

# **Multi Core Computing**

## **Credit: 3 + 3 Hr. /Week Lab**

### **1. Introduction to Multi-Core Architecture**

Motivation for Concurrency in Software, Parallel Computing Platforms, Parallel Computing in Microprocessors, Differentiating Multi-Core Architectures from Hyper-Threading Technology, Multi-threading on Single-Core versus Multi-Core Platforms, Understanding Performance.

### **2. System Overview of Threading**

Defining Threads, System View of Threads, Threading above the Operating System Threads inside the OS, Threads inside the Hardware, What Happens When a Thread Is Created, Application Programming Models and Threading, Virtual Environment: VMs and Platforms, Runtime Virtualization, System Virtualization.

### **3. Software Multi-threading**

Threading APIs, Creating Threads, Managing Threads, Thread Pools, Thread Synchronization, POSIX Threads, Creating Threads, Managing Threads, Thread Synchronization, Signaling, Compilation and Linking, Software Multi-threading using Tread Building Blocks (TBB) and Cilk++ programming.

### **4. Threading on Intel Multi-Core Processors**

Hardware-based Threading, , Hyper-Threading Technology Difference between Multiprocessor and Hyper-Threading, Technology, Hyper-Threading Technology Architecture, Multi-Core Processors, Architectural Details, Comparison between Multiprocessors and Multi-Core, Processors, Multi-Core for Itanium Architecture, Multiple Processor Interaction, Inter-Processor Communication and Multi-threaded Programming, Power Consumption, Power Metrics.

### **5. Introduction to Heterogeneous Multi-Core Processors**

Introduction to Many cores Programming, Cell Processor Multinode Computing, The Early Days of GPGPU Coding , GPU Hardware, Alternatives to CUDA, OpenCL, Direct Compute CPU alternatives, Directives and libraries, Understanding Parallelism with GPUs.

### **6. Heterogeneous Multi-Core Programming with CUDA**

Introduction to GPU Computing, CUDA Programming Model, CUDA API, Simple Matrix Multiplication in CUDA, CUDA Memory Model, Shared Memory Matrix Multiplication, Additional CUDA API Features, Threading Hardware, Memory Hardware, Memory Bank Conflicts, Parallel Thread Execution, Control Flow, Precision.

## **Text book:**

1. Shameem A and Jason, Multicore Programming, Intel Press, 2006.
2. Programming Massively Parallel Processors: A Hands-on Approach, authors, David B. Kirk, Wenmei W. Hwu, Morgan Kaufmann, 2010 (This book is only on NVIDIA GPUs and CUDA programming despite its title)
3. CUDA by Example: An Introduction to General-Purpose GPU Programming by Jason Sanders and Edwards Kandrot Addison-Wesley, 2011.
4. CUDA Programming A Developer's Guide to Parallel Computing with GPUs Shane Cook, Morgan Kaufmann