



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**

**Subject Code: 3170721**

**Semester – VII**

**Subject Name: Parallel and Distributed Computing**

**Type of course: Elective**

**Prerequisite:** Fundamental of programming and operating system, computer networking, and computer Organization

**Rationale:** To introduce the fundamentals of parallel and distributed programming models, design principles, and application development in different parallel programming environments.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs
1	<b>Introduction to Parallel Computing:</b> The Idea of Parallelism, Power and potential of parallelism, Examining sequential and parallel programs, Scope and issues of parallel and distributed computing, Goals of parallelism, Parallelism and concurrency using multiple instructions streams.	05
2	<b>Parallel Architecture:</b> Pipeline architecture, Array processor, Multi processor architecture, Systolic architecture, Dataflow architecture, Architectural classification schemes, Memory access classification, Memory Issues : Shared vs. distributed, Symmetric multiprocessing (SMP), SIMD, Vector processing, GPU co-processing, Flynn's Taxonomy, Instruction Level support for parallel programming, Multiprocessor caches and Cache Coherence, Non-Uniform Memory Access (NUMA).	10
3	<b>Parallel Algorithm Design Principles and Programming:</b> Need for communication and coordination/synchronization, Scheduling and contention, Independence and partitioning, Task- Based Decomposition, Data Parallel Decomposition, Characteristics of task and interaction, Load balancing, Data Management, parallel algorithm models, Sources of overhead in parallel programs, Performance metrics for parallel algorithm implementations, Parallel algorithmic patterns like divide and conquer, Map and Reduce, Specific algorithms like parallel Merge Sort, Parallel graph Algorithms.	10
4	<b>Introduction to Distributed Systems:</b> Goals of the Distributed Systems, Relation to parallel systems, synchronous versus asynchronous execution, design issues and challenges, Types of Distributed	06

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	Systems, Distributed System Models, Hardware and software concepts related to distributed systems, middleware models.	
5	<b>Distributed Computing and Communication design principles:</b> A Model of distributed executions, Models of communication networks, Global state of distributed system, Models of process communication. Communication and Coordination: Shared Memory, Consistency, Atomicity, Message-Passing, Consensus, Conditional Actions, Critical Paths, Scalability, and cache coherence in multiprocessor systems, synchronization mechanism.	08
6	<b>Parallel and Distributed Programming Frameworks</b> Overview of CUDA, OpenMP, POSIX Threads, Apache Hadoop (DFS), and current trends in parallel and distributed computing.	06

### Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	14	21	14	7	7

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

### Reference Books:

- 1) Introduction to Parallel Computing (2nd Edition), Ananth Grama, Anshul Gupta, and George Karypis, Vipin Kumar, Addison Wesley
- 2) Parallel and Distributed Systems 2nd Edition, Arun Kulkarni, Nupur Prasad Giri, Nikhilesh Joshi, Bhushan Jadhav, Wiley
- 3) Introduction To Parallel Programming, Steven Brawer, Academic Press
- 4) Introduction To Parallel Processing, M.Sasikumar, Dinesh Shikhare and P. Ravi Prakash, Randy Chow, T. Johnson, Distributed Operating Systems and Algorithms, Addison Wesley
- 5) Distributed Operating Systems, A.S. Tanenbaum, Prentice Hall
- 6) Ian Foster: Designing and Building Parallel Programs – Concepts and tools for Parallel Software Engineering, Pearson Publisher, 1st Edition, 2019.
- 7) Parallel Programming in C with MPI and OpenMP Michael J.Quinn, McGrawHill Higher Education



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## **Course Outcomes:**

<b>Sr. No.</b>	<b>CO statement</b>	<b>Marks % weightage</b>
CO-1	Apply the fundamentals of parallel and distributed computing including parallel architectures and paradigms.	30%
CO-2	Analyze the various design principles of parallel algorithms.	20%
CO-3	Learn the intricacies of parallel and distributed programming	30%
CO-4	Develop and execute basic parallel and distributed applications using basic programming models and tools.	20%

## **List of Experiments:**

The laboratory will be based on the implementation of the parallel algorithms (on a PC-cluster under Linux platform). The programs will be based on POSIX Thread, MPI programming, Hadoop, Apache Spark etc.

## **List of e-Learning Resources:**

1. <https://hpc.llnl.gov/training/tutorials/introduction-parallel-computing-tutorial>
2. <https://www.geeksforgeeks.org/introduction-to-parallel-computing/>
3. <https://nptel.ac.in/>
4. <https://www.coursera.org/>