ID5130: Parallel Scientific Computing

Instructor

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Teaching assistants

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General information

- 10 credit course
- 3 lectures and 1 lab-hour per week in 'F' slot
  - Tuesday 17:00 – 17:50
  - Wednesday 11:00 – 11:50
  - Thursday 9:00 – 9:50
  - Friday 8:00 – 8:50
  - Venue: CRC 103
- Announcements via moodle: https://coursesnew.iitm.ac.in/course/view.php?id=4565

Learning outcomes

- To learn parallel programming using distributed-memory, shared-memory and graphics processing unit (GPU) based systems.
- To understand and implement numerical methods to be run using parallel environments.

Syllabus

1. **Introduction (1 week)**: Motivation and need for parallelization, Examples and applications in scientific computing, Parallel programming paradigms, Terminology.
2. **OpenMP programming (2 weeks)**: Basics, scope of variables, parallel loop directives, scheduling, critical directives.
3. **Numerical Methods using OpenMP (2 weeks)**: Numerical integration, explicit and implicit finite-differences, solution of system of linear equations, solution of partial differential equations.
4. **MPI Programming (2 weeks)**: Basics, point-to-point and collective communication, MPI derived data types, performance evaluation, advanced function calls, performance analysis.
5. **Numerical Methods using MPI (3 weeks)**: The same applications as for OpenMP.
6. **OpenACC Programming (1 week)**: Motivation, Compute Constructs (Kernel, Parallel, Loop, Routine), Data Directives, Reductions, Atomics, Data Transfers, Asynchronous Processing, Multi-Device Programming.

7. **Numerical Methods using OpenACC (3 weeks)**: The same applications as for OpenMP and MPI, with focus on optimizing for GPUs. Time permitting, new topics such as Programming in Julia can be covered

Textbooks

1. An Introduction to Parallel Programming, Peter S. Pacheco, Morgan Kaufmann, 2011
2. Parallel programming in C with MPI and OpenMP, Michael Quinn, McGraw Hill Education, 2017
3. OpenACC for Programmers: Concepts and Strategies, Sunita Chandrasekaran, Guido Juckeland, Addison Wesley, 2017
4. Parallel Scientific Computing in C++ and MPI, George Em Karniadakis, and Robert Kirby II, Cambridge Universities Press, 2003

Reference books

1. Using MPI, William Gropp, Ewing Lusk, Anthony Skjellum, The MIT Press, 2014
2. Using OpenMP, Barbara Chapman, Gabriele Jost, Ruud van der Pas, The MIT Press, 2008

Grading policy

- Number of Assignments: 3
- Average of Assignments: 20%
- Mid-term Exam: 20%
- Final Exam: 40%
- Project: 20%
- Attendance: 100% expected, however, the institute norm is $\geq$ 75% to be eligible to write the final exam.