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भारतीय विज्ञान संस्थान
बेंगलूर, भारत

Supercomputer Education & Research Centre

www.serc.iisc.ernet.in

SERC Computer Systems (SERC-CS) Stream
Research Admissions Brochure, 2015

Congratulations on being short listed for interview for the Research Program (M.Sc. and Ph.D.) of Supercomputer Education and Research Centre (SERC)'s Computer Systems Stream!

This brochure provides information on the Research Admission process into the Computer Systems Stream (SERC-CS) of SERC for 2015. It describes the research laboratories in SERC-CS which are accepting students this year, and the topics for the written and oral components of the interview. This is an important document, so review it carefully. It will help you be well-prepared for the interview and also get a good sense of your research direction. This will guide you to a good fit between your interests and specific research labs. A *Preference Sheet* at the end of this brochure must be filled and signed by you when you appear for the interview.

A   Research Activities at SERC

Research activities at SERC is broadly categorized into two streams: *Computational Science* and *Computer Systems* with research admissions conducted <u>separately</u> for each stream. Research labs at SERC are placed in one of these two streams.

- **Computer Systems Stream (SERC-CS)** deals with the design, implementation and evaluation of computer hardware and software systems. Prominent research topics in the Computer Systems stream include: Cloud Systems, Computer Aided Design, Computer Architecture, Database Systems, Distributed Systems & Applications, High Performance Computing, Image & Video Analytics, Information Systems & Security, Machine Learning & Natural Language Processing, Middleware & Runtime Systems, and Visualization & Graphics.

- **Computational Science Stream (SERC-CP)** deals with computational methods and their application to scientific domains. This typically requires skills at the intersection of applied mathematics, application-specific knowledge, and effective use of computing platforms. Research in this area include Bio-molecular Computation, Computational Electrodynamics, Computational Photonics, Medical Imaging, Numerical Mathematics, Scientific Computation, and Structural Biology & Bio-Computing. *Refer to the SERC Computational Science (SERC-CP) Research Admissions Brochure, 2015 for more details on this stream.*

Details on specific research labs in the **Computer Systems** stream, their affiliated faculty and websites are provided in Section B.2.

B   Research Interview – Computer Systems Stream

B.1   The Interview Process
The research interview for the Computer Systems stream has two components, both conducted on the same day.

(a) **Written Component** *(Duration: 30 minutes):* A written exam consisting of short answer questions is conducted first to test the candidate's suitability for the research programs at SERC. The questions will be from the following subjects: *Programming in C, Data Structures,*

Algorithms, Discrete Mathematics, Probability and Statistics. The level of preparation expected will be at the <u>final year engineering undergraduate level</u>.

(b) **Oral Interview**: Candidates who are successful in the written component will face an oral interview before a faculty committee. In the oral interview, you will be questioned on:

   i. ***Basic Area Subjects*** for the Computer Systems Stream: *Programming in C, Data Structures, and Algorithms*. Students are expected to be prepared in *all these subjects* for oral examination. The level of preparation expected will be at the <u>final year engineering undergraduate level</u>.

   ii. ***Advanced Subjects*** for the <u>lab(s)</u> you have selected in the Preference Sheet. Advanced Area Subject topics and relevant text books are given in Section B.2.

To identify which of the research activities in SERC matches your interests most closely, please review the research labs and faculty in Section B.2., and their websites. The research lab(s) you choose will decide the Advanced Subject topics you will be questioned on during the oral interview. You may choose either one or two labs; if choosing two, then you <u>must</u> prepared in both labs' Advanced Subjects. You should fill up the Preference Sheet at the end of this document before the interview to indicate your choice of Research Lab(s).

Figure 1 illustrates the flowchart of the Interview process for a successful candidate.

1. Candidates called for the interview submit their *Preference Sheet* on the interview day.
2. Candidates first take the *Written Component*. This will be immediately graded and the results posted.
3. Qualifying candidates in the written interview are invited to attend the *Oral Interview* with the faculty committee right afterwards.
4. In the Oral Interview, candidates are first asked questions in the *Basic Area Subjects*.
5. Following this, based on the *Research Lab(s)* selected, candidates are asked to pick one of the *Advanced Subjects* for the lab and interviewed on it. If two labs are selected, candidates are questioned on one subject from each lab.
6. After the interview of all candidates during the week, the merit list is posted and the admission list is subsequently announced by the Institute. Please refer to the IISc Admissions Website and its "Important Dates" section for more details.
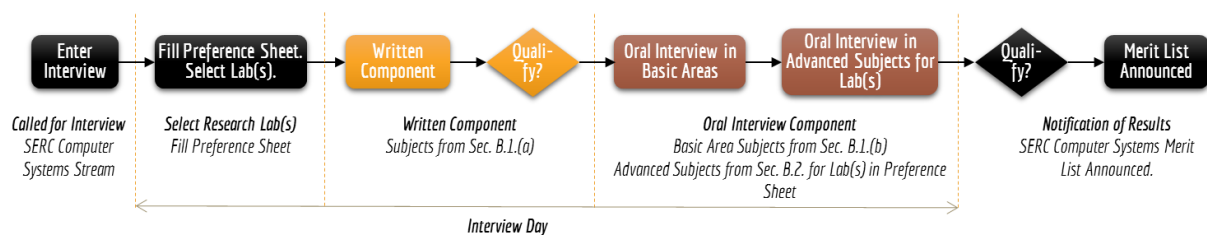

Figure 1. Flowchart of Admissions Process for Successful Candidates

 Note:

- Candidates successful in this interview will be admitted into the Computer Systems Stream (SERC-CS) of the SERC department.
- Candidates with *B.E./B.Tech./M.Sc./MCA* qualification can choose either the M.Sc. (Engineering) *[or]* the Direct Ph.D. program. Candidates with *M.S./M.E./M.Tech.* qualification are only eligible for the Ph.D. program.
- *External Registration Programme (ERP)* candidates will be asked to give a 5 minute oral presentation of their research proposal as part of the oral interview. In addition to the Basic and Advanced interview subjects, these candidates will be also tested on the proposal content. Do not prepare slides for presentation.

B.2   Advanced Area Subjects *(By Lab)*

The list of research labs under the Computer Systems Stream of SERC that are accepting research students this year, along with their affiliated faculty and lab website, are given below. The Advanced Area Subject(s) and topics within them for the oral interview for each lab are also provided. Candidates will have to choose either *one* or *two* of these research labs and prepare for at least *one subject* within each lab.

NOTE: If you are selected for interview with the SERC Computational Science Stream (SERC-CP), refer to the *SERC Computational Science (SERC-CP) Research Admissions Brochure, 2015* for details on the corresponding Labs.

1. **Cloud Systems Lab**
   Faculty: **J. Lakshmi**
   Website: http://www.serc.iisc.ernet.in/~jlakshmi/Research/CloudsandQoS/
   Cloud_Architectures_and_QoS.html
   a. **Subject 1**: Advanced Operating Systems Concepts. Topics: Resource concurrency constructs in OS; Device Interrupts and interrupt handling; I/O devices, abstractions, access control and communication. Text Book: "Advanced concepts in OS", Singhal and Shivaratri.
   b. **Subject 2**: Operating Systems. Topics: Process and disk scheduling; Virtual memory, signals, traps and interrupts, IPC, processor privilege modes, memory mapped files, etc. Text Book: Standard OS book like Tanenbaum, Shilbertshatz.

2. **Computer Architecture Lab**
   Faculty: **Mathew Jacob**
   a. **Subject 1**: Computer Architecture. Topics: Pipelining, ILP Processors, Memory Hierarchy, Cache Coherence and Memory consistency. Text Book: "Computer Architecture", Hennessy and Patterson.

3. **Distributed Research on Emerging Applications & Machines (DREAM) Lab**
   Faculty: **Yogesh Simmhan**
   Website: www.dream-lab.in , serc.iisc.ernet.in/~simmhan

   a. **Subject 1**: Operating Systems. Topics: Process Management, Memory Management, Storage Management. Text Book: "Operating Systems Concepts", Chapters 3-12, Silberschatz, Galvin and Gagne, 7th edition.
   b. **Subject 2**: Distributed Systems. Topics: Remote Procedure Calls (RPC) and Message Oriented Communication; Naming and Directory Services; Logical Clocks and Leader Election Algorithms; Replication and Consistency Models; Distributed 2-Phase and 3-Phase Commit. Text Book: "Distributed Systems: Principles and Paradigms", Tanenbaum and Van Steen, 2nd edition.

4. **High Performance Computing Lab**
   Faculty: **R. Govindarajan**
   Website: hpc.serc.iisc.ernet.in
   a. **Subject 1**: Computer Architecture. Topics: Pipelining, ILP Processors, Memory Hierarchy, Cache Coherence and Memory consistency. Text Book: "Computer Architecture", Hennessy and Patterson.
   b. **Subject 2**: Compilers. Topics: Code Generation, Dataflow Analysis, Optimizations. Text Book: "Compilers, principles, techniques, and tools", Aho, Sethi, Ullman, *(or)* "Advanced Compiler Design and Implementation", S. Muchnick.

5. **Information Systems & Security Lab**
   Faculty: **N. Balakrishnan**
   Website: www.serc.iisc.ernet.in/~balki/Research_grp.htm
   a. **Subject 1**: Graph Algorithms.
   b. **Subject 2**: Machine Learning.

6. **Machine And Language Learning (MALL) Lab**
   Faculty: **Partha Pratim Talukdar**
   Website: www.talukdar.net
   a. **Subject 1**: Machine Learning.
   b. **Subject 2**: Natural Language Processing (NLP).

7. **Middleware And Runtime Systems (MARS) Lab**
   Faculty: **Sathish Vadhiyar**
   Website: www.serc.iisc.ernet.in/~vss , mars.serc.iisc.ernet.in
   a. **Subject 1**: Operating Systems. Topics: CPU scheduling, disk scheduling, virtual memory management.
   b. **Subject 2**: Algorithms. Topics: Graph algorithms, Updates of trees, viz., binary search trees, red-black trees, tries.

8. **Video Analytics Lab**
   Faculty: **Venkatesh Babu**
   Website: val.serc.iisc.ernet.in
   a. **Subject 1**: Digital Image Processing. Topics: Sampling and Quantization, Image transformation, Spatial Filtering, Filtering in frequency domain. Text Book: "Fundamentals of digital image processing", Anil K. Jain *(and)* "Digital Image Processing", R. C. Gonzalez and R. E. Woods.
   b. **Subject 2**: Probability. Topics: Distributions and densities, Random Variables, conditional probability, independence, expectations. Text Book: "Introduction to Probability", Charles M. Grinstead.

9. **Visualization & Graphics Lab**
   Faculty: **Vijay Natarajan**
   Website: vgl.serc.iisc.ernet.in
   a. **Subject 1**: Algorithms. Topics: Graph algorithms, geometric algorithms. Text Book: "Introduction to Algorithms", Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest.
   b. **Subject 2**: Graphics. Topics: Graphics pipeline; Transformations; Shading; Multi-resolution methods; Ray tracing. Text Book: "Interactive Computer Graphics: A top-down approach with OpenG", Edward S. Angel.

Preference Sheet for Research Admissions – Computer Systems Stream (SERC-CS)

Carefully review the brochure and Research Lab descriptions for SERC-CS before filling in this Preference Sheet. Choose the lab(s) whose research areas most closely match your own interests. You may choose up to two labs. You will be tested in the Basic Area Subjects for the Computer Systems Stream and in an Advanced Subject for the lab(s) chosen. Ph.D. students, if admitted, will be placed in the lab(s) chosen here, and this selection is binding.

1. Name: _____

2. Application No: _____

3. Program: *(Tick one)*   [ ] M.Sc. (Engineering) [ ] Direct Ph.D.   [ ] Ph.D.

4. External Research Program Candidate? *(Tick one)* [ ] No   [ ] Yes

5. Select <u>one</u> (or) <u>two</u> of the Research Labs below. This will determine your Advance Area Subjects for the Oral Interview. You should prepare on one Advanced Subject in the lab(s) chosen. During the interview, you may state the subject you have prepared for within the selected lab(s).

[ ] Cloud Systems Lab

[ ] Computer Architecture Lab

[ ] Distributed Research on Emerging Applications & Machines (DREAM) Lab

[ ] High Performance Computing Lab

[ ] Information Systems & Security Lab

[ ] Machine And Language Learning (MALL) Lab

[ ] Middleware & Runtime Systems (MARS) Lab

[ ] Video Analytics Lab

[ ] Visualization & Graphics Lab

I have read and understood the brochure and the instructions before filling in this Preference Sheet.

Signature: _____