ACB-2007 : Parallel Computing Module

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

Venue: IICT-Hyderabad **Date: September 17-25, 2007**

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

Day 1: September 17, 2007 (Monday)

Time (Hrs)	Activity
0900 ~ 0930	**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 Anant Message Passing Cluster); Summary of Assignments; Details of Examination System (Open Book System) for Parallel Computing Module (Class-Room Lectures /Hands-on Session) for ACB 2007
0930 ~ 1100	**Parallel Computing Introduction (Part-I) :** Introduction; What is Parallel Computing? ; Application requirements; The Scope of Parallel Computing; Notations and Conventions; 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 Anant Message Passing Cluster ? How to Compile and Execution of Sequential and Parallel programs on PARAM Anant Message Passing Cluster ?; Simple MPI 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 Anant Message Passing Cluster:** Understanding Basic library calls semantics; Compilation and Execution of Simple MPI Parallel Programs (FORTRAN or C language); MPI Parallel programs using MPI point-to-point library calls on PARAM Anant Message Passing Cluster

Day 2: September 18, 2007 (Tuesday)

Time (Hrs)	Activity
0900 ~ 1000	**Multi-Core Computing Systems**: An overview of Multi-Core Computing systems: Multi-thread Programming Environment & Performance Issues
1000 ~ 1100	**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 Anant Message Passing Cluster
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 and Challenges; Performance Issues on Clusters; An overview of PARAM Anant Message Passing Cluster; PARAM Padma and PARAM 10000 - Message Passing Clusters; PARAM – PARAMNet System Interconnect; Compute Node features; Parallel Programming Environment and tools; Basic Communication Library operations
1230 ~ 1300	**An Overview of Hand-on Session:** Compilation and Execution of Sequential and Parallel programs on PARAM Anant Message Passing Cluster
Lunch Break: 1300 ~ 1400 Hrs; Tea and Refreshments Break: 1600 ~1615 Hrs	
1400 ~ 1800	**Hands-on Session on PARAM Anant 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 Anant Message Passing Cluster

Day 3: September 19, 2007 (Wednesday)

Time (Hrs)	Activity
0900 ~ 1000	**Explicit Parallelism: Shared Memory Programming - Pthreads**: What is Thread model; Designing Threaded Programs; Examples of threaded Programs on PARAM Anant Message Passing Cluster; Understanding Pthreads implementation; Pthread functions for Synchronization
1000 ~ 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 Anant Message Passing Cluster

ACB-2007: Parallel Computing Module
Day 3: September 19, 2007 (Wednesday)

Tea and Refreshments Break: 1100 ~1115 Hrs	
Time (Hrs)	**Activity**
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 and Dynamic load balancing techniques; Overheads in algorithm design; Performance Issues
1145 ~ 1200	**Feedback Session on HPC module & Hands-on Session on PARAM Anant Message Passing Cluster**
1200 ~ 1215	**Assignment Session (Questions & Answers):** Solutions to Assignment 1 questions; Assignment 2 questions on Class-Room lectures and Parallel programs using MPI/OpenMP
1230 ~ 1300	**Hands-on Session on PARAM Anant Message Passing Cluster:** Parallel Programs using OpenMP; Parallel programs using Point-point communication library calls on vector-vector multiplication algorithms
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 Anant Message Passing Cluster

Day 4: September 20, 2007 (Thursday)

Time (Hrs)	Activity
0900 ~ 1000	**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
1000 ~ 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; Overview of AMBER
Tea and Refreshments Break: 1100 Hrs ~1115 Hrs	
1115 ~ 1200	**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
1200 ~ 1230	**Explicit Parallelism: Message Passing Programming (MPI) – Part III:** MPI Collective Communication & Computation and Computation Library Calls; MPI Communication modes Example Programs on advanced Point-to-Point library calls
1230 ~ 1300	**Feedback Session on HPC module & Hands-on Session on PARAM Anant Message Passing Cluster**
Lunch Break 1300 Hrs ~1400 Hrs; Tea Break: 1600 Hrs ~1615 Hrs	
1400 ~ 1800	**Hands-on Session on PARAM Anant Message Passing Cluster:** Example programs on Pthreads, MPI & OpenMP; Parallel programs on matrix-vector multiplication; Demonstration of Assignments-1 & Assignment-2 programs on PARAM Anant Message Passing Cluster

Day 5: September 21, 2007 (Friday)

Time (Hrs)	Activity
0900 ~ 1000	**Explicit Parallelism: Combination of MPI/OpenMP (Part-I):** Combining MPI and OpenMP; Profiling; Performance of MPI/OpenMP programs; Examples of MPI/OpenMP Programs
1000 ~ 1100	**An overview of Application and System Benchmarks:** Benchmarks Classification; Micro & Micro Benchmarks (BLAS, DGEMM, LINPACK, HPCC Benchmark Suite, LLCBench,LMBENCH, STREAM)
Tea and Refreshments Break: 1100 ~1115 Hrs	
1115 ~ 1145	**Feedback Session on HPC module and Hands-on Session on PARAM Anant Message Passing Cluster**
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** :Questions on Day 04/05 Class-Room lectures and writing parallel programs using Pthreads on PARAM ANANT.
1215 ~ 1300	**Hands-on Session on PARAM Anant Message Passing Cluster:** Parallel Programs using OpenMP/MPI; Parallel programs on matrix-vector and matrix-matrix multiplication algorithms; Assignments
Lunch Break:1300 ~1400 Hrs; Tea and Refreshments Break:1600 ~1615 Hrs	

ACB-2007: Parallel Computing Module

Day 5: September 21, 2007 (Friday)

Time (Hrs)	Activity
1400 ~ 1800	**Hands-on Session on Anant Message Passing Cluster:** Simple Pthreads, MPI and OpenMP 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; Demonstration of Assignments-1, Assignments-2 programs on PARAM **Anant** Message Passing Cluster

Day 6: September 22, 2007 (Saturday)

Time (Hrs)	Activity
0900 ~ 1000	**Explicit Parallelism: Message Passing Programming (MPI) - Advanced Features – Part -IV:** MPI advanced point-to-point communication; MPI Derived Data types; Grouping data for Communication, Communication and Topologies; Cost of Message Passing Operations
1000 ~ 1100	**Performance Visualization tools**: Performance Visualization tools for Parallel Programs; MPI's Profiling Interface; Upshot – Performance Analysis Tool; Parallel Debuggers on PARAM Anant Message Passing Cluster
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 PARAM Anant Message Passing Cluster:** Parallel Programs using MPI & OpenMP, Parallel Programs on matrix-vector and matrix-matrix multiplication algorithms; Demonstration of Assignments programs on PARAM Anant Message Passing Cluster
Lunch Break: 1300 ~1400 Hrs; Tea and Refreshments Break: 1600 ~1615 Hrs	
1400 ~ 1800	**Hands-on Session on PARAM Anant Message Passing Cluster:** MPI parallel programs using parallel visualization tools; MPI parallel programs to measure communication overheads Parallel Processing Platforms (P-COMS); Parallel programs using different OpenMP programs on Dense Matrix Computations; Demonstration of Assignments-2, Assignments-3 programs on PARAM Anant Message Passing Cluster

Day 7: September 24, 2007 (Monday)

Time (Hrs)	Activity
0900 ~ 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
Tea and Refreshments Break: 1100 ~1115 Hrs	
1115 ~ 1300	**Assignment Session (Questions & Answers):** Solutions to Assignment 3 Questions & Assignment 4 questions
Lunch Break: 1300 ~1400 Hrs; Tea and Refreshments Break: 1600 ~1615 Hrs	
1400 ~ 1600	**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? ; Compiler role in loop optimization techniques; An overview tuned Mathematical libraries (BLAS-I, II & III; DGEMM, HPCC Suite) on Shared and Distributed Memory Computing platforms; Case Study on Matrix into Matrix Multiplication suite on PARAM Anant Message Passing Cluster
1615 ~ 1800	**Hands-on Session on PARAM Anant Message Passing Cluster:** MPI parallel programs using parallel visualization tools; MPI parallel programs to measure communication overheads Parallel Processing Platforms (P-COMS); Parallel programs using different OpenMP programs on Dense Matrix Computations; Demonstration of Assignments-2, Assignments-3 programs on Anant Message Passing Cluster

Day 8: September 25, 2007 (Tuesday)

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)**