

HIGH PERFORMANCE SCIENTIFIC COMPUTING

MULTIFACULTY

PRE-REQUISITES : Basic course on programming and applied mathematics

INTENDED AUDIENCE : Researchers, graduate students , postdocs working in the area of computational science.

INDUSTRY SUPPORT : The industries in which this would be useful for is aerospace, automotive, defence, chemical , electrical, materials, biomedical and nuclear industries which employ simulation technologies.

COURSE OUTLINE :

Scientific computing has become an important third axis in the development of science in conjunction with theoretical and experimental studies. The tremendous growth in computing power, especially with high performance computing (HPC) clusters, over the last few decades have opened up opportunities to computationally study phenomena which were earlier beyond reach. Fluid Dynamics, Electromagnetics, Astrophysics, Biology, Finance etc are few of the domains which are greatly aided by scientific computing. There is a dire need to train researchers and graduate students in the effective use and programming practices of these HPC clusters. This course will aim to fill the gap in understanding and use of such systems.

ABOUT INSTRUCTOR :

Prof. Shiva Gopalakrishnan in 2012 joined the Indian Institute of Technology Bombay as a faculty member and currently is an Associate Professor in the Department of Mechanical Engineering at the Indian Institute of Technology Bombay. He obtained his Ph.D from the University of Massachusetts - Amherst and subsequently was a National Research Council Postdoctoral Fellow in the Department of Applied Mathematics at the Naval Postgraduate School, Monterey, California. Shiva Gopalakrishnan has developed a graduate level course on High Performance Scientific Computing. Scientific computing has become an important third axis in the development of science in conjunction with theoretical and experimental studies. The tremendous growth in computing power, especially with high performance computing (HPC) clusters, over the last few decades have opened up opportunities to computationally study phenomena which were earlier beyond reach. Fluid Dynamics, Electromagnetics, Astrophysics, Biology, Finance etc are few of the domains which are greatly aided by scientific computing. There is a dire need to train researchers and graduate students in the effective use and programming practices of these HPC clusters. This course fills the gap in understanding and use of such systems. The curriculum introduces the basics of modern computer architecture, parallel computing machines and parallel programming. It covers an in depth discussion on different parallel programming paradigms and associated techniques for efficient programming and model development. The success of this course is shown in the enrolment which is in excess of 120 students every time it is offered at the Indian Institute of Technology Bombay. In addition this course has been offered in adapted forms at the University of Florida Gainesville and Koc University, Istanbul, Turkey where it was well received.

Prof. Om Jadhav has received his master's degree in Telecom Technology from IIT Delhi. He is working as a Scientist D, at Centre for Development of Advanced Computing, where he is associated with HPC-Technologies team at C-DAC Pune. His areas of expertise include, HPC Application's Optimization and management on HPC clusters along with understanding of parallel programming, distributed computing, and HPC architectures. He is currently working on different projects associated with Research and Development activities in HPC and AI domains.

Prof. Ashish Kuvelkar obtained Mmasters degree in Electrical Engineering from V. J. T. I., Bombay University. He is working as a Scientist G, at Centre for Development of Advanced Computing, where he is associated with HPC-Technologies team at C-DAC Pune. Previously, he worked for Hardware Division of Patni Computers for 9 years. At C-DAC, he has been associated with design of hardware subsystems for various generation of PARAM supercomputers. He also contributes to training activities of Advanced Computing Training School of C-DAC, which conducts Post-Graduate Diploma courses in various specializations. Currently, he is involved in the HPC aware Human Resource development activities of the National Supercomputing Mission.

Prof. Ashish Kuvelkar obtained Mmasters degree in Electrical Engineering from V. J. T. I., Bombay University. He is working as a Scientist G, at Centre for Development of Advanced Computing, where he is associated with HPC-Technologies team at C-DAC Pune. Previously, he worked for Hardware Division of Patni Computers for 9 years. At C-DAC, he has been associated with design of hardware subsystems for various generation of PARAM supercomputers. He also contributes to training activities of Advanced Computing Training School of C-DAC, which conducts Post-Graduate Diploma courses in various specializations. Currently, he is involved in the HPC aware Human Resource development activities of the National Supercomputing Mission.

COURSE PLAN:

- Week 1:** Introduction to high performance computing and scientific computing. The need for HPSC.
- Week 2:** Processor performance. Memory hierarchy. Multi-core processing and Vector computing
- Week 3:** Introduction to parallel programming concepts and parallel algorithms
- Week 4:** Effective use of command line Linux. Bash scripting
- Week 5:** Use of version control systems such as Git/SVN/Mercurial.
- Week 6:** Introduction to OpenMP and thread programming
- Week 7:** Introduction to MPI programming
- Week 8:** Introduction to GPGPU / Vector
- Week 9:** Effective use of debuggers and parallel
- Week 10:** Performance analysis of parallel
- Week 11:** Use of toolkits such as BLAS, LAPACK,
- Week 12:** Advanced scientific visualization.