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***CSX445 Distributed Algorithms***

**L-T-P-Cr: 3-0-0-3**

**Pre-requisites:** Networks, Algorithms

**Objectives/Overview:**

* To design system models, algorithms and protocols that allow computers to communicate and coordinate their actions to solve a problem.
* To learn the principles, architectures, algorithms and programming models used in distributed systems.
* To examine and analyze how a set of connected computers can form a functional, usable and high-performance distributed system.

**Course Outcomes:**

At the end of the course, a student should:

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| **Sl. No.** | **Outcome** | **Mapping to POs** |
| 1. | Identify the core concepts of distributed systems: the way in which several machines orchestrate to correctly solve problems in an efficient, reliable and scalable way. | PO1, PO2, PO4, PO5 |
| 2. | Understand and account for models, limitations, and fundamental concepts in the area of message passing and shared memory concurrency and apply this understanding to example systems and algorithms. | PO1, PO3, PO5, PO7 |
| 3. | Adapt, and design algorithms for execution distributed settings | PO2, PO4, PO5, PO7 |
| 4. | Examine how existing systems have applied the concepts of distributed systems in designing large systems. | PO3, PO4, PO5, PO7 |
| 5. | * Analyse the algorithms for correctness, and performance. | PO1, PO2, PO5, PO3 |

**UNIT I: Lectures: 10**

Clocks and Event Ordering-Ordering of Events, Lamport’s Logical Clock, Birman-Schiper-Stephenson Protocol, Vector Clocks, Global Snapshot-Termination Detection, Chandy-Lamport’s Algorithm, Huang’s Algorithm, Wave and Traversal Algorithms-Echo Algorithm, Sequential Polling, Classical Depth-first Search, Awerbuch’s DFS Algorithm, Cidon’s DFS Algorithm.

**UNIT II: Lectures: 10**

Mutual Exclusion-Non-token based / Permission based, Permission from all processes: Lamport, Ricart-Agarwala, Raicourol-Carvalho, Permission from a subset: Maekawa Token based: Suzuki-Kasami, Leader Election-LeLann’s and Chang-Robert’s Algorithms, Hirschberg-Sinclair Algorithm, The Echo Algorithm – a wave algorithm, Extinction on The Echo Algorithm.

**UNIT III: Lectures: 10**

Spanning Tree Construction-Leader Election versus Spanning Tree, Gallager-Humblet-Spira Algorithm, Deadlock Detection-Centralized Control, Distributed Control, Hierarchical Control.

**UNIT IV: Lectures: 12**

Agreement Protocols-Consensus Algorithm for Crash Failures, Correctness of Crash Consensus, Byzantine Agreement, Lamport-Shostak-Pease Algorithm, Commit Protocols-Distributed Transactions, System Failure Modes, two-phase commit (2PC) protocol, three-phase commit (2PC) protocol, Fault Tolerance & Self Stabilization Basics-Issues in design of self-stabilization algorithm, Randomized self-stabilization, Dijkstra’s self-stabilizing token ring, Dolev’s Self Stabilizing Spanning Tree.

**Text/ Reference Book:**

1. Advanced Operating Systems by Mukesh Singhal and Nirajan Shivaratri, Tata McGraw-Hill Education.
2. Distributed Algorithms by Nancy Lynch, Elsevier.
3. Distributed Algorithms: Principles, Algorithms, and Systems by A. D. Kshemkalyani and M. Singhal, Cambridge University Press.
4. Distributed Systems - An Algorithmic approach by Sukumar Ghosh, No eBook available, CRC Press.