(JMS) Resource Management System (RMS), Queues, Hosts, Resources, Jobs and Policies, Policies for Resource Utilization, Scheduling Policies Load Sharing and Load Balancing, Strategies for Load Balancing, Modeling Parameters Case Studies of Cluster Systems: Beowulf, PARAM.

Text Books:

1. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter: Cloud Computing, A Practical Approach, McGraw Fill, 2010.
2. Prabhu: Grid and Cluster Computing, PHI, 2008.

Reference Books:

1. Joshy Joseph, Craig Fellenstein: Grid Computing, Pearson Education, 2007.
2. Internet Resources

MULTI-CORE ARCHITECTURE AND PROGRAMMING

Subject Code: 10CS846	**I.A. Marks : 25**
Hours/Week : 04	**Exam Hours: 03**
Total Hours : 52	**Exam Marks: 100**

PART - A

UNIT 1 **7 Hours**

Introduction

The power and potential of parallelism, Examining sequential and parallel programs, Parallelism using multiple instruction streams, The Goals: Scalability and performance portability, Balancing machine specifics with portability, A look at six parallel computers: Chip multiprocessors, Symmetric multiprocessor architectures, Heterogeneous chip designs, Clusters, Supercomputers, Observations from the six parallel computers.

UNIT 2 **6 Hours**

Reasoning about Performance

Motivation and basic concepts, Sources of performance loss, Parallel structure, Performance trade-offs, Measuring performance, Scalable performance.

UNIT 3 **6 Hours**

Examples of Multi-Core Architectures

Introduction to Intel Architecture, How an Intel Architecture System works, Basic Components of the Intel Core 2 Duo Processor: The CPU, Memory Controller, I/O Controller; Intel Core i7: Architecture, The Intel Core i7 Processor, Intel QuickPath Interconnect, The SCH; Intel Atom Architecture.

Introduction to Texas Instruments' Multi-Core Multilayer SoC architecture for communications, infrastructure equipment

UNIT 4 **7 Hours**

Parallel Algorithm Design

Introduction, The Task / Channel model, Foster's design methodology, Examples: Boundary value problem, Finding the maximum, The n-Body problem, Adding data input.

PART – B

UNIT 5 **7 Hours**

Parallel Programming – 1 (Using OpenMP)

Designing for threads: Task decomposition, Data decomposition, Data flow decomposition, Implications of different decompositions; Challenges in decomposition, Parallel programming patters, A motivating problem: Error diffusion.

Threading and Parallel Programming Constructs: Synchronization, Critical sections, Deadlocks, Synchronization primitives: Semaphores, Locks, Condition variables; Messages, Flow Control-Based concepts: Fence, Barrier; Implementation-Dependent threading issues.

UNIT 6 **6 Hours**

Parallel Programming – 2 (Using OpenMP)

Introduction, The shared-memory model, Parallel *for* loops, Declaring private variables, Critical sections, Reductions, Performance improvements, More general data parallelism, Functional parallelism.

UNIT 7 **7 Hours**

Solutions to Common Parallel Programming Problems

Too many threads, Data races, deadlocks, and live locks, Heavily contended locks, Non-blocking algorithms, Thread-safe functions and libraries, Memory issues, Cache-related issues, Avoiding pipeline stalls, Data organization for high performance.

UNIT 8 **6 Hours**

Threading in the Processor

Single-Core Processors: Processor architecture fundamentals, Comparing Superscalar and EPIC architectures.

Multi-Core Processors: Hardware-based threading, Hyper-threading technology, Multi-Core processors, Multiple processor interactions, Power consumption, Beyond multi-core architecture.

NOTE: In order to acquire a sound understanding of the subject, it is desirable for the students to work in the laboratory using OpenMP. The hands-on experience would reinforce the concepts learnt in theory. Problems similar to the ones solved in the Algorithms Laboratory can be solved and issues like speed-up achieved can be analyzed in depth. Several free tools are available from companies like INTEL to facilitate such a study.

Text Books:

1. Calvin Lin, Lawrence Snyder: Principles of Parallel Programming, Pearson Education, 2009.
   (Listed topics only from Chapters 1, 2, 3)
2. Michael J. Quinn: Parallel Programming in C with MPI and OpenMP, Tata McGraw Hill, 2004.
   (Listed topics only from Chapters 3, 17)
3. Shameem Akhter, Jason Roberts: Multi-Core Programming, Increasing Performance through Software Multithreading, Intel Press, 2006.
   (Listed topics only from Chapters 3, 4, 7, 9, 10)
4. Web resources for Example Architectures of INTEL and Texas Instruments:
   http://download.intel.com/design/intarch/papers/321087.pdf ;
   http://focus.ti.com/lit/wp/spry133/spry133.pdf

Reference Books:

1. Introduction to Parallel Computing – Ananth Grama et. al., Pearson Education, 2009.
2. Reinders : Intel Threading Building Blocks, O'reilly – 2005
3. David Culler et. al.: Parallel Computer Architecture: A Hardware/Software Approach, Elsevier, 2006.
4. Richard Gerber, Aart J.C. Bik, Kevin B. Smith, Xinmin Tian: Software Optimization Cookbook, High-Performance Recipes for IA-32 Platforms, 2nd Edition, Intel Press, 2006.

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