candidates admitted to TA category can choose any supervisor; however, candidates admitted under TAP/RAP category may have to work with the specific Project Investigators listed in this booklet.

# List of TAP/RAP Topics (Project Positions)

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Project Investigator: Prof. Dipankar Saha

Title of the project: **GaN Based RF High Electron Mobility Transistors for High Frequency Integrated Circuits**

Desired specialization: EE 7 (Solid State Devices)

*Abstract of the project:*

We are seeking a motivated PhD student to join our lab focusing on the development of GaN HEMT technology. This role offers hands-on experience in cleanroom fabrication along with detailed electrical and thermal characterization. You will also work on creating compact models to better understand device physics and reliability. Our research aims to improve performance for practical applications in power electronics and RF systems.

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Project Investigator: Prof. Dipankar Saha

Title of the project: **InP High Electron Mobility Transistor Fabrication and Characterization for Low Noise Amplifier for quantum bit readout**

Desired specialization: EE 7 (Solid State Devices)

*Abstract of the project:*

We are looking for a PhD student to focus on the development of Indium Phosphide (InP) HEMTs tailored for cryogenic low-noise amplifiers. This project involves hands-on cleanroom fabrication and high-frequency characterization to optimize devices for the extreme environments required in quantum computing. You will investigate noise performance and electron transport at milli-Kelvin temperatures to improve the readout of quantum bits.

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Project Investigator: Prof. Sandeep Anand

Title of the project: **SiC and GaN based Power Electronics for Electric Vehicles**

Desired specialization: EE 7 (Solid State Devices)

*Abstract of the project:*

Ph.D. Opportunities in SiC and GaN Based Power Electronics for Electric Vehicles: Electric vehicles are growing and also undergoing a paradigm shift, and wide bandgap semiconductors such as Silicon Carbide (SiC) and Gallium Nitride (GaN) are enabling the next generation of high-efficiency, compact, and reliable power electronics. This Ph.D. offers an exceptional opportunity to engage in cutting-edge research conducted in collaboration with industry partners and ongoing projects, ensuring both academic depth and real-world impact.

Students will investigate one or more sub-topics: (i) advanced power converter design, (ii) circuit topologies, (iii) control techniques, (iii) medium-voltage power electronic circuits, (iv) health monitoring and prognostics for power electronics systems. Applications will span across DC fast

chargers (Solid state transformers), onboard EV chargers, and motor drive controllers, with emphasis on reliability, scalability, and indigenous innovation. The program integrates fundamental research with industrial collaboration, preparing scholars to lead in both academia and industry..

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Project Investigator: Profs. Gaurav S. Kasbekar, Manjesh Hanawal

Title of the project: **Resource Optimization in Space-Air-Ground Integrated Networks**

Desired specialization: EE 1 (Communication & Signal Processing)

*Abstract of the project:*

Sixth-generation (6G) wireless cellular networks, which are a subject of extensive ongoing research in academia and industry, are expected to revolutionize wireless networks by significantly enhancing their performance and coverage relative to the current 5G standard, and supporting numerous novel applications. Space-air-ground integrated networks (SAGINs), which interconnect satellites, aerial platforms such as Unmanned Aerial Vehicles (UAVs) and high-altitude platforms (HAPs), and terrestrial nodes, have been widely acknowledged as a key component of future 6G networks, and offer a variety of use cases including connectivity in remote areas, disaster management, emergency response, intelligent transportation systems, environmental monitoring, military applications, etc. A critical challenge in the design of SAGINs is resource optimization, as part of which several problems need to be solved, e.g.: (i) task/ computation offloading, (ii) spectrum sharing and interference management, (iii) user association and handover management, (iv) clustering of satellites and aerial platforms, etc. These problems need to be solved in order to achieve various goals, including throughput and capacity maximization, energy efficiency, delay minimization, increasing reliability, network deployment and operation cost minimization, etc. Moreover, the above problems need to be solved while addressing the unique challenges facing SAGINs, such as limited available resources (bandwidth, computing power, storage, energy, etc.) at satellites and aerial nodes, interference among the transmissions of space, aerial, and terrestrial nodes, high mobility of satellites and aerial nodes, unbalanced traffic, long propagation delays, high path loss and vulnerability of wireless transmissions to atmospheric conditions, limited backhaul capacity, etc. Our objective in this proposal is to design efficient schemes for resource optimization in SAGINs and to evaluate their performance via mathematical analysis as well as simulations. Our work on resource optimization in SAGINs in this project will be novel in several respects, including the following: (i) the formulation of the task/ computation offloading and user association problems using classical multi-armed bandits (MAB) and restless multi-armed bandits (RMAB), and their solution using various indices such as upper confidence bound and the Whittle index, (ii) solution of the task/ computation offloading problem jointly with one or more of the following related problems in SAGINs: (1) Internet of Things (IoT) device-Space Aerial Platform (SAP) association, (2) power allocation, (3) precoding and beamforming, (4) task assignment, (5) trajectory planning, (6) task queue management, and (7) distributed inference, (iii) design of a number of economic mechanisms such as auctions, markets, bargaining-based solutions, etc., to enable spectrum sharing, (iv) design of algorithms for performing complex handovers, (v) design of algorithms for dividing the set of all satellites or UAVs into clusters, which are optimal or have provable approximation ratios, etc. The algorithms we develop in this project will significantly aid in enhancing the network performance of SAGINs, improving the user experience and Quality-of-Service (QoS) provided to the network users, effectively supporting various network applications, and addressing the unique challenges facing SAGINs. Since SAGINs will be a fundamental component of 6G networks, our work will have a high impact and significantly contribute towards their successful deployment and efficient operation..

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Project Investigator: Prof. Kasturi Saha

Title of the project: **Development chip-scale magnetic field sensor integrated with drone**

Desired specialization: EE 5 (Electronic Systems), EE 7 (Solid State Devices)

*Abstract of the project:*

This project aims to develop a precise, portable magnetic field sensor using nitrogen-vacancy (NV) centers in diamond. NV centers possess unique quantum properties, enabling sensitive magnetic field detection by tracking changes in their spin states. The sensor will combine lasers and microwave systems for spin state control, offering high sensitivity and spatial resolution at room temperature. Applications range from navigation to oil-gas detection, allowing real-time magnetic field mapping. The student will design the sensor head, including optical design, simulations, and experiments, and interface it with electronic systems, creating a magnetometer that can be integrated with drones and other mobile platforms.

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Project Investigator: Prof. Kasturi Saha

Title of the project: **Development quantum diamond microscope for semiconductor chip diagnostics**

Desired specialization: EE 5 (Electronic Systems), EE 7 (Solid State Devices)

*Abstract of the project:*

This project aims to develop an advanced microscope capable of imaging magnetic fields at the micron scale in both 2D and 3D. The system will be designed for analyzing integrated circuits and microchips, enabling fault detection and chip security assessment using Nitrogen Vacancy (NV) centers in diamond. A key focus is enhancing the per-pixel sensitivity of the magnetic field microscope. Another goal will be implementation of AC sensing in widefield.

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Project Investigator: Prof. Ashwin A. Seshia

Title of the project: **MEMS-based gas and flow sensors**

Desired specialization: EE 5 (Electronic Systems), EE 7 (Solid State Devices)

*Abstract of the project:*

This project will explore nanofabrication processes, device design and associated modeling, characterization, and the construction of MEMS-based sensor systems. Applications include chemical sensors (gases, other analytes), and physical sensors (flow, pressure). Multiple transduction modalities will be investigated including electrochemical, resistive, and gravimetric, based on a micro-hot plate platform. The project will involve aspects that are more device/process oriented involving exploring the integration of new materials into a platform technology (EE-7) in the IITB Nanofabrication facility, and separately that are packaging/system oriented involving the design of suitable packages for gas, flow, and other MEMS sensors (both at the die and wafer levels) and associated interface electronics and data processing (EE-5/7).

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Project Investigator: Prof. Ashwin A. Seshia

Title of the project: **Reliability Physics of Vibrating and Impacting Nonlinear Microelectromechanical Devices**

Desired specialization: EE 5 (Electronic Systems), EE 7 (Solid State Devices)

*Abstract of the project:*

This project seeks to develop design-linked reliability models for MEMS devices such as resonators and switches operating under extreme nonlinear regimes and operational regimes resulting in continuous impact between surfaces.

One or more of the following objectives will be addressed:

- reliability models for vibrating and impacting nonlinear MEMS devices;
- design approaches to circumvent limitations imposed including leveraging nonlinearities to address improved performance or new functionality;
- material/nanofabrication process enhancements to address reliability limitations towards the innovation of new classes of nonlinear MEMS that overcome current technological constraints;
- experimental validation of associated reliability models and distilling the generated insight towards optimization of MEMS design.

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Project Investigator: Profs. Kumar Appaiah, Sibi Raj Pillai, Sharayu Moharir

Title of the project: **Intelligent Spectrum Innovation**

Desired specialization: EE 1 (Communication & Signal Processing)

*Abstract of the project:*

Synergistic integration of cutting-edge wireless technologies, including Cell-free MIMO, Beam Sweeping, Reconfigurable Intelligent Surfaces (RIS), Semantic-Aware Collaborative Sensing, Mobile Edge Computing (MEC), Multi-Agent Systems.

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Project Investigator: Prof. Shiladri Chakraborty

Title of the project: **Multi-functional wireless charger for LEVs with minimal on-board power electronics**

Desired specialization: EE 3 (Power Electronics & Power Systems)

*Abstract of the project:*

Power converters in EVs, viz., the main battery charger, auxiliary power, and the traction inverter, are typically implemented as distinct units. Integrating them into a single multi-port, power electronic interface can offer significant weight, size, and cost benefits. This project aims to design and demonstrate a high-power integrated charger for 48 V EVs featuring minimal on-board power electronics (resulting in reduction in vehicle weight), > 90 % efficiency at 15 cm air-gap for feasible variation of coupling, along with exploring the scope for integration of DC-DC converter (resulting in further BOM and cost reduction). This project is sponsored by ANRF under the MAHA-EV mission and co-sponsored by a prominent Indian EV 2-wheeler OEM as industry partner.

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Project Investigator: Prof. Shiladri Chakraborty

Title of the project: **GaN based DC-DC converters for next-generation EV power electronic subsystems**

Desired specialization: EE 3 (Power Electronics & Power Systems)

*Abstract of the project:*

Power electronics converters play a vital role in EV power systems, and the use of Wide-Bandgap (WBG) devices, such as Gallium Nitride (GaN), enhances power density, efficiency, and cost-effectiveness. This project focuses on developing high-performance GaN-based DC-DC converters for auxiliary power modules (APMs) and on-board chargers (OBCs), ensuring reliable bidirectional power flow and high-frequency operation for compact, efficient designs.

The objectives are:

1. Evaluate existing GaN-based DC-DC converter solutions.
2. Develop cost-effective GaN-based converter topologies.
3. Design and implement robust control strategies for efficiency and stability.
4. Investigate high-frequency magnetics and gate-driver designs for optimal performance.
5. Create teaching-learning resources and kits for academic use.

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Project Investigator: Prof. Shiladri Chakraborty

Title of the project: **Design and Implementation of Modular High-power Off-board Chargers for Two-Wheeler /Three-Wheeler Application**

Desired specialization: EE 3 (Power Electronics & Power Systems)

*Abstract of the project:*

Increasing EV adoption requires low-cost, fast off-board chargers compatible with multiple LEV voltages (48 V–120 V). This project aims to develop modular chargers to serve both 2- and 3-wheelers efficiently. Key differentiators of the proposed technical approach are the development of energy-storage/electrolytic, capacitor-less, and systematic evaluation of topologies considering wide fleet battery voltage variation and fleet distribution. The project is sponsored by ANRF under the MAHA-EV mission and co-sponsored by a prominent Indian tier-1 power electronic subsystem supplier for automotive and solar applications.

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Project Investigator: Prof. Rahul Singh

Title of the project: **RF/Analog IC Design for Various Applications (Wireless, Quantum etc)**

Desired specialization: EE 5 (Electronic Systems), EE 6 (Integrated Circuit & Systems)

*Abstract of the project:*

Designing and testing complex integrated circuits (high-frequency, analog, digital/mixed-signal calibration). Candidates are expected to have good academic standing and a strong inclination to design, build and prototype analog/RF circuits/subsystems.

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Project Investigator: Prof. Prasanna Chaporkar

Title of the project: **Sustainable 6G: AI/ML techniques for Energy-aware and Intelligent Wireless Networks)**

Desired specialization: EE 1 (Communication & Signal Processing)

*Abstract of the project:*

We propose to build an energy-aware 6G system using AI/ML to automate network design and control. The solution aims to reduce energy consumption and enhance network efficiency by integrating AI/ML based network management for both RAN and Core network functions.

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Project Investigator: Prof. Prasanna Chaporkar

Title of the project: **Core Network for 6G and Beyond**

Desired specialization: EE 1 (Communication & Signal Processing)

*Abstract of the project:*

The research activities are focused on designing a modular, scalable, and flexible core network for the 6G system. The project is likely to facilitate early IPR and technology development for the 6G system in the country and may also enable us to make significant contributions to global 6G standards.

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Project Investigator: Prof. Anwesha Mukhopadhyay

Title of the project: **Design and Development of Wireless Charging Setup for UAV**

Desired specialization: EE 3 (Power Electronics & Power Systems)

*Abstract of the project:*

Unmanned Aerial Vehicles (UAVs) are increasingly used in surveillance, disaster response, and time-critical missions, but their operational endurance is limited by battery capacity and strict payload-to-weight constraints. Increasing battery capacity adds weight and raises power consumption, making frequent opportunity charging a more practical solution. Wireless charging enables automated charging without physical connectors and is particularly suitable for remote deployments such as telecom towers or lighting masts, potentially powered by solar energy.

This project aims to develop a high-power, lightweight wireless charging system for UAVs to enable fast and automated opportunity charging. The work focuses on the design of a 1 kW GaN-based high-frequency inverter operating in the 100 kHz–1 MHz range and the optimization of coil and converter architectures to minimize receiver weight. Key research aspects include converter topology selection, high-frequency operation, passive component and thermal optimization, coil design considering misalignment, and evaluation of control strategies from transmitter and receiver sides.

The project targets a gravimetric power density exceeding 5 W/g for a 250 W receiver prototype, scalable toward 1 kW operation. The proposed research will contribute to enabling efficient, lightweight wireless charging solutions that extend UAV flight endurance in remote and mission-critical applications.

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Project Investigator: Prof. Chetupalli Srikanth Raj

Title of the project: **Audio Source Separation and Extraction**

Desired specialization: EE 1 (Communication & Signal Processing)

*Abstract of the project:*

Audio source separation, the task of separating individual source signals from a recording of an acoustic scene containing multiple sources, is an important problem in machine audition, with interesting applications in multimedia, communications, and entertainment. A closely related task is that of extracting a specific source from the audio mixture, guided by an additional cue such as a text description. This project explores the application of modern machine learning methods and generative AI methods for general audio understanding and audio source separation/extraction using multimodal conditioning.

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Project Investigator: Prof. Anirban Sarkar

Title of the project: **Development of Advanced Phased Array Antenna System for Satcom on the Move Communication (C/Ku/Ka band)**

Desired specialization: EE 1 (Communication & Signal Processing), EE 6 (Integrated Circuit & Systems)

*Abstract of the project:*

This proposal outlines the development of an advanced phased array communication system for different Variants at C-band (4-8 GHz), Ku-band (10.7-14.5 GHz) and Ka-band (17.5-31 GHz) frequencies achieving unprecedented  $0.05^\circ$  beam pointing accuracy both in azimuth and elevation plane with sub-microsecond switching capabilities. The system delivers superior performance compared to existing global competitors while maintaining cost-effectiveness for Indian market penetration.

The proposed system will establish India's technological leadership in precision SATCOM arrays, offering 10x better beam accuracy than current market leaders at competitive pricing. With applications spanning defense, commercial SATCOM, and export markets, this development will create significant import substitution opportunities while positioning India as a global technology provider in the critical phased array antenna domain.

This document provides a detailed step-by-step developmental plan for the design and commercial realization of Advanced Phased Array Antennas for C-, Ku- and Ka-band communication systems. The timeline spans 18 months and covers antenna design, RF component integration, MMIC chip fabrication, PCB manufacturing, SMT assembly, thermal management, mechanical housing, testing, and validation.

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Project Investigator: Prof. Bhaskaran M

Title of the project: **ML integrated design and testing of single-pixel IR photodetectors for space applications**

Desired specialization: EE 7 (Solid State Devices)

*Abstract of the project:*

IR photodetectors are of great technological importance. They enable night vision, thermal imaging for surveillance, non-contact temperature measurement, autonomous vehicle sensors, and environmental monitoring. This project aims to optimise device design on the state-of-the-art type II superlattice based single pixel devices optimised for fabrication and testing. The project will use a combination of TCAD design with ML integration with active interactions toward single pixel and array fabrication with foundries.

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Project Investigator: Prof. Bhaskaran M

Title of the project: **Design of 2D-devices for single photon detection**

Desired specialization: EE 7 (Solid State Devices)

*Abstract of the project:*

This is a national quantum mission grant on the wafer scale single photon detection for quantum technologies. We will be developing composite computational models integrating ML into quantum transport solvers for facilitating device designs. The work will focus on 2D material based device modeling which includes TCAD, quantum transport based on NEGF and Monte Carlo techniques, and will be performed with close collaboration with cutting edge experiments in the field.

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Project Investigator: Prof. Saravanan Vijayakumaran

Title of the project: **Development of an open-source consent management platform for compliance with the DPDPA Rules 2025**

Desired specialization: EE 1 (Communication & Signal Processing), EE 2 (Control & Computing)

*Abstract of the project:*

On August 11, 2023, the President of India gave his approval for the Digital Personal Data Protection Act (DPDPA) 2023. The DPDPA Rules 2025 came into force in November 2025. It will kickstart a new era where the personal data of Indian citizens will receive significant protections by law. While the DPDPA Rules specify the roles and responsibilities of the data principals (owners of the data) and data fiduciaries (processors of the data), there remain significant challenges in implementation. The project goal is to design and implement an open-source consent management platform which will enable data principals to give, manage, review and withdraw their consent through an accessible, transparent and interoperable platform.

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Project Investigator: Prof. Jayanta Mukherjee

Title of the project: **High Efficiency Power Amplifier Design**

Desired specialization: EE 1 (Communication & Signal Processing), EE 6 (Integrated Circuit & Systems)

*Abstract of the project:*

This project explores the use of source-side higher-order impedance matching to improve the linearity of high-efficiency RF power amplifiers operating in the 2–6 GHz frequency range, which is relevant for many modern wireless communication systems. The work focuses on amplifier modes

such as Class F<sup>-1</sup>, Class X, and Class E, as well as possible hybrid combinations of these classes. The project investigates how higher-order matching networks implemented at the source side can shape harmonic impedances and influence the voltage and current waveforms of the active device. By properly controlling these harmonic components, the design aims to reduce distortion and enhance linearity while maintaining high efficiency. The design and analysis will be carried out using RF simulation tools such as Keysight Advanced Design System (ADS), enabling harmonic balance simulations, load/source pull analysis, and waveform optimization to evaluate performance improvements in linearity, efficiency, and harmonic suppression.

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Project Investigator: Prof. Siddharth Tallur

Title of the project: **Long term structural health monitoring (LT-SHM) systems for sustainable built environment**

Desired specialization: EE 1 (Communication & Signal Processing), EE 2 (Control & Computing), EE 3 (Power Electronics & Power Systems), EE 5 (Electronic Systems), EE 6 (Integrated Circuit & Systems), EE 7 (Solid State Devices)

*Abstract of the project:*

Conventional structural health monitoring (SHM) schemes are implemented after an asset (e.g. bridge, dam, building etc.) is constructed. Most of the structural problems originate during the construction stage due to construction flaws and deficiencies owing to the manual nature of the process. However, there is no tool for monitoring quality of construction in real-time while an asset is being constructed. Incorporating SHM right at construction stage using novel low-power sensors, AI and IoT is a powerful idea to fill this gap. But there are several challenges at present that limit its effective implementation: real-time data synchronization with planning systems, interoperability, managing massive sensor datasets, high sensor costs, lack of industry standards, skill gaps, and limited AI explainability, slowing adoption from construction through the operational lifecycle. In the longer run, this leads to wastage due to inefficient use of resources, increased repair and maintenance costs, and reduced service life of assets. The objectives of this research are to integrate ultra-low power sensors and SHM systems with conventional planning systems to provide real-time structural health insights from construction onward, enabling early detection of risks and enhancing safety, and develop a Digital Twin framework using IoT and edge-AI for predictive analytics, optimized maintenance, cost reduction, and extended asset lifespan.

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Project Investigator: Prof. Siddharth Tallur

Title of the project: **Precision, stable, low-noise electronic systems for quantum sensing**

Desired specialization: EE 1 (Communication & Signal Processing), EE 2 (Control & Computing), EE 3 (Power Electronics & Power Systems), EE 5 (Electronic Systems), EE 6 (Integrated Circuit & Systems), EE 7 (Solid State Devices)

*Abstract of the project:*

Conventional structural health monitoring (SHM) schemes are implemented after an asset (e.g. This proposed PhD research focuses on the development of electronic systems for quantum sensors, with a specific emphasis on nitrogen-vacancy (NV) centers in diamond for high-resolution magnetic field sensing. The primary objective is to design and implement board-level electronics, integrating innovative transduction and control schemes that enhance the performance of NV-based quantum sensors, to sub-pT/rt-Hz sensitivity magnetometry.

The research will explore novel approaches to optimize signal acquisition and processing, improve noise reduction, and ensure robust control of quantum states in NV centers. By developing advanced control electronics and employing state-of-the-art hardware, the work aims to improve sensitivity, bandwidth, and stability in quantum magnetic sensing systems. The outcomes of this research will potentially contribute to applications ranging from biomedical imaging and material characterization to navigation and geophysics, pushing the boundaries of quantum sensing technology.

Candidates interested in this project are suggested to contact Prof. Tallur and discuss their interests.

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Project Investigator: Prof. Sandip Mondal

Title of the project: **Design and fabrication of multi-level Charge Trapping Memory Devices**

Desired specialization: EE 5 (Electronic Systems), EE 6 (Integrated Circuit & Systems), EE 7 (Solid State Devices)

*Abstract of the project:*

Advanced semiconductor memory technology has revolutionary effects in our daily life. When using advanced computational systems, cameras or solid-state memory devices, a large number of electrons interact in a tiny pocket located inside the semiconductor. The field of advanced semiconductor memory technology has rapidly expanded towards developing low-cost, large area and low-power highly efficient consumer electronics such as transparent, stretchable and even biodegradable systems. This brings in an experimental challenge to understand the fundamental behavior of electrons in novel semiconducting quantum materials and devices. In this project, we will fabricate the most typical architecture of multilevel semiconductor memory devices to observe electronic charge storage in non-volatile quantum memory devices. Following that, we will probe the memory states in the quantum materials by program and erase operations in a micro time scale using an advanced ultra-fast capacitance-voltage measurement system. Finally, the experimental challenge of fabricating a large area of semiconductor quantum memory devices will be performed as a future direction of the project.

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Project Investigator: Prof. Apurba Laha

Title of the project: **Design, Fabrication, and Characterization of Ultra-High-Frequency, High-Q Sezawa-Mode Resonators Using Scandium-Doped Aluminum Nitride ( $\text{Al}_{0.8}\text{Sc}_{0.2}\text{N}$ ) on Polycrystalline Diamond with Integrated Phononic Crystal Reflectors for 6G RF Front-Ends and Harsh-Environment Sensing**

Desired specialization: EE 7 (Solid State Devices)

*Abstract of the project:*

The project focuses on the design, fabrication, and characterization of ultra-high-frequency Sezawa-mode resonators using 20% scandium-doped aluminum nitride ( $\text{Al}_{0.8}\text{Sc}_{0.2}\text{N}$ ) thin films on single-crystal diamond substrates.

By integrating phononic crystal reflectors, the work aims to achieve record-high quality factors ( $Q > 10,000$ ) and electromechanical coupling ( $k^2_{\text{eff}} > 25\%$ ) at 8–15 GHz — performances currently unattainable with conventional SAW/BAW technologies.

The research comprises 3D multiphysics modelling, advanced thin-film growth using Plasma Assisted Molecular Beam Epitaxy (PAMBE) and Sputtering, sub-200 nm e-beam lithography, and

comprehensive RF/optical characterization under harsh conditions (high temperature, pressure, and radiation).

Successful outcomes will produce 6G sub-THz front-ends and wireless sensors in aerospace, geothermal, and nuclear environments.

This project offers exceptional opportunities for high-impact publications (Nature Electronics, Advanced Materials, IEEE Trans. UFFC), patents, and international collaborations.

If you are passionate about RF-MEMS, piezoelectric materials, and cutting-edge nanofabrication, this is your chance to work on a truly transformative and multidisciplinary PhD topic at the frontier of acoustic wave engineering..

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Project Investigator: Prof. Bikash Kumar Dey

Title of the project: **Finite blocklength communication rates of channels**

Desired specialization: EE 1 (Communication & Signal Processing)

*Abstract of the project:*

Practical communication systems use finite blocks or packets. Shannon's work on information theory initiated the study of asymptotic rates, i.e., the rates at which we can communicate over channels as the packet length approaches infinity. While this line of work dominated information theory research for several decades, a new line of research has emerged in recent times, focusing on coding rates for finite blocklength. This project will study coding rates in the finite blocklength regime for certain communication problems.

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Project Investigator: Prof. Bikash Kumar Dey

Title of the project: **Coding with privacy**

Desired specialization: EE 1 (Communication & Signal Processing)

*Abstract of the project:*

Coding for detecting and correcting errors is a classical problem, which is relevant in any communication system. In addition, in many communication systems with multiple involved parties, various information also needs to be kept secret from unintended parties. This project will study such problems. The project will use ideas and tools from information theory and coding theory. The applicant should be good in mathematics.

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Project Investigator: Prof. Anupama Kowli

Title of the project: **Impact Assessment (E-RIDES)**

Desired specialization: EE 1 (Communication & Signal Processing), EE 2 (Control & Computing), EE 3 (Power Electronics & Power Systems)

*Abstract of the project:*

India has committed to ambitious EV targets that are motivated by the goal of GHG emissions reduction, but also to achieve the co-benefit of air quality improvement and domestic EV industry development. This project proposes to study the state-level CO<sub>2</sub> and air pollution impacts from

ICEV-to-EV transition in India across transport, power, and industry sectors. This cross-sectoral analysis would allow an assessment of the emission impacts of both EV adoption and manufacturing. The aim is to provide an assessment of the regional linkages between the benefits and co-benefits of EV development in the country. This research can guide policy-making for energy transitions by identifying the locations (states), and magnitude of benefits from EV development, and also highlighting the locations that are likely to accrue minimal benefits or lose out because of the transitions to EVs. The student will work on data curation and modelling.

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Project Investigator: Prof. Udayan Ganguly

Title of the project: **Neural Networks Hardware - Efficient Models for Speech & Vision (Spiking & Non Spiking)**

Desired specialization: EE 1 (Communication & Signal Processing), EE 2 (Control & Computing)

*Abstract of the project:*

1. Speech processing Neural Network Algorithms – 1 position

For this role, we will focus on the edge AI applications using neural network algorithms for spoken word recognition, denoising, speaker recognition, time series prediction and control.

The member will develop expertise in Deep Neural Network to Spiking Deep Neural Network conversion, time series processing (e.g. LSTMs, RNNs), energy-efficient data encoding and model development, model compaction, reservoir computing, etc.

2. Vision processing Neural Network Algorithms – 1 position

For this role, we will focus on Edge AI-based vision processing for drones and space applications where energy and data efficiency are paramount.

Team: You will be working in a cross disciplinary team of Algorithms, IC Designers (AMS) and Device Engineers to build neural network chips

For more info: <https://nanomemorylogic.wordpress.com/algorithms/>

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Project Investigator: Prof. Udayan Ganguly

Title of the project: **Neural Networks Analog Mixed Signal IC Design (Spiking & Non Spiking)**

Desired specialization: EE 5 (Electronic Systems), EE 6 (Integrated Circuit & Systems)

*Abstract of the project:*

We are building neuronal circuits on silicon for ultra-low power Edge AI accelerators.

For more info: <https://nanomemorylogic.wordpress.com/systems/>

<https://nanomemorylogic.wordpress.com/circuits/>

We are looking for IC Design & Electronic System enthusiasts as PhD students. The prospective members must be motivated to engineer chips through specification development, IC design, foundry tapeout, test board design, testing, and modeling.

Applicants with a strong background in one or more topics will be attractive – (1) analog mixed signal design, (2) digital design, (3) Verilog/VHDL (4) PCB design & Chip testing. Preference is for Electrical/Electronics, Computer Science or equivalent candidates.

1. Neural Network Chip Design (Analog Mixed Signal) – 1 position

For this role, we will focus on the neural network IC design. The member will develop expertise in advanced IC design tape-out, evaluation board design, testing for neural network chip development.

2. Electronic System Design (Sensor integration with SNN Chip) – 1 position

For this role, we will focus on the system design.

The member will develop expertise to integrate various sensors (microphones, vision cameras, accelerometers) with our AI/SNN chips and evaluation boards.

Team: You will be working in a cross disciplinary team of Algorithms, IC Designers (AMS) and Device Engineers to build neural network chips

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Project Investigator: Prof. Udayan Ganguly

Title of the project: **Devices & Technology - Memory, Synapse, Neurons (Spiking & Non Spiking)**

Desired specialization: EE 7 (Solid State Devices)

*Abstract of the project:*

We are building neurons and synaptic array for efficient edgeAI. The SOI transistor based neuron show tunneling current based low power. Memories like RRAM and Ferroelectric RAM based synapses show compact data storage for synaptic applications.

For more info:

<https://nanomemorylogic.wordpress.com/resistance-ram/>

<https://nanomemorylogic.wordpress.com/circuits/>

Applicants with a strong background in one or more topics will be attractive – (1) device physics, (2) nanofabrication, (3) TCAD, and compact modeling of transistors/memory, (4) materials engineering. Preference is for Electrical/Electronics, Materials/Metallurgy, Physics-trained or equivalent candidates.

1. Device Engineering (Neuron) – 1 position

For this role, we will focus on the neuron. We use quantum tunneling in silicon and Silicon-Germanium transistors at a 45 nm node to build neurons. The member will develop expertise in design, nanofabrication, testing, and modeling these transistors to emulate the neurons.

2. Device Engineering (Synapse) – 1 position

For this role, we will focus on the synapse. We use Resistive Random Access Memories (RRAM), One-Time Programmable (OTP) Memories, and Ferroelectric memories to develop compact, low-power synapses. The member will develop expertise in engineering electron and atomic motion in insulating oxides (e.g. HfO<sub>2</sub>, PrCaMnO, etc.) based devices to enable data storage.

Team: You will be working in a cross disciplinary team of Algorithms, IC Designers (AMS) and Device Engineers to build neural network chips

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Project Investigator: Prof. Virendra Singh

Title of the project: **Security of Futuristic Technology (AI/ML/AR/VR/Quantum Computing)**

Desired specialization: EE 1 (Communication & Signal Processing), EE 2 (Control & Computing), EE 5 (Electronic Systems), EE 6 (Integrated Circuit & Systems)

*Abstract of the project:*

AI for Cryptanalysis of PQC problems: The advent of large-scale quantum computers promises to bring unprecedented computational capabilities, enabling efficient solutions to problems that are intractable for classical computers. While this progress marks a major milestone in computing, it also poses a significant challenge to modern cryptography. To address the challenges posed by quantum computers, NIST initiated the post-quantum cryptography (PQC) standardization process in 2016. The process culminated in selecting several candidate schemes, the majority of which are lattice-based and rely on the hardness of the LWE and the NTRU problem. This project is to develop cryptanalytics technique for PQC problems.

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Project Investigator: Prof. Saurabh Lodha

Title of the project: **2D Photodetectors for Quantum Applications**

Desired specialization: EE 7 (Solid State Devices)

*Abstract of the project:*

We are looking for a PhD candidates to work on developing 2D semiconductor based photodetectors for quantum applications under the national quantum mission. This is an exciting opportunity to contribute to the development of quantum computing and communication with more sensitive optoelectronic devices using 2D semiconductors.

Requirements

Background in materials science, electrical engineering, or physics

Interest in semiconductor devices (fabrication, simulation, characterization) and quantum applications.

Why Apply?

Work with an established, industry-facing group in the field

Access to advanced cleanroom and characterization labs and resources.

Opportunity to contribute to practical, application-driven research.

Some recent examples of our work:

<https://doi.org/10.1002/adfm.202517870>

<https://doi.org/10.1021/acsnano.5c00683>

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Project Investigator: Prof. Saurabh Lodha

Title of the project: **Development of Ga<sub>2</sub>O<sub>3</sub> devices for next generation power electronics**

Desired specialization: EE 7 (Solid State Devices)

*Abstract of the project:*

We are looking for a PhD candidate to work on developing Ga<sub>2</sub>O<sub>3</sub>-based devices for high-power, high-voltage applications. This is an exciting opportunity to contribute to the development of more efficient electric vehicle and power delivery systems through advanced semiconductor research and next-generation power electronics.

### Requirements

Background in materials science, electrical engineering, or physics

Interest in semiconductor devices (fabrication, simulation, characterization) and high-power electronics

### Why Apply?

Work with an established, industry-facing group in the field

Access to advanced cleanroom and characterization labs and resources.

Opportunity to contribute to practical, application-driven research.

To learn more about our recent work:

■ <https://doi.org/10.1063/5.0232679>

■ <https://doi.org/10.1063/5.0240375>

■ <https://doi.org/10.1063/5.0214589>

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