- Write programs related to syntax and semantics
- Compare programs between C, Perl and Small Talk
- Write programs using scripting languages
- Demonstrate event-driven and concurrent programming using Prolog
- Apply Prolog for developing distributed systems

EVALUATION METHOD:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	**40**	**20**	**40**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									
CO2	✓	✓	✓	✓	✓				✓			✓
CO3	✓	✓	✓	✓	✓				✓		✓	✓
CO4	✓	✓	✓	✓	✓				✓			✓
CO5	✓	✓	✓	✓	✓				✓		✓	✓

CS6303	**DISTRIBUTED SYSTEMS**	**L**	**T**	**P**	**EL**	**CREDITS**
		3	**0**	**0**	**3**	**4**

Prerequisites for the course: NONE

OBJECTIVES:

- To understand the foundations of distributed systems
- To learn issues related to clock Synchronization and the need for global state in distributed systems
- To learn distributed mutual exclusion and deadlock detection algorithms
- To understand the significance of agreement, fault tolerance and recovery protocols in distributed systems
- To learn the characteristics of peer-to-peer and distributed shared memory systems

MODULE I INTRODUCTION	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**

Definition –Relation to computer system components –Motivation –Relation to parallel systems – Message-passing systems versus shared memory systems –Primitives for distributed communication –Synchronous versus asynchronous executions –Design issues and challenges.

SUGGESTED ACTIVITIES :

- EL – Fundamentals of Distributed Systems
- Flipped classroom and activity

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE II A MODEL OF DISTRIBUTED COMPUTATIONS AND LOGICAL TIME	**L**	**T**	**P**	**EL**
	6	**0**	**0**	**3**

A distributed program –A model of distributed executions –Models of communication networks –

Global state –Cuts –Past and future cones of an event –Models of process communications –A framework for a system of logical clocks –Scalar time –Vector time –Physical clock synchronization: NTP.

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Basics of Communication Networks

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE III MESSAGE ORDERING AND GROUP COMMUNICATION	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**

Message ordering paradigms –Asynchronous execution with synchronous communication – Synchronous program order on an asynchronous system –Group communication – Causal order (CO) - Total order.

SUGGESTED ACTIVITIES :

- EL- Basic concepts on Group Communication
- In class Activity on Message Ordering

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IV GLOBAL STATE AND SNAPSHOT RECORDING ALGORITHMS	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**

Introduction –System model and definitions –Snapshot algorithms for FIFO channels.

SUGGESTED ACTIVITIES :

- Flipped Class room
- EL - Introduction to Snapshot Algorithm

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE V DISTRIBUTED MUTUAL EXCLUSION ALGORITHMS	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**

Introduction – Preliminaries – Lamport's algorithm – Ricart - Agrawala algorithm – Maekawa's algorithm – Suzuki–Kasami's broadcast algorithm.

SUGGESTED ACTIVITIES :

- EL – Introduction to Mutual Exclusion
- In class activity on problem solving in Distributed Mutual Exclusion Algorithms

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VI	DEADLOCK DETECTION IN DISTRIBUTED SYSTEMS	L	T	P	EL
		4	0	0	3

Introduction – System model – Preliminaries – Models of deadlocks – Knapp's classification– Algorithms for the single resource model, the AND model and the OR model.

SUGGESTED ACTIVITIES :

- EL – Introduction to Deadlock Detection.
- Flipped classroom and activity

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VII	CHECKPOINTING AND ROLLBACK RECOVERY	L	T	P	EL
		5	0	0	3

Introduction – Background and definitions – Issues in failure recovery – Checkpoint-based recovery – Log-based rollback recovery –Coordinated check pointing algorithm –Algorithm for asynchronous checkpointing and recovery.

SUGGESTED ACTIVITIES :

- Combinations of in Class & Flipped class rooms
- EL – Applications for Rollback Recovery

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VIII	CONSENSUS AND AGREEMENT ALGORITHMS	L	T	P	EL
		4	0	0	3

Problem definition – Overview of results – Agreement in a failure –free system – Agreement in synchronous systems with failures.

SUGGESTED ACTIVITIES :

- Flipped classroom
- EL – Basics concepts of Agreement Algorithms

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IX	PEER-TO-PEER COMPUTING AND OVERLAY GRAPHS	L	T	P	EL
		4	0	0	3

Introduction – Data indexing and overlays –Chord – Content addressable networks –Tapestry.

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Introduction to peer to peer computing

MODULE X	DISTRIBUTED SHARED MEMORY	L	T	P	EL
		4	0	0	3

Abstraction and advantages – Memory consistency models –Shared memory Mutual Exclusion.

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Introduction to Memory Consistency Models

OUTCOMES:

Upon completion of the course, the students will be able to:

- Elucidate the foundations and issues of distributed systems
- Point out the various synchronization issues and global state for distributed systems
- Demonstrate the mutual exclusion and deadlock detection in distributed systems
- Demonstrate the agreement protocols and fault tolerance mechanisms in distributed systems
- Describe the features of peer-to-peer and distributed shared memory systems

TEXT BOOK:

1. Ajay D. Kshemkalyani and Mukesh Singhal, "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2011.

REFERENCES:

1. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, “Distributed Systems Concepts and Design”, Fifth Edition, Pearson Education, 2012.
2. Pradeep K Sinha, "Distributed Operating Systems: Concepts and Design", Prentice Hall of India, 2007.
3. Mukesh Singhal and Niranjan G. Shivaratri, “Advanced Concepts in Operating Systems, McGraw Hill, 2001.
4. Tanenbaum A.S., Van Steen M., “Distributed Systems: Principles and Paradigms”, Pearson Education, 2007.
5. Liu M.L., “Distributed Computing, Principles and Applications”, Pearson Education, 2004.
6. Nancy A Lynch, “Distributed Algorithms”, Morgan Kaufmann Publishers, USA, 2003.

EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	**40**	**20**	**40**

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓					✓	✓		✓
CO2	✓	✓		✓					✓	✓		✓
CO3	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
CO5	✓			✓					✓	✓		✓