KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY

Deemed to be University

BHUBANESWAR-751024

School of Computer Engineering

LESSON PLAN

Course Title: Distributed Operating Systems (CS 30009)

5th Semester B. Tech. (Department Elective: PE1)

Session: Autumn 2024: July to December 2024

L	T	P	Total	Credit
3	0	0	3	3

Faculty

Dr. Satyananda Champati Rai

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Chamber: Faculty Block – 401, Block-c, Campus – 14

Available Time: 8:30 AM – 10:30 AM (All days except Sundays & Holidays)

Course Objectives

1. To understand the fundamentals of distributed systems
2. To acquire the basic concepts of shared memory architecture
3. To understand various implementation difficulties of distributed operating systems.
4. To understand transparency in distributed operating systems.

Syllabus

UNIT-I **[4 Hours]**

Fundamentals of Distributed Systems:

Introduction to distributed systems, Goals of Distributed Systems, Hardware Concepts, Software Concepts, Design Issues, Network Operating Systems, True Distributed System and Time sharing Multiprocessor Operating System, System Architectures.

UNIT-II **[9 Hours]**

Communication in Distributed Systems:

Basics of Communication Systems, Layered Protocols, ATM Models, Client Server Model, Blocking Primitives and Non-Blocking Primitives, Buffered Primitives and Unbuffered Primitives, Reliable and Unreliable primitives, Message Passing, Remote Procedure Call.

UNIT-III **[9 Hours]**

Synchronization and Processes:

Clock Synchronization, Mutual Exclusion, Election Algorithm, Atomic Transactions, Deadlock in Distributed Systems, Process and Threads, System Models, Processor Allocation, Process Scheduling.

UNIT-IV **[8 Hours]**

Consistency, Replication, and Fault Tolerance:

Data-Centric Consistency Models, Client-Centric Consistency Models, Replica Management, Consistency protocols, Fault Tolerance, Process Resilience, Distributed Commit, Reliable Client Server Communication, Reliable Client Server Communication.

UNIT-V **[6 Hours]**

Overview of shared memory:

Architecture, Algorithm, Protocols, Design Issues, consistency model, Page based Distributed Shared Memory, Shared variable Distributed shared Memory, and Object-based Distributed Shared Memory

Detailed Lesson Plan

Total No. of Lectures ≈ 38

No. of classes before Mid-semester ≈ 19

No. of Classes after Mid-semester ≈ 19

UNIT – I: Fundamentals of Distributed Systems

Lecture	Topics
1	Introduction to distributed systems, Goals of Distributed Systems.
2	Hardware Concepts – Bus-based Multiprocessors, Switched Multiprocessors, Bus-based Multicomputers, Switched Multicomputer.
3	Software Concepts – Network OS, True Distributed Systems, Multiprocessor Timesharing Systems.
4	System Architecture and Design Issues – Transparency, Flexibility, Reliability, Performance, Scalability.

UNIT II: Communication in Distributed Systems

Lecture	Topics
5	Layered Protocols – ISO OSI Reference Model
6	Asynchronous Transfer Mode (ATM) Networks
7	The Client-Server Model - Clients and Servers, Addressing Process via Machine, Broadcasting and ASCII names Lookup
8	Blocking versus Nonblocking Primitives, Buffered versus Unbuffered Primitives
9	Reliable and Unreliable primitives, Message Passing (Implementing the Client-Server Model)
10	Remote Procedure Call (RPC)– Basic Operation, Parameter Passing, Dynamic Binding
11	RPC Semantics during different Failures – Server location, Message Lost, Client Crashes
12	RPC Performance Parameters – Protocol Selection, Acknowledgements, Critical Path, Copying, Timer Management

UNIT III: Synchronization and Processes

Lecture	Topics
13	Clock Synchronization – Logical Clock versus Physical Clock
14	Clock Synchronization Algorithms – Cristian's Algorithm, The Berkeley Algorithm, Averaging Algorithms; Use of Synchronization Clocks
15	Mutual Exclusion Algorithms – Centralized, Distributed, Token Ring
16	Election Algorithms – A Bully Algorithm, A Ring Algorithm
17	Atomic Transactions & Modeling – Stable Storage, Transaction Primitives, Properties
18	Atomic Transaction Implementation – Private Workspace, Writeahead Log, Two-Phase Commit Protocol
19	Concurrency Control Algorithms in Atomic Transaction – Locking System, Optimistic Approach, Time stamps
	Mid Semester
20	Deadlocks in Distributed Systems (Deadlock Detection and Prevention)
21	Process and Threads – Introduction, Usage, Implementing Thread in User Space and Kernel Space
22	Threads and RPC. System Models- The Workstation Model, Using Idle Workstations, The Processor Pool Model
23	Processor Allocation Algorithms – Graph-Theoretic, Centralized, Hierarchical, Sender-Initiated, Receiver-Initiated and Bidding
24	Scheduling in Distributed Systems

UNIT-IV: Consistency, Replication and Fault Tolerance

Lecture	Topics
25	Data-Centric Consistency Models
26	Client-Centric Consistency Models
27	Replica Management, Consistency Protocols
28	Fault Tolerance – Component Faults, System Failures,
29	Fault Tolerance - Use of Redundancy, Active Replication, Use of Primary Backup
30	Process Resilience, Distributed Commit
31	Reliable Client-Server Communication

UNIT - V: Overview of Distributed Shared Memory (DSM)

Lecture	Topics
32	Architecture – On-Chip Memory, Bus-Based Multiprocessors, Ring-Based Multiprocessors
33	Switched Multiprocessors, Directories, Caching
34	Protocols – Dash Protocols, NUMA Multiprocessors, NUMA Algorithms
35	Different Consistency Models – Strict, Sequential, Causal, PRAM, Processor, Weak, Release, and Entry Consistency
36	Page-based Distributed Shared Memory
37	Shared-Variable Distributed Shared Memory (Eg: Munin, Midway)
38	Object-based Distributed Shared Memory (Eg: Linda, Orca)

Course Outcomes

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

CO1: Visualize the concept of Distributed Operating Systems

CO2: Enlist the communication techniques in Distributed Operating Systems

CO3: Learn the clock synchronous concepts and algorithms

CO4: Examine the distributed system that fulfills requirements concerning key distributed systems properties

CO5: Discuss distributed shared memory architectures and algorithms

CO6: Analyze the distributed file systems

Activities

Task	Marks
Before Mid-semester	
Activity -1 : Test	5
Activity – 2 : Quiz	5
Activity – 3 : Assignment	5
After Mid-semester	
Activity – 4 : Test	5
Activity – 5 : Quiz	5
Activity – 6 : Assignment	5

Textbooks:

1. Andrew S. Tanenbaum, “Distributed Operating Systems”, Pearson Education, 1995.

Reference Books:

1. G. Coulouris, J. Dollimore, and T. Kindberg, “Distributed Systems: Concepts & Design”, Pearson Publication, 4th Edition,2005.
2. Pradeep K. Sinha, “Distributed Operating Systems Concepts and Design”, PHI, 1998.