ACB-2008: High Performance Computing (HPC) Module

HPC Module Coordinator: **Dr. VCV. Rao, C-DAC, Pune**

Venue: IICT-Hyderabad **Date: November 03-10, 2008**

Day 1: November 03, 2008 (Monday)

Time (Hrs)	Activity
0930 ~ 1000	**An Overview of Parallel Computing Module:** An overview of HPC Module; Summary of Class–Room Lectures; An overview of Hands-on Sessions on PARAM series (PARAM Multi-Core Message Passing Cluster); Summary of Assignments; Details of Examination System (Open Book System) for Module (Class-Room Lectures /Hands-on Session) for ACB 2008
1000~ 1100	**Parallel Computing Introduction (Part-I) :** Introduction; What is Parallel Computing? ; Application requirements; The Scope of Parallel Computing; Issues in Parallel Computing, Performance of Parallel Programs; Parallel Programming Overview; Basic Communication Operations
Tea and Refreshments Break: 1100 ~1115 Hrs	
1115 ~ 1215	**Explicit Parallelism: Message Passing Programming (MPI) - Part I:** 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 PARAM Multi-Core Message Passing Cluster? How to Compile and Execution of Sequential and Parallel programs on PARAM Multi-Core Message Passing Cluster?; Simple MPI and Pthread Parallel programs
1230 ~ 1300	**Assignment Session:** Assignment I questions on Class-room lectures and Write parallel programs using MPI
Lunch Break: 1300 ~1400 Hrs; Tea and Refreshments Break: 1600 ~1615 Hrs	
1400 ~ 1800	**Hands-on Session on PARAM Multi-Core Message Passing Cluster:** Understanding Basic library calls semantics; Compilation and Execution of Simple MPI Parallel Programs (FORTRAN or C, C++ language); MPI Parallel programs using MPI point-to-point library calls on PARAM Multi -Core Message Passing Cluster

Day 2: November 04, 2008 (Tuesday)

Time (Hrs)	Activity
0930 ~ 1015	**Multi-Core Computing Systems**: An overview of Multi-Core Computing systems: Multi-thread Programming Environment & Performance Issues
1015 ~ 1100	**Explicit Parallelism: Shared Memory Programming - Pthreads**: What is Thread model; Designing Threaded Programs; Examples of threaded Programs on PARAM Multi-Core Message Passing Cluster; Understanding Pthreads implementation; Pthread functions for Synchronization
Tea and Refreshments Break: 1100 ~1115 Hrs	
1115 ~ 1230	**An overview of Parallel Processing Platforms:** An overview of SIMD; and MIMD Machines; An overview of Cluster Computing & Challenges; Performance Issues on Clusters; An overview of PARAM Message Passing Clusters; PARAM Padma - Message Passing Clusters; Compute Node features; Programming environment & Tools; Basic Communication Library operations
1230 ~ 1300	**An Overview of Hand-on Session:** Compilation and Execution of Sequential and Parallel programs on **PARAM Multi-Core- Message Passing Cluster**
Lunch Break: 1300 ~ 1400 Hrs; Tea and Refreshments Break: 1600 ~1615 Hrs	
1400 ~ 1800	**Hands-on Session on Multi-Core Message Passing Cluster:** Performance of FORTRAN/c programs using compiler optimization features and using code-restructuring techniques; MPI Parallel programs using MPI Collective Communications library calls and Simple programs on Matrix Computations; Demonstration of Assignments-1 programs on PARAM Multi-Core-Message Passing Cluster; Simple MPI and Pthread Parallel programs

Day 3: November 05, 2008 (Wednesday)

Time (Hrs)	Activity
0930 ~ 1030	**Explicit Parallelism - Message Passing Programming (MPI) – Part II:** MPI Basic library calls; Point-to-Point blocking and Non-blocking library calls; MPI Collective Communication library calls, Execution of Example Programs on PARAM Multi-CoreMessage Passing Cluster
1030 ~ 1100	**Explicit Parallelism: Shared Memory Programming (OpenMP) - Part-I:** An Overview of Shared Memory Programming Model, OpenMP Constructs, Parallel for Loops, Example Programs on PARAM Multi-Core Message Passing Cluster

ACB-2008 : High Performance Computing (HPC) Module

Day 3: November 05, 2008 (Wednesday)

Time (Hrs)	Activity
Tea and Refreshments Break: 1100 ~1115 Hrs	
1115 ~ 1145	**Parallel Programming Paradigms, Programming Models & Parallel Algorithms design -** An overview of Parallel Algorithmic Paradigms; Programming Models; Implicit /Explicit Parallelism; Types of Parallelism; Decomposition techniques; Static & Dynamic load balancing techniques; Overheads in algorithm design; Performance Issues
1145 ~ 1200	**Assignment Session (Questions & Answers):** Solutions to Assignment 1 questions; Assignment 2 questions on Class-Room lectures and Parallel Programs using MPI/OpenMP
1200 ~ 1215	**Feedback Session:** Hands-on Session on Multi-Core- Message Passing Cluster
1230 ~ 1300	**Hands-on Session on Multi-Core Message Passing Cluster:** Parallel Programs using MPI, Pthreads, OpenMP; Parallel programs on Matrix & vector Computations
Lunch Break: 1300 Hrs ~1400 Hrs; Tea and Refreshments Break: 1600 Hrs ~1615 Hrs	
1400~1800	**Hands-on Session:** Simple Ptheads, 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 Assignments-1 and Assignments-2 programs on PARAM Multi-Core- Message Passing Cluster

Day 4: November 06, 2008 (Thursday)

Time (Hrs)	Activity
0930 ~ 1015	**Performance Visualization tools**: Performance Analysis tools for Parallel Programs; MPI's Profiling Interface; Upshot – Performance Analysis tools; Intel Vtune Performance Analysis Tools on Multi-Core Message Passing Cluster
1015 ~ 1100	**Explicit Parallelism: Shared Memory Programming: Advanced Feature of (OpenMP)-Part-II:** Example Programs of OpenMP Programs; Advanced Features of OpenMP -Critical Sections; Functional Parallelism; Reductions
Tea and Refreshments Break: 1100 Hrs ~1115 Hrs	
1115 ~ 1230	**Programming on Multi-Core Processors – Intel Thread Building Blocks (TBB) & Performance Analysis tools** - An Overview of Intel thread building blocks (TBB); Fast Search Algorithms on Multi-Core systems and Performance Issues; Case Study Examples - An Overview of Multi-Core systems and Performance Analysis tools
1230 ~ 1245	**Feedback Session:** Hands-on Session on Multi-Core- Message Passing Cluster
1230 ~ 1245	**Assignment 4**: Questions on Day 02/03/04/05 Classroom lectures and writing parallel programs using Pthreads on PARAM Multi-Core- Message Passing Cluster.
Lunch Break 1300 Hrs ~1400 Hrs; Tea Break: 1600 Hrs ~1615 Hrs	
1400 ~ 1800	**Hands-on Session on Multi-Core Message Passing Cluster:** Example programs on Pthreads, MPI, Pthreads, & OpenMP; Parallel programs on matrix-vector multiplication; Demonstration of Assignments-1 & Assignment-2 programs on PARAM Multi-Core Message Passing Cluster; Simple Intel TBB Parallel programs

Day 5: November 07, 2008 (Friday)

Time (Hrs)	Activity
0930 ~ 1015	**Explicit Parallelism: Combination of MPI/OpenMP (Part-I):** Combining MPI and OpenMP; Profiling; Performance of MPI/OpenMP programs; Examples of MPI/OpenMP Programs
1015 ~ 1100	**An overview of Application and System Benchmarks:** Benchmarks Classification; Micro & Micro Benchmarks (BLAS, DGEMM, LINPACK, HPCC Benchmark Suite, LLCBench,LMBENCH, STREAM); **Performance – Using Compiler Techniques for Sequential /Parallel Codes; & An overview of Scientific Libraries:** An Overview of Basic Compiler Techniques:
Tea and Refreshments Break: 1100 ~1115 Hrs	
1115 ~ 1145	**An Overview of Intel Thread Building blocks (TBB) :** How to write programs using Intel Thread Building Blocks on Multi-Core systems; Example Programs
1145 ~ 1215	**Assignment Session (Questions & Answers):** Solutions to **Assignment 2** Questions; **Assignment 3** Questions on Class-Room lectures and Parallel programs using MPI/OpenMP **Assignment 4**: Discussion on Questions on Day 02/03/04/05 Class-Room lectures and writing parallel programs using Pthreads on PARAM Multi-Core- Message Passing Cluster.
1215 ~ 1300	**Hands-on Session on Multi-Core Message Passing Cluster:** Parallel Programs using OpenMP, MPI, Pthreads, TBB; Parallel programs on matrix computations; Assignments; Example programs using combination of MPI and OpenMP; MPI and Pthreads;
Lunch Break:1300 ~1400 Hrs; Tea and Refreshments Break:1600 ~1615 Hrs	

ACB-2008 : High Performance Computing (HPC) Module

Day 5: November 07, 2008 (Friday)

Time (Hrs)	Activity
1400 ~ 1800	**Hands-on Session on Multi-Core Message Passing Cluster:** Simple Pthreads, MPI, OpenMP, and TBB Parallel programs; Parallel programs on matrix-matrix multiplication algorithms; Solution of matrix system of linear equations by Direct/Iterative Methods; Example programs using combination of MPI and OpenMP; MPI and Pthreads; Demonstration of Assignments-1, Assignments-2 programs on PARAM Multi-CoreMessage Passing Cluster

Day 6: November 08, 2008 (Saturday)

Time (Hrs)	Activity
0930 ~ 1015	**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
1015 ~ 1100	**Computational Challenges-Parallel Molecular Dynamics Applications:** Introduction; Classical MD simulation; Force Computations; Issues in Parallelization; Partitioning Algorithms: Atom Decomposition, Domain Decomposition, Force Decomposition Methods;
Tea and Refreshments Break: 1100 ~1115 Hrs	
1115 ~ 1215	**Explicit Parallelism: Mixed Mode of Programming - Combination of MPI/OpenMP (Part-II) & MPI-Pthreads:** Combining MPI and OpenMP; Profiling; Examples of MPI- OpenMPI & MPI-Pthreads Programs
1215 ~ 1300	**Hands-on Session on Multi-Core Message Passing Cluster:** Parallel Programs using MPI & OpenMP, MPI and Pthreads Parallel Programs on matrix-vector and matrix-matrix multiplication algorithms; Demonstration of Assignments programs on Multi-Core- Message Passing Cluster
Lunch Break: 1300 ~1400 Hrs; Tea and Refreshments Break: 1600 ~1615 Hrs	
1400 ~ 1800	**Hands-on Session on Multi-Core- Message Passing Cluster:** MPI parallel programs using parallel visualization tools; Example programs using Intel Vtune - Performance Analyzer tools, Parallel programs using different OpenMP programs on Dense Matrix Computations; Demonstration of Assignments-2, Assignments-3, Assignments-4 programs on PARAM Multi-Core Message Passing Cluster

Day 7: November 09, 2008 (Sunday)

Time (Hrs)	Activity
1000 ~ 1300	**Examination for Classroom Lectures (Theory) - Open Book System**
Lunch Break: 1300 ~1400 Hrs	
1430 ~ 1630	**Examination for Classroom Lectures (Hands-on Session)**