

MULTI-CORE PROGRAMMING (ELECTIVE-IV) (Common to CSE & IT)

Course Code :13CT1137

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Pre requisites: Linux

Course Educational Objectives:

The main objective of the course is to expose the students to the basic concepts of Multi Core programming and various practical models of Multi Core programming.

- ❖ Understand the Multi Core Architecture.
- ❖ Understand Parallel Programming Concepts and Threading API's.
- ❖ Understand OpenMP programming and MPI programming.
- ❖ Learn about Multi Core Debugging Techniques.
- ❖ Use Multi Core Processors efficiently with the help Multi Core programming tools.

Course Outcomes:

At the end of the course the student will be able to

- ❖ Learn about different OpenMP programming, MPI programming,
- ❖ Learn multi-core processors software development products,
- ❖ Understand multi-threaded debugging techniques
- ❖ Understand OpenMP programming and mpi programming
- ❖ Learn various Multi-core processors

UNIT-I

(12 Lectures)

INTRODUCTION TO MULTI-CORE ARCHITECTURE:

Motivation for Concurrency in Software, Parallel Computing Platforms (SIMD & MIMD systems, an overview of Single-Core, Multi-Processor,

Multi-Core Architectures) , Parallel Computing in Microprocessors, Differentiating Multi-Core Architectures from Hyper-Threading Technology, Multi-threading on Single-Core versus Multi-Core Platforms, Understanding Performance, Amdahl's Law, Gustafson's Law

UNIT-II

(12 Lectures)

MULTI-CORE PROCESSORS:

An Overview of Software Threading Defining Threads, System View of Threads: Threading above the Operating System, Threads inside the OS , Threads inside the Hardware , Application Programming Models and Threading ,Virtual Environment: Virtual Machines and Platforms, Runtime Virtualization, System Virtualization.

PARALLEL PROGRAMMING FUNDAMENTAL CONCEPTS:

Designing for threads, parallel programming patterns, Threading and parallel programming constructs: Synchronization, Critical sections, Deadlock, Synchronization Primitives, and Messages

UNIT-III

(12 Lectures)

THREADING APIS:

Threading APIs for Microsoft Windows, Threading APIs for Microsoft .NET Framework: Creating Threads, Managing Threads, Thread Pools, Thread Synchronization, POSIX Threads: Creating Threads, Managing Threads, Thread Synchronization , Signaling , Compilation and Linking

UNIT-IV

(12 Lectures)

OPENMP PROGRAMMING:

OpenMP Challenges in Threading a loop, Minimizing Threading overhead, Performance oriented Programming ,Library Functions. Solutions to parallel programming problems: Data races, deadlocks and Livelocks Non-blocking algorithms, Memory and cache related issues.

MPI PROGRAMMING:

Message-Passing Model, Message-Passing Interface, MPI functions, Compiling and running MPI Programs, collective communication, data decomposition, Point-to-point communication – MPI Library.

UNIT-V**(12 Lectures)****MULTI-THREADED DEBUGGING TECHNIQUES:**

General Debug Techniques, Debugging Multi-threaded Applications in Windows: Threads Window, Trace points, Breakpoint Filters, Naming Threads, Multi-threaded Debugging Using GDB.

MULTI-CORE PROCESSORS SOFTWARE DEVELOPMENT PRODUCTS:

An Overview of Software tools on Multi-Core Processors, Intel Software Development Products: overview, Thread Checker, Compilers: OpenMP, Software-based Speculative Pre computation, Compiler Optimization and Cache Optimization, Debugger , Intel Libraries, Intel Threading Building Blocks , VTune Performance Analyzer , Thread Profiler , MPI Programming :Intel Support for MPI

TEXT BOOKS:

1. Shameem Akhter and Jason Roberts, “*Multi-core Programming- Increasing Performance through Software Multi-Threading*”, 1st Edition, Intel Press, 2006.
2. Michael J Quinn, “*Parallel programming in C with MPI and OpenMP*”, 2nd Edition, Tata McGraw Hill, 2007.

REFERENCES:

1. John L.Hennessey and David A.Patterson, “*Computer architecture – A quantitative approach*”, 4th Edition, Morgan Kaufmann Elsevier Publishers, 2007.
2. David E. Culler, Jaswinder Pal Singh, “*Parallel computing architecture: A hardware software approach*”, 1st Edition, Morgan Kaufmann Elsevier Publishers, 1999.

