Department of Computational and Data Sciences (CDS)

Indian Institute of Science, Bangalore

Research Admissions Interview Procedure

PhD and MTech (Research) Aug 2020 Cycle

Overview

Research activities at CDS are categorized into two streams: *Computational Science (CD-CP)* and *Computer and Data systems (CD-CS)*. The admissions process is common to both streams.

Candidates shortlisted for the interview will receive an interview call letter email from IISc with the date and the session (forenoon or afternoon) for your interview. You will also receive an email from the CDS department with the time duration for the interview during that session. Students are expected to be available for their entire interview session.

There are two mandatory components during the interview session. At the start of the session, there will be an ***online objective test*** on the HackerEarth platform for 45 minutes. This will have multiple choice and programming questions. This will be followed by an ***oral home interview*** through video conferencing with a panel of CDS faculty using Microsoft Teams or Google Meet. The home interview will last for up to 45 minutes. The performance of the candidate in both the online test and the home interview will contribute to their overall interview marks. The email from the CDS department will have a link to the online test and to the video conference channel. The syllabus for the test and interview are given below.

About 1 week before the interview, the candidates will be sent an email from the CDS department to fill an **online student information Google form**. This must be completed and submitted on time. As part of this, they should choose up to three labs for which they will be considered. These labs are described below.

Online Objective Test on HackerEarth

The online objective and programming test will be conducted using the HackerEarth online platform. Candidates will need a **desktop/laptop with internet connection, Chrome, Firefox or Safari browser, and a webcam**. Candidates will be sent an email with a link to the online test a few days before the interview. The test will be enabled at the start of your interview session. It will last for **45mins** and has to be completed in a single sitting. You will need to create a **free HackerEarth account** to take the test. You MUST use the **same email address** as the one used for your IISc Admissions Application. Please do this ahead of time.

That email will also have another link to let you take a **practice test**, to test your browser and webcam, and get familiar with the programming interface. These practice questions are not from the same syllabus. Candidates may take the practice test as many times as they want. Candidates should get familiar with the programming IDE, compilation and testing interface of HackerEarth to ensure that the programming questions are attempted properly.

The online objective test will have 7 questions, each carrying 5 points. There will be 5 multiple choice questions and 2 programming questions. The **topics** for the objective test is from:

- Combinatorics, Linear Algebra/Matrices, Probability and Statistics, Differential Equations, Plotting, data structures and algorithms

The programming languages that you can use are **C, C++** and **Java**. The HackerEarth interface will allow you to type the program, compile it and run test cases, all within the browser. We will provide the basic code template for reading and writing the inputs and outputs for each problem. The candidates should focus on the actual code logic, and brush up on concepts such as `if/then/else` conditions and `for` loops.

Students are encouraged to solve the problems that are comfortable with at first and then move on to more difficult problems.

Home Interview over Video Conference

After finishing the online test, candidates will attend an oral interview over video conference before a CDS faculty committee. We will use either **Microsoft Teams** or **Google Meet**. Details will be provided separately over email with a link to join and a time slot within the interview session.

In the oral interview, you will be questioned on the following basic topics, and on advanced topics that are based on your lab preferences:

Basic Topics: Linear Algebra; Probability & Statistics; Programming, Data Structures, Algorithms; Numerical Methods; Ordinary Differential Equations; Discrete Mathematics. Final year undergraduate level preparation is required.

Advanced Topics: You will be questioned on the topics related to labs selected in the student information Google form. The topics for each lab and the prior training expected are listed below. Candidates choosing a lab must be prepared on *at least one* of the lab-related interview topics.

Note: Most labs give preference to applicants for the Ph.D. program over the M.Tech. program. Some labs may not even take any students for the M.Tech. program. Students with a B.E./B.Tech. degree are also eligible to apply for the Ph.D. program.

Candidates for the Ph.D. program should prepare well on their fundamentals, come with a focus and knowledge of the research areas they would like to target in their PhD, and have clarity on the preferred lab(s) and the kind of work done in them. Review the research topics and the papers from the labs you are interested in. Responses like *"I like a specific area. But I do not know anything about the field and can pick up if admitted"* are not helpful.

B. List of labs that are admitting students

1. Biomolecular Computation Laboratory

Faculty: Debnath Pal

Website*:* *pallab.serc.iisc.ernet.in/lab.php*

Lab description: The focus of Biomolecular Computation Lab is to understand biological function at multiple scales. Towards this goal we work at molecular level and pathway level and develop methods and algorithms to understand biochemical function better. The scope of work spans the areas of genomics, proteomics and metabolomics. We also work on bio-molecules to understand sequence, structure function relationships, their interactions and dynamics. There is opportunity to do research problems in real-life projects in cancer, diabetes, neurodegeneration etc., where intensive bio-computational analysis is required. Students opting for BCL has the opportunity to work in CAD LAB to address hardware acceleration problems in bioinformatics/computational biology applications

Interview topics: Students are expected to have good programming knowledge and a sound understanding in at least one of the basic subjects at the undergraduate level: Math, Physics or Chemistry. Exposure to bioinformatics and computational biology is desirable but not essential.

Prior training: Students from any background with interest in learning biology.

2. Computational Mathematics Group

Faculty: Sashikumaar Ganesan

Website: *http://cds.iisc.ac.in/faculty/sashi/*

Lab description: The research group focuses on the development and advancement of robust numerical (finite element) methods and solver for solving partial differential equations (PDEs) that describe incompressible fluid flows and species concentration and/or energy in complex

systems. The group also works on implementing efficient parallel algorithms for high-performance computing. See the website for complete details.

Interview topics: Numerical Linear Algebra, Numerical Methods, Parallel computing

Prior training: Any degree with prior knowledge on modelling and simulation and strong programming knowledge

3. DREAM:Lab (Distributed systems Research on Emerging Applications & Machines)

Faculty: Yogesh Simmhan

Website: http://cds.iisc.ac.in/faculty/simmhan

Lab Description: Designing and developing Big Data processing and storage platforms, and NoSQL databases; Distributed Graph Algorithms, query engines and frameworks; Scalable software platforms for Cloud, Mobile, Edge computing and Internet of Things (IoT); Leveraging distributed systems for application domains like drones/UAVs, video analytics, genomics and COVID-19.

Interview topics: Operating Systems, Graph Algorithms or Distributed Systems.

Prior training: Students must have a Bachelors' or Masters' degree in Computer Science, Information Technology, Electrical, Electronics and/or Communications. Strong programming, algorithms and systems skills are required. Ph.D. candidates are preferred.

4. FLAME (FLow Analysis and Multi-physics simulations at Extreme-scale) Lab

Faculty: Konduri Aditya

Website: http://cds.iisc.ac.in/faculty/konduriadi/

Lab description: The research group focuses on the simulation and analysis of multi-scale multi-physics fluid flow problems that leverage high performance computing (HPC) platforms. Specifically, the work would involve development of HPC centric numerical methods and algorithms for solving partial differential equations, application of machine learning methods to analyze and model data generated from simulations, and investigation of turbulent flow problems that arise in combustion systems (gas turbine and scramjet engines), high-speed aerodynamics and environmental flows.

Interview topics: Numerical methods, Linear algebra, Probability, Scientific programming, Differential equations, Fluid mechanics (optional), Programming models (optional)

Prior training: Students should have a Bachelors' or Masters' degree in any one of the following areas: Mechanical Engineering, Aerospace Engineering, Chemical Engineering, Computational Engineering, Computational Physics, Applied Mathematics, Scientific computing or similar areas. Ph.D. candidates preferred.

5. MATRIX Lab (Materials-physics & Algorithmic Techniques Research In eXtreme-computing)

Faculty: Phani Motamarri

Website*:* https://sites.google.com/view/matrix-lab/home

Lab description: The research goal is centered around the development of novel mathematical techniques and HPC driven computational algorithms, aimed at pushing the frontiers of current predictive capabilities of computation based design of materials, with a focus on quantum-mechanical modeling of materials. Research at MATRIX lab is highly interdisciplinary and combines core ideas from condensed matter theory, materials science, mechanics of solids, adaptive finite-element methods, numerical methods for large-scale eigenvalue problems, machine learning and a heavy dose of high performance computing (MPI+GPU programming) .

Interview topics: Numerical methods, Linear Algebra, Calculus, Scientific programming, Differential equations, Topics based on student's UG/PG background. (for eg: Solid Mechanics, Quantum Physics, Computational Materials, Finite-element methods, Machine learning concepts)

Prior training: Bachelors' or a Masters' degree in any one of the following areas**:** Mechanical Engineering, Materials Science Engineering, Chemical Engineering, Computational Engineering, Computational Physics, Applied Mathematics, Scientific computing or similar areas. Strong inclination towards parallel programming skills is a big bonus. Ph.D. candidates preferred.

6. Middleware And Runtime Systems (MARS) Lab

Faculty: Sathish Vadhiyar

Website: http://cds.iisc.ac.in/faculty/vss and http://mars.cds.iisc.ac.in

Lab Description: High performance computing (HPC), Parallel computing – middleware, system software, algorithms and applications on large-scale parallel computers and GPUs.

Interview topics: Operating Systems, Graph Algorithms

Prior training: Students must have a Bachelors' or Masters' degree in Computer Science, Information Technology, Electrical, Electronics and/or Communications.

7. QUEST (Quantifying Uncertainty in Engineering, Science and Technology) Lab

Faculty: Deepak Subramani

Website: *http://cds.iisc.ac.in/faculty/deepakns/*

Lab description: We build holistic science-based data-driven computational solutions to complex engineering and environmental problems. Projects available for 2020: Machine Learning for Ocean Modeling, Uncertainty Quantification (in FEM), Nonlinear Optimization (theory-heavy).

Interview topics: Probability, Linear Algebra, Calculus, Programming, Dynamics (Optional), Atmosphere and Ocean Science (Optional Bonus Topic)

Prior training: All UG/PG backgrounds welcome. Must have interest, motivation and commitment to do whatever it takes to complete the required task.

8. Structural Biology & Bio-Computing Lab

Faculty: K. Sekar;

Website: http://cds.iisc.ac.in/faculty/sekar/

Lab description: The research group focuses on solving three-dimensional crystal structures of protein molecules using X-ray crystallography and molecular dynamics simulations. Further, we are also interested in data mining of protein sequences and structures.

Interview topics: General Maths, programming and some knowledge about protein structures and genome sequences.

Prior training: Bachelor's or Master's degree in Biotechnology/Chemistry/Physics with adequate knowledge in general maths and programming.

9. Video Analytics Lab (VAL)

Faculty: R. Venkatesh Babu

Website: http://cds.iisc.ac.in/faculty/venky/ and http://val.cds.iisc.ac.in

Lab Description: Deep Learning for Computer Vision, Representation Learning, Domain Adaptation, Adversarial Learning, Self supervised and unsupervised learning, Object Detection, 3D reconstruction, Crowd and Traffic Analysis.

Interview topics: Signal Processing, Image Processing, Probability and Machine Learning basics.

Prior training: Students must have a Bachelors' or Masters' degree in Computer Science, Information Technology, Electrical, Electronics and/or Communications or in any other closely related areas.

10. Cloud Systems Lab

Faculty: J. Lakshmi

Website: http://www.serc.iisc.ac.in/faculty/jlakshmi and http://www.serc.iisc.ac.in/faculty/jlakshmi/cloud-system-lab

Lab Description: Cloud System Architectures for end-to-end QoS of hosted applications with regard to performance, security, dependability and fault tolerance; virtualization stack for compute, network and storage clouds; Cloud middleware for elasticity, placement optimization, resilience and other QoS properties.

Interview topics: Operating Systems, Distributed Systems, Computer Organization

Prior training: Students must have a Bachelors' or Masters' degree in Computer Science, Information Technology, Electrical, Electronics and/or Communications.

Preference Sheet – Research Admissions Aug 2020 Cycle

Eligibility for labs taking only CS/EE graduates: *B.E./B.Tech. or equivalent degree in Computer Science/Engineering; Information Technology/Science; Electrical, Electronics and/or Communication Engineering; or Master's degree in Computer Science; Computer Application or Electronics. Good programming skills are required.*

- You need to fill this Preference Sheet through an **online Google Form link** you will receive by email from the CDS department.
- Carefully review the Admissions Brochure, the Research Lab descriptions and their websites before filling the Online Form.
- You may choose up to three labs for which you are eligible and rank order them.
- The labs chosen in the Form are binding and cannot be changed later. Your interview questions will be based on the labs you choose.
- Choose the lab(s) whose research areas most closely match your own interests.

1. Name: _____
2. Application No: _____
3. Program *(Select all that apply)*: [ ] Ph.D. [ ] M. Tech. (Research)
   Note: Students with a BE/BTech degree are also eligible to select the Ph.D. program.
4. External Research Program candidate? *(Tick one)* [ ] No [ ] Yes

Rank up to three research labs you are eligible for, using numbers 1, 2 and 3.

[ ] Biomolecular Computation Laboratory [ ] Structural Biology & Bio-Computing Lab [ ] Computational Mathematics Group [ ] QUEST Lab [ ] FLAME Lab [ ] MATRIX Lab	**Labs taking only CS/EE graduates** [ ] Cloud Systems Lab [ ] DREAM Lab [ ] MARS Lab [ ] Video Analytics Lab

I have read and understood the brochure and the instructions before filling in this preference sheet.

Signature: _____ Date: _____ Place: _____

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