INFORMATION ON ECE RESEARCH INTERVIEWS 2021

Congratulations on being selected to be interviewed for admission to the research programme in the ECE Department, IISc. Our department is one among the top ECE departments in the country with faculty members earning their academic credentials from leading universities, often supplemented with rich industry experience. You may visit the Department website for more details.

You would have received a letter from our Admissions Office inviting you to an interview at IISc during 17-21 May, 2021, for admission to our research programme. The intent of my letter to you is to inform you about the interview procedure in our department, so that you can prepare well for it. Due to the prevailing COVID-19 pandemic situation, this year research interviews will be conducted virtually. If you received this letter from the Admissions office, kindly fill additional information using the form below to help us schedule your interview in ECE:
https://forms.gle/rxAbcGWPLLo2QjW7A

Please fill this form as early as possible, latest by 10 AM on 14th May, 2021. A list of Research Areas in which research admissions will be made, are appended below. Kindly note that

1. Please visit the web page for FAQs about these programs (MTech (Res), Ph.D.) and updates about the interview process.
2. There will be no separate written/online test.
3. Several **subtopics** and **names of faculty members** who will be taking research students in these Research Areas are listed below.
4. You are welcome to look up **personal websites** of these faculty members before indicating your preferences of Research sub-topics. It may help to list as may topics as relevant. If you are open for any available topic, please indicate this.
5. We will be able offer of to the MTech (Res) program **only in Research Areas A, B or C**.
6. It is recommended that you choose Probability Theory and Random Processes as one of the areas of basic mathematics for the interview if you wish to be selected for Research Areas A or B.
7. We will be considering you for admission **only to Research area / sub-topics listed here**, during this cycle of interview.
8. Openings may be available in other research topics in subsequent admission cycles. If you are not interested in any of the Areas/sub-topics listed here, and/or do not want to be interviewed in ECE, you **may not fill the google form** above.

The department will send additional information on the schedule and the process of the online home interview to the candidates later. During the interview, candidates will be examined on their analytical ability in **two** of the following areas of basic mathematics:

- Calculus and Differential Equations
- Matrix Analysis and Linear Algebra
- Fourier, Laplace, and z-Transforms
- Probability Theory and Random Processes
- Discrete Mathematics (combinatorics, graphs).

You are required to indicate **two of the above areas** to be tested. The problems posed will not involve lengthy calculations, but will test the basics, and the **ability to think** "on one's feet".

Candidates may also be asked questions on **fundamentals** related to the proposed Research Area (or related) during the interview. These questions will be from topics of undergraduate and/or post-graduate study (as applicable). The nature of questions will be to explore the student's clarity of thought and depth of understanding of the topics, rather than descriptive system level knowledge. The online video technical interview will be about 30 minutes long. Please keep some **white sheets** and **sketch pens** ready to write and show to the interview panel, if needed.

Immediately after the interview, candidates have the option to change the priority order of the departments that they had indicated in their application form.

With best wishes,

CHAIR

List of Research Areas (August 2021 Admissions)

Candidates have to indicate their first and second preferences from the following six research areas (A,B,C,D,E) by entering these preferences in the Google form shared in the email.

A. Communication Theory & Systems

Current research in this area encompasses a broad range of topics covering the theory and practice of communications theory and systems.

Example of research topics include (but are not limited to):

- 5G, 6G, wireless communications, Internet-of-things (IoT), Device-to-device communication, Vehicular communication (V2V and V2X), Multi-user/massive MIMO, OTFS modulation for high-Doppler channels; deep neural networks in wireless communications; Ultra-low latency communications; Massive machine-type communications, Signal processing for communications, Visible light communications; Optical networks

- Reconfigurable intelligent surfaces (RIS), Index modulation classification, Sparse code multiple access (SCMA), Cache-aided Communication.

- Information theory, Coding theory (including codes for DNA-based data storage, Coded caching and network coding), Quantum error-correcting codes, Coding for privacy and secrecy.

We use mathematical tools based on probability and statistics, random processes, linear algebra, real and complex analysis, detection and estimation, etc. It is recommended that candidates on this area choose Probability as one of the mathematics topics for the interview.

Faculty willing to guide PhD: A. Chockalingam, B. Sundar Rajan, Navin Kashyap, Sundeep Chepuri, Neelesh B Mehta. Himanshu Tyagi, Chandra R. Murthy

Faculty willing to guide MTech (Res): Neelesh B. Mehta, A. Chockalingam, Sundeep Chepuri,

B. Networks, Control & Optimization

Current research in this area encompasses a broad range of topics covering the theory and practice of networks optimization and control for communications and beyond.

Example of research topics include (but are not limited to):

- Distributed computing, communication networks (modelling, analysis, optimization and control); communications and network protocols;

- Machine learning, sequential and distributed decision-making and optimization, Network Coding, Content Delivery Networks.

- Hybrid systems, Networked and distributed control, large scale IoT (Internet of Things) test beds, Distributed computing architectures, Robotics, Security and Privacy in CPS

We use mathematical tools based on probability and statistics, random processes, linear algebra, real and complex analysis, detection and estimation, optimization, statistical physics, etc. It is recommended that candidates on this area choose Probability as one of the mathematics topics for the interview.

Faculty willing to guide PhD: Parimal Parag, Rahul Singh, Vaibhav Katewa, Aditya Gopalan, Himanshu Tyagi, B. Sundar Rajan, Rajesh Sundaresan

Faculty willing to guide MTech (Res): Vaibhav Katewa, Rahul Singh, Utpal Mukherji

C. Signal Processing & Machine Learning

Current research in Signal Processing/Machine learning encompasses a broad range of topics covering both classical and modern learning-based techniques for signal, image and video processing. The research approach in this domain includes the design of algorithms for various applications and their theoretical and/or experimental analysis on real world benchmarking datasets.

Some example research topics, classified as techniques and applications, include:

- Techniques: compressive and sparse sensing; Sparse signal processing; Distributed signal processing; Graph signal processing; Distributed computing, deep learning; Convex and non-convex optimization; Federated learning; Machine learning, Deep Representation Learning, Deep Generative Models, Self/Semi-Supervised and Few-shot learning techniques, Statistical estimation and inference, Deep learning in wireless communications; Graph representation learning; Graph neural networks;

- Applications: Internet of Things (IoT); massive machine-type communications; computer vision and virtual reality; image and video quality assessment, compression and restoration; video streaming; Deep learning for HealthCare analytics, clinical image analysis, Caching and coded caching for content delivery networks (CDN).

We use mathematical tools based on matrix theory, stochastic processes, optimization theory, and statistics. The candidates should have basic computer programming skills.

Faculty willing to guide PhD: A. Chockalingam, B. Sundar Rajan, Parimal Parag, Sundeep Chepuri, Rahul Singh, Rajesh Sundaresan, Neelesh B. Mehta, Rajiv Soundararajan, Aditya Gopalan, Chandra R. Murthy

Faculty willing to guide MTech (Res): Neelesh B. Mehta, Rajiv Soundararajan, A. Chockalingam, Sundeep Chepuri, Rahul Singh

D. Microelectronics & Photonics

Research topics currently on offer:

- Nano-transistors with Si, III-V, 2D materials (Graphene, TMD), spintronics, novel memory, CMOS sensors, ultra-low power devices.

- Semiconductor optoelectronic devices, 2D valley-tronics, photodetectors and IR detectors, solar cell, quantum technology

- Photonic integrated circuits, Nano-photonics, Bio-photonics & Microscopy, Quantum Information Technology

Faculty willing to guide PhD: Kausik Majumdar, Varun Raghunathan, T. Srinivas,

Faculty willing to guide MTech (Res): **None**

E. RF, Microwaves & Computational Electromagnetics

Research topics currently on offer:

- Computational electromagnetics, Solutions to Maxwell's equations: finite difference time domain method (FDTD),

- Signal and Power Integrity, EMI/EMC for high frequency circuits

- Beam steering antenna arrays and intelligent reflecting surfaces (IRS) for 5G and beyond, Space-time controlled metasurfaces, MIMO Radars

- Near-field Modelling and measurement for antennas, Implantable and Wearable antennas for biomedical devices, Wireless power transfer

Faculty willing to guide PhD: Dipanjan Gope, Debdeep Sarkar

Faculty willing to guide MTech (Res): **None**