Program: BS (Computer Science)
Course Name: Parallel & Distributed Computing
Course Code: CSC-601
Credit Hours: 03
Total Weeks: 16
Total Hours: 48

Course Objectives:

This course aims to provide students with a comprehensive understanding of the principles and practices of parallel and distributed computing. It focuses on designing, analyzing, and implementing parallel algorithms and distributed systems, ensuring efficient utilization of computational resources.

Weekly Breakdown:

Week 1:

- Introduction to Parallel & Distributed Computing
- Definitions and Applications of Parallel and Distributed Systems
- Differences Between Parallel and Distributed Computing

Week 2:

- Parallel Computing Architecture
- Flynn's Taxonomy: SISD, SIMD, MISD, MIMD
- Shared Memory and Distributed Memory Systems

Week 3:

- Distributed System Architecture
- Client-Server Model
- Peer-to-Peer Systems and Multi-Tier Architecture

Week 4:

- Communication in Parallel and Distributed Systems
- Message Passing Interface (MPI) Basics
- Remote Procedure Calls (RPCs)

Week 5:

- Parallel Algorithms
- Decomposition Techniques for Parallel Algorithms
- Performance Metrics: Speedup, Efficiency, Scalability

Week 6:

- Synchronization in Parallel Computing
- Mutexes, Semaphores, and Barriers
- Deadlock Detection and Avoidance

Week 7:

- Distributed Algorithms
- Leader Election and Mutual Exclusion Algorithms
- Consensus and Fault Tolerance

Week 8:

- Load Balancing and Resource Allocation
- Techniques for Load Balancing in Distributed Systems
- Scheduling in Parallel Systems

Week 9:

- Parallel Programming Models
- OpenMP for Shared Memory Programming
- CUDA for GPU Computing

Week 10:

- Distributed Databases
- Distributed Database Design Principles
- Consistency and Replication

Week 11:

- Cloud Computing and Distributed Systems
- Virtualization and Containerization
- Cloud Service Models: IaaS, PaaS, SaaS

Week 12:

- Big Data and Distributed File Systems
- Hadoop Distributed File System (HDFS)
- MapReduce Programming Model

Week 13:

- Security in Distributed Systems
- Authentication and Authorization in Distributed Environments
- Secure Communication Protocols

Week 14:

- Fault Tolerance and Recovery Mechanisms
- Redundancy, Checkpointing, and Replication Techniques
- Recovery in Distributed Systems

Week 15:

- Advanced Topics in Parallel & Distributed Computing
- Edge Computing and IoT Systems
- Blockchain Technology

Week 16:

- Case Studies and Applications
- High-Performance Computing Applications
- Final Review and Assessment

Total Marks: 100

Recommended Books:

1. *Introduction to Parallel Computing* by Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar
2. *Distributed Systems: Principles and Paradigms* by Andrew S. Tanenbaum and Maarten Van Steen