Parallel Computing Module for ACB 2004

Organized by **C-DAC, Pune and IICT, Hyderabad;**   **Date :** *October 18-26, 2004*

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Day 1: October 18, 2004 (Monday)

Time (Hrs)	Activity
0900 ~ 0915	**An Overview of Parallel Computing Module:** An overview of Class–Room Lectures and Hands-on Sessions on PARAM 10000, Summary of Assignments, Examination pattern of Parallel Computing Module (Class-Room Lectures /Hands-on Session) for ACB 2004
0915 ~1000	**Introduction (part-I):** Introduction, What is Parallel Computing? The Scope of Parallel Computing, Concept of Scalability, Notations and Conventions, Parallel Computer Models
1000 ~1100	**Introduction (Part-II):** Application requirements, Issues in Parallel Computing, Performance of Parallel Programs Parallel Programming Overview, Basic Communication Operations, Scalability
	Tea and Refreshments Break: 1100 Hrs ~1115 Hrs
1115~1200	**Explicit Parallelism: Message Passing Programming (MPI) - Part I:** Introduction, MPI Basics, MPI Messages, Features, MPI Point-to-Point Communication library calls, Simple MPI programs
1200~1245	**Hands-on Session on PARAM 10000:** Compile and Execution of Sequential Parallel programs on PARAM 10000, Simple MPI Parallel programs using MPI point-to-point Communications
1245~1300	**Assignment I :** Questions on Assignment 1 on Day 01/02 Class-Room lectures and writing parallel programs using MPI on PARAM 10000
	Lunch Break: 1300 Hrs~1400 Hrs; Tea and Refreshments Break:1600 Hrs ~1630 Hrs
1400~1800	**Hands-on Session on PARAM 10000:** *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 10000*

Day 2: October 19, 2004 (Tuesday)

Time (Hrs)	Activity
0900 ~1000	**Explicit Parallelism: Message Passing Programming (MPI) – Part II:** Message Envelope in MPI. MPI Collective Communication library calls, MPI Collective Computation and Computation Library Calls, Timing MPI Programs, MPI Implementation, Examples
1000 ~1100	**An overview of Parallel Computing and PARAM 10000:** An overview of SIMD, and MIMD Machines, An overview of Cluster Computing and Challenges, Performance Issues on Clusters An overview of PARAM 10000 – PARAMNet System Interconnect, Compute Node features, Parallel Programming Environment and tools, Basic Communication Library operations
	Tea and Refreshments Break: 1100 Hrs ~1115 Hrs
1115 ~1200	**Performance – Using Compiler Techniques for Sequential /Parallel Codes:** Basic Compiler Techniques: What an Optimizing Compiler does to get maximum performance of your code? Compiler role in loop optimization techniques; Single processor optimization techniques
1200~1245	**Parallel Programming Paradigms and Programming Models:** An overview of Parallel Algorithmic Paradigms, Programming Models; Implicit Parallelism – Role of Compilers, Explicit Parallelism – Message Passing Programming (MPI); Shared Memory Programming (OpenMP, Pthreads); Data Parallel Programming (f90/f95/HPF)
	Lunch Break:1300 Hrs ~ 1400 Hrs; Tea and Refreshments Break:1600 Hrs ~1630 Hrs
1400~1800	**Hands-on Session on PARAM 10000:** *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 Dense Matrix Computations.*

Day 3: October 20, 2004 (Wednesday)

Time (Hrs)	Activity
0900~1000	**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	**Explicit Parallelism: Shared Memory Programming (OpenMP):** (An Overview of Shared Memory Programming Model, OpenMP Constructs, Parallel for Loops, Critical Sections; Performance Improvements, Support of Data Parallelism, Example Programs)
	Tea and Refreshments Break: 1100 Hrs ~1115 Hrs
1115~1200	**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
1200~1215	**Assignments I and Assignment 2:** Solutions to Assignment 1; Questions on Assignment 2 on Day 02/03 Class-Room lectures and parallel programs using MPI/OpenMP on PARAM 10000
1215~1245	**Hands-on Session on PARAM 10000:** Parallel Programs using OpenMP, Parallel on vector-vector, matrix-vector and matrix-matrix multiplication algorithms
	Lunch Break: 1300 Hrs ~1400 Hrs; Tea and Refreshments Break:1600 Hrs ~1630 Hrs
1400~1800	**Hands-on Session:** Simple OpenM and /MPI Parallel programs, Performance of programs for matrix computations using math libraries BLAS; Parallel MPI Fortran 77/C/f90 programs on vector-vector, matrix-vector and matrix-matrix multiplication algorithms

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Day 4: October 21, 2004 (Thursday)

Time (Hrs)	Activity
0900~1000	**Explicit Parallelism: Message Passing Programming (MPI) - Advanced Features – Part -III:** MPI advanced point-to-point communication; MPI Communication modes; MPI Collective Communications; MPI Derived Data types; Grouping data for Communication, Communication and Topologies; Cost of Message Passing Operations, MPI-2 Features
1000~1100	**Parallel Algorithms design -**Types of Parallelism, Decomposition techniques; Static and Dynamic load balancing techniques; Overheads in algorithm design, Performance Issues
	Tea and Refreshments Break: 1100 Hrs ~1115 Hrs
1115~1245	**An overview of Application and System Benchmarks**: Benchmarks Classification; Micro Benchmarks (LINPACK, LMBENCH, STREAM, P-COMS); Macro Benchmarks (NAS, PARKBENCH, STAP, SPEC, TCP Benchmarks) Performance Issues
	Lunch Break 1300 Hrs ~1400 Hrs; Tea Break: 1630 Hrs ~1645 Hrs
1400 ~1800	**Hands-on Session:** *MPI and OpenMP Parallel programs for matrix computations; Parallel MPI programs on matrix-matrix multiplication algorithms; Solution of matrix system of linear equations by Direct/Iterative Methods; parallel programs using combination of MPI and OpenMP*

OCTOBER 22 (Friday) HOLIDAY

Day 5: October 23, 2004 (Saturday)

Time (Hrs)	Activity
0900~1000	**Explicit Parallelism:** Shared Memory Programming -An overview of Pthreads
1000~1100	**Explicit Parallelism: Combination of MPI/OpenMP & Advanced Feature of OpenMP:** Combining MPI and OpenMP; Profiling; Performance of MPI/OpenMP programs; Examples OpenMP Programs, Advanced Features of OpenMP – Data Parallelism
	Tea and Refreshments Break: 1100 Hrs ~1115 Hrs
1115-1200	**Performance Visualization tools**: Performance Visualization tools for Parallel Programs MPI's Profiling Interface; Upshot – Performance Analysis Tool; Parallel Debuggers on PARAM 10000
1200 ~1215	**Assignments 2 and Assignment 3**: Solutions to Assignment 2 Questions; Questions on Assignment 3 on Day 04/Day 05 Class-Room lectures and parallel programs using MPI/OpenMP
1245 ~1300	.
1200~1245	**Hands-on Session on PARAM 10000:** Parallel Programs using OpenMP/MPI, Parallel on vector-vector, matrix-vector and matrix-matrix multiplication algorithms; Assignments
	Lunch Break:1300 Hrs ~1400 Hrs; Tea and Refreshments Break:1600 Hrs ~1630 Hrs
1400~1800	**Hands-on Session:** *Demonstration of MPI parallel programs using parallel visualization tools; Demonstration of MPI parallel programs to measure communication overheads (P-COMS) on PARAM 10000, Demonstration of Performance benchmarks on PARAM 10000, Example programs using combination of MPI and OpenMP*

Day 6: October 25, 2004 (Monday)

Time (Hrs)	Activity
0900~1000	**An overview of PARAM Padma:** Features of PARAM Padma Cluster, PARAMNet-Interconnect and Compute nodes features, Programming Environment, Performance of Benchmarks
1000~1100	**An overview of Performance of Scientific Applications**: Important issues for application Scalability, Algorithms used, Memory Optimization, Optimization, Tuned Mathematical libraries
	1100 Hrs ~1115 Hrs Tea break
1115-1200	**Assignment – 3 :** Solutions to on Assignment 3 Questions.
	Lunch Break: 1300 Hrs ~1400 Hrs; Tea and Refreshments Break:1600 Hrs ~1630 Hrs
1400 ~1800	**Hands-on Session:** *Demonstration of MPI parallel programs* using parallel visualization tools; *Demonstration of MPI parallel programs* to measure communication overheads using P-COMS. *Parallel programs* using different OpenMP *pragmas on Dense Matrix Computations*

Day 7: October 26, 2004 (Tuesday)

Time (Hrs)	Activity
0900~1000	**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
1000~1100	**Assignment 1,2,3:** Discussions on Assignment 1, 2, 3
	1100 Hrs ~1115 Hrs Tea break
1115-1300	**Examination for Class Room Lectures Theory:** An Overview (Open Book System)
	Lunch Break: 1300 Hrs ~1400 Hrs; Tea and Refreshments Break:1600 Hrs ~1630 Hrs
1400 ~1630	**Examination for Hands-on Session:** Demonstration and Writing of parallel programs