First Course Handout

January 2024

Course Title: Parallel Computing (CS633)

Credits: 3-0-0-0 (9)

Lecture Hours: MW 3:30 - 5:00 PM (RM101)

Office Hour: MTW 5:00 - 5:30 PM (KD221)

Prerequisites:

Exposure to CS330 (Operating Systems), CS422 (Computer Architecture) and CS425 (Computer Networks) is desirable. Proficiency in C is strongly desirable.

1 Course Objectives

Parallel programming is ubiquitous in today's multi-core era. Parallel programming is crucial to solving many real-world scientific problems. Massive parallelism entails significant hardware and software challenges. The course is structured so that the participants understand the challenges in efficient execution of large-scale parallel applications. This course will cover topics related to programming on multiple nodes using the message passing interface (MPI) paradigm. The assignments will be designed to strengthen the understanding of parallel programming.

2 Course Content

1. Introduction: Why parallel computing? Amdahl's law, speedup and efficiency.
2. Message passing: MPI basics, point-to-point communication, collective communication, synchronous/asynchronous send/recv, parallel algorithms for collectives.
3. Parallel communication: Network topologies, network evaluation metrics, communication cost, routing in interconnection networks, process-to-processor mapping.
4. Performance: Scalability, benchmarking, performance modeling, impact of network topologies, parallel code analysis and profiling.
5. Parallel code design: Domain decomposition, communication-to-computation ratio, load balancing, adaptivity, case studies: weather and material simulation codes.

6. Parallel I/O: MPI I/O algorithms, contemporary large-scale I/O architecture, I/O bottlenecks.
7. Supercomputer design: Study of most powerful supercomputers, exascale.
8. Advanced topics from recent research papers.

Approximate estimate of lecture hours may be found in [1].

3 Evaluation Scheme

We'll follow relative grading scheme. The grading policy is shown in Figure 1. The assignments (2–3) will be based on programming in C with MPI, they will have equal weightage. Note that there's weightage for class participation.

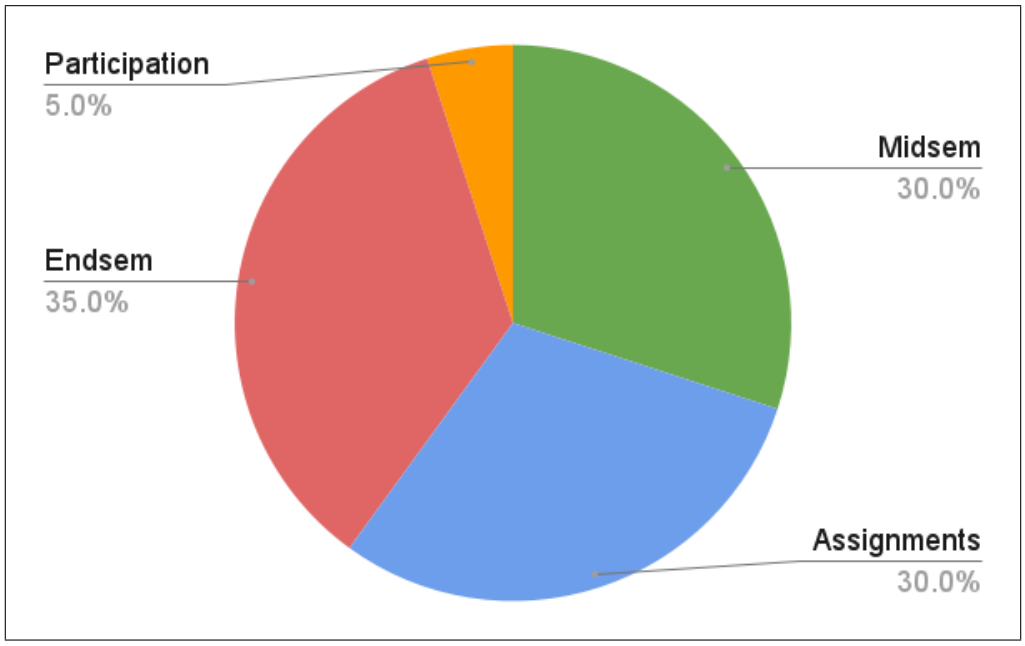

Figure 1: Grading Policy

4 Books/References

1. DE Culler, JP Singh and A Gupta, Parallel Computer Architecture: A Hardware/Software Approach Morgan-Kaufmann, 1998.
2. A Grama, A Gupta, G Karypis, and V Kumar, Introduction to Parallel Computing. 2nd Ed., Addison-Wesley, 2003.
3. Marc Snir, Steve W. Otto, Steven Huss-Lederman, David W. Walker and Jack Dongarra, MPI - The Complete Reference, Second Edition, Volume 1, The MPI Core.
4. William Gropp, Ewing Lusk, Anthony Skjellum, Using MPI: portable parallel programming with the message-passing interface, 3rd Ed., Cambridge MIT Press, 2014.
5. Peter S Pacheco, An Introduction to Parallel Programming, Morgan Kaufmann, 2011.
6. Research papers (will be notified during class).

5 Course Policy

Please refer to the CSE policy on plagiarism [2]. This will be strictly followed. You'll not be allowed to drop the course if you're found to be involved in unfair means. Attendance is not compulsory. However, please refer to Section 3.

References

[1] CS633 Course Content. https://www.cse.iitk.ac.in/pages/CS633.html. Accessed: 2023-01-04.

[2] CSE Plagiarism Policy. https://www.cse.iitk.ac.in/pages/AntiCheatingPolicy.html. Accessed: 2023-01-04.