Teaching Guidelines for

Introduction to HPC & Its Architecture

ACC-HPC June 2025

Duration: 24 classroom hours + 24 lab hours

Objective: To introduce the student to HPC & Its Architecture

Prerequisites: Linux, knowledge of Computer Design and Organization, Network

Evaluation method: CCEE exam– 40% weightage

Lab exam – 40% weightage

Internal exam – 20% weightage

List of Books / Other training material

Reference Book:

1. "Computer Organization". 5th Edition. "Peter", 2003 by V.C. Hamacher, Z.G. Vranesic, S.G. Zaky/ Mcgraw Hill Education.

2. David A. Patterson and John L. Hennessy. Computer Organization and Design, Revised Printing, Third Edition, Third Edition: The Hardware/Software Interface (The Morgan Kaufmann Series in Computer. Series in Computer Architecture and Design). Morgan Kaufmann; 3rd Edition. 2007

Note: Each session mentioned is for theory and of 2 hours duration.

Lab assignments are indicatives, faculty need to assign more assignments for better practice.

Session 1:

Basic concepts of computer organization

- Introduction of Organization and Architecture
- A Brief History of Computers
- Designing for Performance
- Computer Components
- Computer Function
- Interconnection Structures

Session 2:

Processors & System Architecture

- Description of a Processor
- Machine Language Programming
- A specific instruction set architecture
- Von Neumann architecture

Session 3 & 4:

Parallel Architecture & Multi-Processor architecture

- Basic Concepts in Parallel Processing
- Classification Of Parallel Architectures.
- Vector Processing, Array Processor
- Superscalar Architecture
- Multi-Core Architecture
- Symmetric Multiprocessor
- Introduction to GPU
- Accelerators (GPGPU & FPGA)

Session 5:

Cluster Architecture & Memory Architecture

- Compute Nodes
- Interconnects
- Shared Memory Architecture (UMA & NUMA)
- Cache Coherence
- Distributed Memory Architecture
- Hybrid Memory

Session 6:

Parallel Programming Models

- Flynn's Taxonomy
- SIMD (Single Instruction, Multiple Data)
- MISD (Multiple Instruction, Single Data)
- MIMD (Multiple Instruction, Multiple Data)

Session 7:

Parallel Processing Concepts

- Concurrency
- Parallelism
- Parallelism Vs Concurrency
- Working Independently
- Dependency
- Synchronous evaluation

- Threads & Process
- Serial & Parallel Code
- Tasks

Session 8:

Level Of Parallelism

- Bit Level Parallelism
- Instruction Level parallelism
- Data Level parallelism
- Task Level parallelism

Session 9

Multicore programming

- Parallelism
- Concurrency
- Multithreading
- Synchronization
- Load Balancing

Session 10

Scheduling in HPC, job partitioning and Allocation

- Scheduling in HPC
- SLURM
- Job Partitioning in HPC
- JOB allocation
- Resource manager

Session 11

Peta-scale and Exa-scale computing

- Peta-scale Computing
- Exa-scale Computing

Session 12:

Overview of GPUs and architecture (AMD and NVIDIA)

- GPU
- GPGPU
- NVIDIA GPGPU architecture
- AMD architecture