Computational Methods and Parallel Processing in Science and Technology

20-30th December 2017

Overview

The generic interdisciplinary approach of scientific computing is generally considered to be a main pillar of science and technology, complementary to experiment and theory. To carry out such interdisciplinary approach there is an urgent demand of researchers who are well-trained in scientific computing methods. It is the particular ambition of the emerging research communities to promote the use of computational methods in yet largely unexplored areas such as targeted medicine, cancer therapy, electromagnetics, magnetohydrodynamics, ferrohydrodynamics, naval architecture, aerodynamics, electro-magnetic wave propagation in optical waveguide etc. To meet this demand, the course, computational methods and parallel processing in science and technology, emphasis the state-of-art in contemporary mathematical methods for the problems related to the fluid dynamics with a wide spectrum of industrial applications. The increasingly important role of numerical methods in science and engineering will be addressed. While treating traditional and well-developed topics, the emphasis will be placed on the concepts and ideas of importance to the design of accurate and efficient algorithms with the applications to scientific computing. The course combines the deep understanding of the computational methods and algorithms in Applied Mathematics, the implementation of these methods using modern computer science technology and the application to real-world problems.

Topics will include the simulations of complex physical, biological, and engineering systems, optimization and evaluation of simulation models, scientific visualization and parallel computing on GPU (Graphics Processing Unit). The comparison between the CPU programming and the hardware-oriented GPU programming executed in machines with much larger number of processing cores will be dealt. Implementation of modern GPUs in different parallel applications will be taught to reduce a large amount of computing time. Mathematical techniques including finite-difference, finite-volume, finite-element and particle methods with their accuracy, convergence, and stability of numerical methods; turbulence modeling; Parallel computing and multiphysics modeling will be the major contents of this course. At the end of the course the participants will be able to pursue innovative research work with a strong application-oriented focus anywhere from mathematics, physics and engineering sciences.

Objectives

This course provides training in the application of contemporary mathematics especially the scientific computing in science and technology. Emphasis will be placed on the formulation of problems, on the analytical and numerical techniques for a solution and the computation of results in terms of vector plots, streamlines, vortex tubes, isotherms, magnetic lines. The primary objectives of the course are as follows:

i) Elucidate the fundamentals of scientific computing methods, viz, finite difference, finite element, finite volume and particle methods.

ii) Application of the above methods in solving the Navier-Stokes and Maxwell equations.

iii) Parallel computing on GPU

iv) Specific application of above mentioned methods in the biomedical science, electromagnetic and defence applications.

Modules	**Part A: Scientific Computing Methods** Part I – Introduction to the Scientific Computing and Cardiovascular Simulation (SCCS); Part II – Scientific Computing: Fundamentals of Scientific Computing; Solution of 3D incompressible Navier-Stokes equations using Finite difference method, Finite element method and Particle method; Finite difference method for 3D Maxwell's equations; Parallel computing on Graphics Processing Units (GPUs). **Part B – Applications** Part I – Computational study on (i) modern medicine, (ii) cardiovascular diseases; and (iii) liver tumor ablation; Part II –Computational study on Chinese medicine; Modeling and simulation on moxibustion; Modeling and simulation on acupuncture. Part III – Computational study on electromagnetic. Part IV – Computational study on engineering flows: Simulation of submarine flow; Simulation of car exterior aerodynamics and interior ventilation flow; Simulation of EM wave propagation in 3D optical waveguide. **Number of participants for the course will be limited to fifty.**
You Should Attend If…	• you are engineer or research scientist interested in solving multidiscipline problems. • you are a undergraduate/postgraduate student / researcher / faculty or scientist from technical and academic institutions / from industry interested in learning or do research in solving problems related to modern medicine, elctromagnetics and engineering flows. • you are faculty member from academic institutions involved in teaching and research on interdisciplinary research.
Fees	**Faculty and Scientists**: Rs.4000/-. **Participants from Research Organizations / Industry / Consultancy firms**: Rs.8000/-. **Students and Research Scholars:** Without award of grade: Rs.1000/- ; With award of grade:Rs.2000/-. **Participants from abroad:** Students: USD$100; Other participants from abroad: USD$200. The above fee includes all instructional materials, computer use for tutorials and assignments, free internet facility, with mid-sessions tea & snacks.

The Faculty

Prof. Tony W.H. Sheu from Department of Mathematics, National Taiwan University, Taiwan, is the recipient of the Taiwan-France Science & Technology Award for his work in computational biology. Prof. Sheu has published more than 300 articles related to code development using contemporary computational techniques and its applications in science and technology, ranging from interaction between electrons and atoms to electromagnetic waves. He is an editorial member of Journal of Computational Surgery, Mathematical Problems in Engineering, American Journal of Heat and Mass Transfer, etc. Researchers across the globe worked with him as a post doc, research associates, master and bachelor degrees. He is one among the researchers in Taiwan who won NSC (National Science Council) special researcher award. Prof. Sheu acted as the deputy director, Centre of Advanced Study in theoretical Science (CASTS), National Taiwan University. He is also contributing his research studies as a Professor, Institute of Applied Mathematical Science, National Taiwan University. Prof. Sheu holds a position of deputy director, Taiwan Society of Industrial Applied Mathematics (TWSIAM), also Centre for Quantum Sciences and Engineering (CQSE) and is an executive committee member of Centre of Advanced Study in Theoretical Sciences (CASTS), National Taiwan University. He is an advisory member of National Centre for High-Performance Computing (NCHC).

Dr. HP Rani, Assistant Professor of Mathematics from NIT-Warangal has vast experience as an academician and a researcher by working in prestigious National Taiwan University, Taiwan and Kyung Hee University, South Korea. She has introduced a new concept of boundary layer flow visualisation through heatlines and masslines concept. Her work in flow assisted corrosion problems has gained currency in the nuclear industry. The detailed analysis of microcirculatory blood flow in hepatic lobule has got much appreciation from the medical community. She published 37 research articles in reputed International Journals, 19 research articles in the international proceedings and visited many countries for her research presentation as well as an Invited Speaker. Her area of interest includes Computational Fluid Dynamics, Heat and Mass Transfer, Biomechanics, MHD, geodynamo and corrosion problems.

Course Co-ordinator

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