Department of Electrical Communication Engineering

Indian Institute of Science, Bangalore

List of Open Positions for Research Admission, August 2022

The following are the open positions with different faculty members of the department.

Communications	
Faculty Name:	**A Chockalingam**
Research Project Title	(as below) (PhD/MTech Res)
Brief Description	
Our current research focus is on 1) robust modulation schemes for high-Doppler channels (e.g., OTFS modulation - Orthogonal Time Frequency Space modulation) suited for emerging use cases in 6G and beyond, 2) deep learning for wireless communications PHY layer design, 3) reconfigurable intelligent surfaces (RIS) aided wireless transceiver design, and 4) Joint communication and radar sensing in autonomous vehicles.	
Faculty Name:	**Sudhan Majhi**
Research Project Title	Digital twin for rate splitting, channel estimation, and intelligent software-defined radio (SDR) for Intelligent reflecting surface communication (IRS) (PhD/MTech Res)
Brief Description	
In this project rate spitting prediction, channel estimation, channel coding and selection of other signal parameters will be carried out at the transmitter based on the digital twin. Then Intelligent SDR will be implemented at the receiver of IRS assisted system for 6G and beyond wireless communications. In this work, along with statistical estimation and detection, machine learning (ML)/distributed machine learning also will be used. After the theoretical studies, the work will be validated by a practical RF testbed. Students joining this project will have the option to choose a joint PhD degree with NTU Singapore (https://rb.gy/xrpos2)/ The University of Melbourne (https://rb.gy/4kuz68).	
Faculty Name:	**Chandra R Murthy**
Research Project Title	(as below) (PhD/MTech Res)
Brief Description	
The research at the SPC lab revolves around two main topics: 5G and beyond communications and sparse signal processing. In the area of 5G and beyond (and 6G) communications, we are developing novel waveforms for communication in harsh environments, new protocols and analyses for massive machine-type communications, intelligent reflecting surface-aided communications, and cell-free communications. In the area of sparse signal recovery, we are looking at new algorithms, analyses, and applications of sparse signal recovery in a wide variety of areas including feedback control systems, cognitive neuroscience, and wireless communications.	
Faculty Name:	**Navin Kashyap**
Research Project Title	(as below) (PhD/MTech Res)
Brief Description	
I am offering two PhD projects in the area of coding and information theory. One is in the application area of codes for secure DNA-based data storage, and the other is in the application area of error-correcting codes for quantum communication and computation. Both these application areas are hot emerging areas of research. Here is a YouTube link to a talk on DNA-based data storage by a leading researcher from Microsoft Research: https://www.youtube.com/watch?v=6rsr9IMo7-4 Wikipedia article on quantum error-correction: https://en.wikipedia.org/wiki/Quantum_error_correction The only pre-requisite for these projects is a strong background in linear algebra and probability theory. For the DNA-based storage project, some recollection of the structure of DNA molecules from high-school biology will be useful. Any other background needed for the projects will be provided by relevant courses and papers.	
Faculty Name:	**B. Sundar Rajan**
Research Project Title	(as below) (PhD/MTech Res)
Brief Description	
The current research interest is in the following four areas: (1) Cache-Aided Communication, (2) Private Information Retrieval, (3) Private Information Delivery and (4) Broadcasting for Content Delivery Networks. The open problems and the results obtained by the current students are best described by the recent papers published which can be seen in the homepage: https://ece.iisc.ac.in/~bsrajan/Publications.html	

Faculty Name:	**Neelesh B Mehta**
Research Project Title	(as below) (PhD/MTech Res)
Brief Description	
Work on 5G and beyond wireless communication systems. Involves doing challenging work on the design, modeling, performance analysis, and optimization of wireless systems.	
Networks & Control for Communications	
Faculty Name:	**Parimal Parag**
Research Project Title	(as below) (PhD/MTech Res)
Brief Description	
1. Distributed trust systems: When there is no single trusted party, distributed nodes have to reach a consensus for the network to accept a transaction. Popular examples for such systems are distributed ledger, cryptocurrencies, etc. We are interested in the modelling, design, and performance analysis of such systems. This is a collaborative project. 2. Data centre networks (DCN): Unlike Internet, DCN is a controlled infrastructure, and we are interested in telemetry and data driven control of DCNs to reduce congestion events and detect and repair faults. This includes developing theoretical tools for process estimation, sampling, flow control, load balancing, and their implementation in DCN testbed. This is a sponsored project from centre for networked intelligence at IISc. 3. Data driven load balancing: Scheduling and load balancing techniques are well studied when the model parameters are known. In many scenarios, these parameters are unknown or varying over time. For such cases, we are interested in data driven load balancing and scheduling strategies, with proven performance guarantees. This is a sponsored project from centre for networked intelligence at IISc.	
Faculty Name:	**Rahul Singh**
Research Project Title	Machine learning, Reinforcement Learning and Networks. (PhD/MTech Res)
Brief Description	
Theoretical research in the fields of machine learning, stochastic control, sequential decision making, reinforcement learning and networks. Work will involve various theoretical tools from probability theory, optimization, dynamical systems, etc, knowledge of which can be built by taking courses offered at IISc. Work will also involve testing the algorithms developed on real-world datasets and real-world problems.	
Faculty Name:	**Vaibhav Katewa**
Research Project Title	(as below) (PhD/MTech Res)
Brief Description	
The students will work in the broad area of Cyber-Physical Systems and Networked Control Systems. The project will be interdisciplinary in nature and require tools and techniques from communication theory, control theory, signal processing, optimization, AI/ML etc. The project will be mathematically involved and requires good background in linear algebra, probability, calculus etc, which can be built by taking courses at IISc. There will be experimental opportunities to implement the algorithms on drones and ground robots. For more details regarding the research and list of publications, visit my webpage - https://cps.iisc.ac.in/faculty/vaibhav/	
Signal Processing, Data Science, and Machine Learning	
Faculty Name:	**Rajesh Sundaresan**
Research Project Title	All projects are related to the theory and practice of data science and engineering (PhD/MTech Res)
Brief Description	
1. Safe, secure, and privacy preserving methods of data sharing 2. Scalable methods for biometric data de-duplication and universal authentication 3. Natural language processing and data mining with applications to computational epidemiology and rare disease identification The student should have a good mathematical foundation and a keen interest to develop practical tools. Prior experience in the above topics is not a prerequisite.	
Faculty Name:	**Prathosh A.P.**
Research Project Title	Our lab works on the problems of Deep Learning where the goal is to learn meaningful representations for a variety of Machine Learning Tasks. (PhD/MTech Res)
Brief Description	
a. Deep Representation Learning for Generative modelling b. Few and zero shot learning for Medical Images c. Generative Continual Learning d. Domain Adaptation/Generalization for low-resource speech/language tasks e. Curriculum learning for Natural Language Processing f. Class imbalanced Deep Generative and Discriminative models Some of the above projects are in collaboration with leading industry and academic labs. Students should have appetite and desire for deep fundamental and applied research. Strong mathematical foundations and moderate programming skills is a must.	

Faculty Name:	**Rajiv Soundararajan**
Research Project Title	(as below) (PhD/MTech Res)

Brief Description

Blind In-the-Wild Visual Quality Assessment: The goal of this project is to design algorithms for image and video quality assessment by adopting a machine learning approach without any supervision using human opinion scores. We wish to adapt self-supervised deep feature learning approaches to elicit rich quality representations that can be used to predict image/video quality without any supervised post processing modules.

View Synthesis using Neural Radiance Fields: In several virtual reality applications, there is a need to render/synthesize unseen views of a scene using very few known views of a scene. Neural radiance fields is a recent technique that helps render unseen views by learning a neural network. While this approach requires a large number of training views, we wish to explore how to predict the views when very few views are available for training by constraining the solution through depth priors and consistency priors. (This is part of a collaborative project with Qualcomm).

Faculty Name:	**SP Arun**
Research Project Title	Image processing in brains and machines (PhD/MTech Res)

Brief Description

We recognize objects easily every day, but object recognition is in fact a very difficult problem. Even leading computer algorithms do not match human performance today. Object recognition is not easy for the brain either: a series of cortical areas, taking up ~40% of the brain, is dedicated to vision. But we know very little about the code in which the brain represents objects for perception, and about how the brain transforms what we see into what we perceive. How do we crack the code for objects? What are its features and what are its rules?

To gain insight into these questions, we perform three types of experiments in our lab: (1) Behavioral experiments, brain imaging (fMRI) and perturbations (TMS) in humans; (2) Recordings from single neurons from the monkey visual cortex and (3) Computer vision.

In the human experiments, we probe the perceptual representation using behavioral tasks such as visual search or categorization and explore the neural correlates using brain imaging or perturbations. In the monkey experiments, we probe the representation at the level of single neurons in the inferotemporal cortex, an area critical for object recognition. In computer vision experiments, we compare state-of-the-art computer vision algorithms with human performance, and look for ways to improve them through insights from biological vision.

For more information see the homepage of our research group, Vision Lab@IISc

https://sites.google.com/site/visionlabiisc/

Faculty Name:	**Sundeep P Chepuri**
Research Project Title	(as below) (PhD/MTech Res)

Brief Description

1. Machine learning with Graphs: Graph neural networks and graph signal processing offer a variety of techniques to process and analyze datasets by modeling the relationship between underlying entities (represented as nodes) through pairwise interactions (represented as edges). Often interactions are not limited to pairs and are of higher order. Such higher-order structures are modeled via hypergraphs or simplicial complexes. Extending graph signal processing toolbox (e.g., graph convolutions, filters, sampling) to higher-order structures opens up many research questions, which we aim to explore in this project. Further, using these basic building blocks to develop simplicial neural network models for higher-order link prediction, classifying simplicial complexes, and providing theoretical characterization of the discriminative and expressive powers of such simplicial neural networks are interesting and fundamental research directions that we will pursue in this project.

2. Sensing and communications for 6G: Reconfigurable intelligent surfaces (RIS) and integrated sensing and communications (ISAC), and distributed MIMO systems will be an integral part of future wireless and sensing systems. In this research project, the goal is to develop signal processing theory and methods for sensing, communication, and ISAC systems enabled with RIS. These include developing signal processing models, understanding theoretical limits of different RIS architectures for localization and ISAC, and developing optimization techniques for joint sensing and channel estimation, joint design of RIS elements, and transmit precoders. AI/ML methods for wireless communications and sensing will play a prominent role in years to come. We will explore model-based signal processing and data-driven deep learning methods, wherein an important aspect of this research would be to explore and understand model-based AI/ML methods for sensing and communications including their performance analyses and limitations/advantages.

3. Distributed optimization for deep learning: Stochastic gradient methods that solve unconstrained optimization problems are at the heart of training any deep or machine learning model. Whenever training data is not centrally available, machine learning models are trained in a federated setting. In such a setting, the information (e.g., gradients or other model parameters) is exchanged over networks. In this research project, we aim to develop algorithms to solve optimization problems that appear while training deep models in a federated setting and understand their convergence analysis for commonly encountered function classes and constraint sets. Further, we will also develop communication-efficient algorithms that exchange compressed or sparsified information for solving constrained optimization problems again in a federated setting over networks.

You may email at spchepuri@iisc.ac.in for more information on these topics.

NanoElectronics	
Faculty Name:	**Kausik Majumdar**
Research Project Title	(as below) (PhD/MTech Res)
Brief Description	
The student is expected to work on one or more of the following projects. All these projects will require a combination of both theory and experiment. The candidate should have a strong foundation of basic physics, mathematics, and electronics. During the PhD tenure, the student will be trained in the state-of-the-art experimental facility the lab hosts. The nature of the projects will make the student ready to take up both academic and industrial positions at the end of the PhD. To get a feel about the nature of the work, I strongly encourage the candidate to have a quick look at our research publications here: https://ece.iisc.ac.in/~kausikm/publications.html Topics: 1. Design and experimental demonstration of single photon emitter [Application area: quantum communication, quantum processing, enhanced imaging, space] 2. Design and experimental demonstration of high efficiency single photon detector at room temperature in visible and infrared region [Application area: quantum communication, quantum processing, sensing, imaging, space, military] 3. Building hardware for high speed "true" random number generation [Application: security, cryptography] 4. Design and demonstration for light-induced artificial magnetism and spin devices [Application: spin manipulation for low power computing, sensing, artificial magnetism, topological physics] 5. Light-matter interaction in 2D materials and their heterojunction [Application: exciton physics, exotic phenomena, spectroscopy] 6. Transistor scaling down to sub-5 nm [Application: electronics, high speed computation]	
Photonics	
Faculty Name:	**T Srinivas**
Research Project Title	photonic integrated devices (M.Tech. Res. only)
Brief Description	
The research involves analysis, design and experimental realization of photonic integrated devices for application to quantum communication and computing. Silicon on insulator (SoI) and Lithium on Insulator (LNoI) are the technology platforms under consideration. This is a part of IISc Quantum Technology Initiative.	
Computational Electromagnetics	
Faculty Name:	**Dipanjan Gope**
Research Project Title	(as below) (PhD/MTech Res)
Brief Description	
The research will be focused on development of EMC models for ICs. Electromagnetic Compatibility (EMC) is a critical issue affecting design of automotive systems, especially for Electric Vehicles. Today most of this work is done post-prototype. An analysis capability will enable early design solutions. This research will require a strong foundation in Electromagnetics, Coding and Basic hardware design knowledge.	

Kindly note that currently we do not have any open positions in Digital/Analog VLSI, RF/microwave circuits and Antennas. Prospective candidates interested in these areas are advised to approach other departments of IISc for availability of open positions.