ACB-2009 : High Performance Computing (HPC) Module

C-DAC, Hyderabad/ Pune, IICT-Hyderabad and JNTU-Hyderabad

Venue: IICT-Hyderabad **Date:** November 21-29, 2009

***Organized by**: Betatesting Group,C-DAC,Pune **HPC Module Coordinator**: Dr. VCV. Rao*

Day 1: November 21, 2009 (Saturday)

Time (Hrs)	Activity
0900 ~ 0930	**HPC Module Overview:** An overview of HPC Module; Summary of Class–Room Lectures; An overview of Hands-on Sessions on Multi-Core Processor System; Summary of Assignments; Details of Examination System (Open Book System) for HPC Module (Class-Room Lectures /Hands-on Session) for ACB 2009
0930 ~ 1100	**Parallel Computing Introduction:** Introduction; What is Parallel Computing? ; An Overview of Parallel Processing Platforms; Application requirements; Challenges & Issues in Parallel Computing, Performance of Parallel Programs; Parallel Programming Paradigms – An Overview
Break Sessions: Refreshments: 1100 ~1115 Hrs & 1600 ~1615 Hrs; Lunch: 1300 ~1400 Hrs	
1115 ~ 1215	**Explicit Parallelism: Message Passing Programming (MPI) :** Introduction; MPI Basics; MPI Messages; MPI Point-to-Point communication library calls; Simple MPI programs
1215 ~ 1230	**An Overview of Hand-on Session:** How to access Multi-Core Processor System? How to Compile and Execution of programs (Sequential/ Parallel) on Multi-Core Processor?; Programming Environment - (OpenMP, TBB, Pthreads, MPI, Mixed Parallel programs)
1230 ~ 1300	**Assignment Session:** Assignment-I questions on Class-room lectures on programs using MPI
1400 ~ 1800	**Hands-on Session on Multi-Core Processor System:** Understanding Basic library calls semantics; Compilation and Execution of MPI Parallel Programs (FORTRAN or C lang);Parallel programs using MPI point-to-point library calls on Multi-Core Processor System

Day 2: November 23, 2009 (Monday)

Time (Hrs)	Activity
0930 ~ 1000	**An Overview of Multi-Core Computing Systems:** An overview of Multi-Core Computing systems (Dual /Quad Core Systems): Multi-thread Prog. Environment; Performance Enhancement through threading; An overview of Intel Threading Building Blocks (TBB)
1000 ~ 1100	**Explicit Parallelism - Message Passing Programming (MPI):** MPI Basic library calls; Point-to-Point blocking and Non-blocking library calls; MPI Collective Communication library calls, Execution of Example Programs on Multi-Core Processor System
Break Sessions: Refreshments: 1100 ~1115 Hrs & 1600 ~1615 Hrs; Lunch: 1300 ~1400 Hrs	
1115 ~ 1230	**An overview of Parallel Processing Platforms:** An overview of SIMD; and MIMD Machines; An overview of Cluster Computing and Challenges; Performance Issues on Message Passing Clusters (PARAM 10000, PARAM Padma and PARAM Anant, PARAM YUVA); PARAMNet System Interconnect; Compute Node features; An overview of Multi-Core Processor System
1230 ~ 1300	**An Overview of Hand-on Session:** Compilation and Execution of Sequential and Parallel programs on Multi-Core Processor System
1400 ~ 1800	**Hands-on Session on Multi-Core Processor System:** Performance of FORTRAN/c programs-Compiler optimization features; TBB Example Programs; MPI Parallel programs using MPI Collective Communications library calls and programs on Matrix Computations; Demonstration of Assignment-1 and Assignment-2 programs on Multi-Core Processor Systems

Day 3: November 24, 2009 (Tuesday)

Time (Hrs)	Activity
0930 ~ 1000	**Explicit Parallelism: Shared Memory Programming- OpenMP:** OpenMP Constructs, Parallel for Loops, Reductions; Example Programs of OpenMP
1000 ~ 1100	**Performance Metrics, Scalability and Speed Up Analysis:** Types of Performance requirements; Performance and Workload Speed Metrics; Parallelism and interaction overheads; Overhead Quantification and measurement methods; Scalability and Speed-up Analysis
Break Sessions: Refreshments: 1100 ~1115 Hrs & 1600 ~1615 Hrs; Lunch: 1300 ~1400 Hrs	
1115 ~ 1145	**Explicit Parallelism Shared Memory Programming (TBB):** An Overview of Intel Threading Building Blocks (TBB); Performance Issues – TBB Templates – Example Programs
1145 ~ 1300	**Performance – Using Compiler Techniques for Sequential /Parallel Codes; & An overview of Scientific Libraries:** Basic Compiler Techniques: What an Optimizing Compiler does to get maximum performance of your code? ; loop optimization techniques; An overview tuned Mathematical libraries (BLAS-I, II & III; DGEMM, HPCC Suite) on Multi-Core Processor Systems
1400~1800	**Hands-on Session:** Simple Ptheads, TBB, OpenMP and MPI programs; Performance of programs for matrix computations using math libraries BLAS; Parallel MPI Fortran 77/C/f90 programs on vector-vector & Matrix vector multiplication algorithms; Demonstration of Assignment-1 and Assignment-2 programs on Multi-Core Processor System

Day 4: November 25, 2009 (Wednesday)

Time (Hrs)	Activity
0930 ~ 1030	**Explicit Parallelism: Shared Memory Programming - Pthreads**: What is Thread model; Designing Threaded Programs; Examples of threaded Programs on Multi-Core Processor System; Understanding Pthreads implementation; Pthread functions for Synchronization
1030 ~ 1200	**Explicit Parallelism: Shared Memory Programming- OpenMP:** An Overview of Shared Memory Programming Model, OpenMP - Critical Sections; Functional Parallelism; Reductions
Break Sessions: Refreshments: 1100 ~1115 Hrs & 1600 ~1615 Hrs; Lunch: 1300 ~1400 Hrs	
1200 ~ 1300	**Assignment Session (Questions & Answers):** Solutions to **Assignment** Questions; **Assignment 3 & Assignment 4** Questions on Theory and Parallel programs using TBB, MPI,OpenMP,Pthreads, and Mixed Programming
1400 ~ 1800	**Hands-on Session on Multi-Core Processor Systems:** Example programs on Pthreads, TBB, MPI & OpenMP; Programs on Matrix multiplication; Demonstration of Assignment-1 & Assignment-2 programs

Day 5: November 26, 2009 (Thursday)

Time (Hrs)	Activity
0930 ~ 1030	**Explicit Parallelism: Combination of MPI/OpenMP /MPI-Pthreads:** Combining MPI and OpenMP/Pthreads - Performance Issues; Examples of MPI/OpenMP & MPI/Pthreads Programs
1030 ~ 1200	**Performance Visualization tools**: **Intel Software Tools Suite** – Thread Checker, Thread Profiler, Intel Vtune Analyzer; MPI's Profiling Interface; Upshot – Performance Analysis Tool; Parallel Debuggers; Performance Visualization tools
Break Sessions: Refreshments: 1100 ~1115 Hrs & 1600 ~1615 Hrs; Lunch: 1300 ~1400 Hrs	
1200 ~ 1300	**Assignment Session (Questions & Answers):** Solutions to **Assignment** Questions; **Assignment 3 & Assignment 4** Questions on Theory and Parallel programs using TBB, MPI,OpenMP,Pthreads, and Mixed Programming
1400 ~ 1800	**Hands-on Session on Multi-Core Processor Systems:** Example programs on Pthreads, TBB, MPI & OpenMP; Programs on Matrix multiplication; Demonstration of Assignment-1 & Assignment-2 programs

Day 6: November 27, 2009 (Friday)

Time (Hrs)	Activity
0930 ~ 1000	**Explicit Parallelism-Data Parallel Programming (f90/f95/HPF)** The Data-Parallel Model; The Fortran 90 /95 Approach (Parallel Array Operations); High Performance Fortran (Data Mapping in HPF, Support for Data Parallelism); Fortran 95 Enhancements - Performance Issues
1000 ~ 1100	**Parallel Programming Paradigms, Programming Models & Parallel Algorithms Design:** Parallel Algorithmic Paradigms; Programming Models; Implicit /Explicit Parallelism; Types of Parallelism; Decomposition and load balancing techniques; Overheads of Algorfithms Design
Break Sessions: Refreshments: 1100 ~1115 Hrs & 1600 ~1615 Hrs; Lunch: 1300 ~1400 Hrs	
1115 ~ 1145	**Computational Challenges-Parallel Molecular Dynamics Applications:** Introduction; Classical MD simulation; Force Computations; Issues in Parallelization; Partitioning Algorithms: Atom Decomposition, Domain Decomposition, Force Decomposition Methods
1145 ~ 1300	**Hands-on Session on Multi-Core Processor Systems:** Assignment Session (Questions & Answers): Solutions to Assignment Questions; Parallel Programs using OpenMP/MPI/TBB; Parallel programs on matrix Computations; Assignments
1400 ~ 1800	**Hands-on Session on Multi-Core Processor Systems** - Simple Pthreads, TBB, MPI and OpenMP Parallel programs; Parallel programs on matrix-matrix multiplication algorithms; Solution of matrix system of linear equations; Example programs using combination of MPI and OpenMP; Demonstration of Assignment-3, Assignment-4 programs

Day 7: November 28, 2009 (Saturday)

Time (Hrs)	Activity
1000 ~ 1300	**Examination for Classroom Lectures (Hands-on Session)**
1400 ~ 1600	**Demonstration of Programs given in Assignments (1,2,3, & 4) & Examination Question Paper in the Hands-on Session** (OpenMP, Pthreads, MPI, TBB, Mixed Programming, Tools)

Day 8: November 29, 2009 (Sunday)

Time (Hrs)	Activity
1000 ~ 1200	**Examination for Classroom Lectures (Theory) - Open Book System**