COURSE CODE**: CSC3026**	L-T-P**: 4-1-1**
COURSE NAME**: DISTRIBUTED SYSTEMS**	CONTACT HOURS/WEEK**: 7**
COURSE TYPE**: CORE**	TOTAL MARKS**: 100 (**INTERNAL**: 60,** EXTERNAL**: 40)**
NUMBER OF CREDITS**: 6**	NATURE**: GRADED**

COURSE OBJECTIVES:

1. To provide students the concepts of basic architecture and components of distributed systems
2. To familiarize the students with the concepts of various distributed algorithms.
3. To give students the concepts of concurrency controlling and distributed file system handing

COURSE PREREQUISITE:

- Basic concepts of Operating Systems and basic concepts of Computer networks

COURSE OUTCOMES:

At the end of the course, students will be able to:

- Explain the architecture and different system models of distributed systems.
- Analyze different process synchronization, Global state recording and termination detection algorithms in distributed systems.
- Compare different Mutual Exclusion, leader election algorithms, different distributed file structures
- Distinguish the Inter-process communication methods and analyze the idea of failure handling, concurrency management and Security handling issues

COURSE CONTENT:

Unit No & Name	Components of the Unit	No of contact hours	Marks
UNIT-I: **Introduction to Distributed Systems**	• Definition of a distributed system. Characteristics of distributed and centralized systems, Design issue and challenges, types of transparency issues, openness, and scalability. Hardware concepts- multiprocessors, homogeneous & heterogeneous systems, middleware, issues in distributed Operating systems, inherent limitations of distributed systems	18	20

	• System models: Fundamental and Architectural model, System architectures- The client-server model and its variations, application layering, client-server architectures.		
UNIT-II: **Synchronization**	• Needs of clock synchronization, external and internal clock synchronization, Logical and vector clocks, Lamport's logical clock, Vector clocks, Causal Order of messages, Birman-Schiper-Stephension protocol, Schiper-Eggli-Sandoz protocol, • Global state, Chandy Lamport snapshot algorithm, termination detection, Haung's algorithm	18	20
UNIT-III: **Distributed Mutual Exclusions**	• Requirements of Mutual Exclusion algorithms, Performance measurement metrics, Classification of mutual exclusion algorithm, Token based algorithms, Non-token based algorithm, Central Server Algorithm, Lamport's timestamp algorithm, Ricart-Agrawala Algorithm, Maekawa's Voting algorithm, Ring based algorithm, Suzuki-Kasami's Broadcast algorithm, Raymond's Tree-based algorithm • Election algorithms- the Bully algorithm, Ring algorithm. Mutual exclusion- definition, algorithms.	18	20
UNIT-IV: **Distributed Scheduling and Deadlock detection**	• Distributed scheduler, issues in distributed load distribution, components of load distribution algorithm, stability, task migration • Basic conditions of deadlocks, Resource and communication deadlock, Strategies of deadlock handling, issues in deadlock detection and resolution, Deadlock detection algorithms (Centralized, Distributed , Hierarchical)	9	10
UNIT-V: **Agreement Protocols and Inter-process Communication**	• System models, classification of agreement problems (Byzantine, Consensus, Interactive), Solutions to the Byzantine agreement problem,	9	10

	Applications of agreement algorithms • Inter-process Communications, API for UDP/TCP, Request Reply Protocol, Remote Procedure Call- basic RPC operation, parameter passing, examples. • Remote Object Invocation- distributed objects, integrating clients and objects, static versus dynamic RMI, parameter passing, examples and case study.		
UNIT-VI: **Naming**	• Naming entities- names, identifiers & addresses, name resolution, name space implementation, the Domain Name System.	4	5
UNIT-VII: **Distributed Transaction Processing**	• Distributed transactions- ACID properties, flat and nested transactions, atomic commit protocols, concurrency control in distributed transactions, Introduction, reasons for replication, object replication, consistency models	7	7
UNIT-VIII: **Distributed File Systems**	• Introduction: characteristics of file systems, distributed file system requirements, File service architecture, file accessing models, detailed case study of Sun Network File System (NFS).	7	8
	Total:	90	100

TEXTBOOKS/ RECOMMENDED READINGS:

- Tanenbaum & Steen; (2004); *Distributed Systems Principles and Paradigms*; Pearson Education
- Coulouris, Dollimore & Kindberg; (2006); *Distributed Systems Concepts and Design*; Pearson Education

COURSE ASSESSMENT DETAILS:

Internal assessment: Class tests, Assignments, Laboratory tests
External assessment: End Semester Examination

DEPARTMENT OF COMPUTER SCIENCE

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LESSON PLAN

Subject Name : **Distributed System**

Paper Code : **CSC3026/INF3026** **Session:** **2018-2019**

Program Name : **M.Sc. (CS/IT)** **Semester:** **THIRD**

Faculty Name : **Dwipen Laskar**

Date : **July, 2018 to December, 2018**

Detailed Lesson Plan

UNIT-I (Introduction to Distributed Systems)

Lecture No	Topics to be Covered
1	Definition of a distributed system. Characteristics of distributed and centralized systems
2	Design issue and challenges, Advantages and Disadvantages of Distributed System
3	Types of transparency issues, Concurrency Control, openness, and scalability.
4	Hardware concepts- multiprocessors, homogeneous & heterogeneous systems, middleware, issues in distributed Operating systems
5	Inherent limitations of distributed systems,
6	System models: Fundamental model
7	System models: Architectural model
8	System models: Interaction model
9	System architectures- The client-server model and its variations
10	Application layering, Client-Server architectures.

UNIT-II (Synchronization)

11	Needs of clock synchronization, External and Internal clock synchronization, Global Clock
12	Logical and Physical Clock Synchronization, Logical and vector clocks, Happened Before Relationship,
13	Lamport's logical clock synchronization algorithm, Limitations of Lamport's Clock
14	Vector clock synchronization, Partial Ordering of Events
15	Causal Order of messages, Birman-Schiper-Stephension protocol

16	Schiper-Eggli-Sandoz protocol: Algorithm, Solutions with examples
17	Global state, Chandy Lamport snapshot algorithm
18	Termination detection, Haung's Termination Detection Algorithm

UNIT-III (Distributed Mutual Exclusions)

19	Definition of Distributed ME, Critical Section, Requirements of Mutual Exclusion algorithms
20	Performance measurement metrics for Distributed ME algorithms, Classification of mutual exclusion algorithm- Token based algorithms, Non-token based algorithm, Quorum Based
21	Central Server Algorithm, Complexities of CS Algorithm, Merits and Demerits
22	Lamport's timestamp algorithm, Complexities of CS Algorithm, Merits and Demerits
23	Ricart-Agrawala Algorithm, Complexities of CS Algorithm, Merits and Demerits
24	Maekawa's Voting algorithm, Complexities of CS Algorithm, Merits and Demerits
25	Ring based algorithms, Complexities of CS Algorithm, Merits and Demerits
26	Suzuki-Kasami's Broadcast algorithm, Complexities of CS Algorithm, Merits and Demerits
27	Raymond's Tree-based algorithm, Complexities of CS Algorithm, Merits and Demerits
28	Election algorithms- Bully algorithm, Ring algorithm, Lelang-Chang-Robert Algorithms

UNIT-IV (Distributed Scheduling and Deadlock detection)

30	Distributed scheduler, issues in distributed load distribution,
31	Components of load distribution algorithm, Stability, Task Migration
32	Basic conditions of deadlocks, Resource and communication deadlock, Strategies of deadlock handling, Necessary conditions of deadlock
33	Issues in deadlock detection and resolution, False Deadlock, Deadlock detection algorithms (Centralized, Distributed , Hierarchical)
34	Completely Centralized Algorithm, HO Ramamurthy (One and Two Phase Algorithm)
35	Distributed Deadlock Algorithm-Path Pushing Algorithm, Edge Chasing Algorithm, Diffusion Computation based and Global State detection algorithm

UNIT-V (Agreement Protocols and Inter-process Communication)

36	System models, classification of agreement problems (Byzantine, Consensus, Interactive), Relations among Agreement Protocols
37	Solutions to the Byzantine agreement problem-Upper bound on number of faulty processors, Treatment of Impossibility Results, Lamport's-Shostak-Pease Algorith,
38	Dolev et at's algorithm, Applications of agreement algorithms
39	Inter-process Communications, API for UDP/TCP, Request Reply Protocol, Remote Procedure Call- basic RPC operation, parameter passing, examples.

40	Remote Object Invocation- distributed objects, integrating clients and objects, static versus dynamic RMI, parameter passing, examples and case study

UNIT-VI (Naming)

41	Naming entities- names, identifiers & addresses, name resolution
42	Name space implementation, the Domain Name System.

UNIT-VII (Distributed Transaction Processing)

43	Distributed transactions- ACID properties, flat and nested transactions
44	Atomic commit protocols, concurrency control in distributed transactions
45	Introduction, reasons for replication, object replication, consistency models
46	Failure Recovery in Distributed System-Classification of failures, Backward and Forward Failure Recovery,
47	Backward Failure Recovery: Operation based recovery and State based recovery, State based approach
48	Recovery in Concurrent System: Orphan messages and Domino effects, Lost messages, Problem of Livelock
49	Consistent Set of Checkpoints, Synchronous Check pointing and Recovery, Koo and Toueg check pointing algorithm

UNIT-VIII (Distributed File Systems)

50	Introduction: characteristics of file systems, distributed file system requirements, File service architecture, Services provided by DFS
51	File accessing models, Architecture of DFS, Advantages and Disadvantages, detailed case study of Sun Network File System (NFS)
52	Distributed Shared Memory, Advantages and disadvantages of DSM, Algorithms for Implementing DSM
53	Central Server algorithm, Migration Algorithm, Read Replication algorithm, Full-Replication Algorithm
54	Security in distributed system, Types of threats, Types of attacks
55	Security policy and mechanisms, Design Issues for security in Distributed System
56	Introduction to cryptography, Symmetric and Asymmetric Key cryptography, RSA Algorithm

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