Fr. Conceicao Rodrigues College of Engineering

Fr. Agnel Ashram, Bandra

Department of Computer Engineering

Course Outcomes & Assessment Plan

B.E. (Computer) (semester VIII)

Subject: Distributed Computing

Subject Code: CSC801

Academic Term: *Jan – May 2023*

Teacher: *Merly Thomas Puthiyadom*

Syllabus:

Module No.	Hrs	Topics	
1.0	**6**	Introduction to Distributed Systems	
		1.1 Characterization of Distributed Systems: Issues, Goals, and Types of distributed systems, Grid and Cluster computing Models, Hardware and Software Concepts: NOS, DOS. 1.2 Middleware: Models of Middleware, Services offered by middleware.	15%
2.0	**4**	Communication	
		2.1 Inter-process communication (IPC), Remote Procedure Call (RPC), Remote Method Invocation (RMI) 2.2 Message Oriented Communication, Stream Oriented Communication, Group Communication.	10%
3.0	**10**	Synchronization	
		3.1 Clock Synchronization: Physical clocks, Logical Clocks, Election Algorithms, 3.2 Mutual Exclusion: Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measures. 3.2 non-Token based Algorithms: Lamport Algorithm, Ricart-Agrawala's Algorithm, Maekawa's Algorithm. Token Based Algorithms: Suzuki-Kasami's Broadcast Algorithms, Singhal's Heuristics Algorithm, Raymond's Tree Based Algorithm, Comparative Performance Analysis. 3.4 Deadlock: Introduction, Deadlock Detection: Centralized approach, Chandy -Misra-Hass Algorithm.	25%
4.0	**6**	Resource and Process Management	
		4.1 Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach, 4.2 Introduction to process management, process migration, Code Migration	15%
5.0	**8**	Consistency, Replication and Fault Tolerance	
		5.1 Distributed Shared Memory: Architecture, design issues. 5.2 Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management 5.2 Fault Tolerance: Introduction, Process resilience, Reliable client-server and group communication, Recovery	20%
6.0	**6**	Distributed File Systems	
		6.1 Introduction, good features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Network File System (NFS). ***6.2*** Designing Distributed Systems: Google Case Study.	15%
	40	**Total**	**100**

Course Learning Objectives:

The price/performance ratios offered by distribution in computing, and the concept of sharing resources globally, along with the steady improvements in networking technologies have made Distributed systems very attractive and highly popular. The fundamental concepts and design principles discussed in the course are applicable to a variety of systems especially WWW.

This course aims to:

Course Objectives.
1 To provide students with contemporary knowledge in distributed systems.
2 To explore the various methods used for communication in distributed systems.
3 To provide skills to measure the performance of distributed synchronization algorithms.
4 To provide knowledge of resource management, and process management including process migration.
5 To learn issues involved in replication, consistency, and file management
6 To equip students with skills to analyze and design distributed applications.

Prerequisites: **Operating Systems**
Computer Networks

Department PSOs

PSO1: Develop Artificial Intelligence (AI) and Machine Learning (ML) systems.
PSO2: Apply cyber security mechanisms to ensure the protection of information technology assets.

Course Outcomes:

Upon successful completion of this course students will be able to:

CSC802.1	Demonstrate knowledge of the basic elements and concepts related to distributed systems & technologies **(B2 – Comprehension)**
CSC802.2	Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware. **(B3 – Application)**
CSC802.3	Analyze the various techniques used for clock synchronization, mutual exclusion and deadlock **(B4 – Analysis)**
CSC802.4	Describe the concepts of Resource and Process management **(B2 – Comprehension)**
CSC802.5	Assess the significance of Consistency and Replication Management models, and Fault Tolerance techniques **(B4 – Analysis)**
CSC802.6	Apply the knowledge of Distributed File System in building large-scale distributed applications. **(B3 – Application)**

Relationship of course outcomes with program outcomes: Indicate 1 (low importance), 2 (Moderate Importance) or 3 (High Importance) in respective mapping cell.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2									2
CO2	3		2	2	2							
CO3	3	2	2	2								
CO4	3		2	2								
CO5	3	3	2									
CO6	3	3		2								
Course	3	3	2	3	3							2

CO-PSO Relevance Mapping - None

Justification of CO to PO mapping

CSC802.1	Demonstrate knowledge of the basic elements and concepts related to distributed systems & technologies	
	PO1	As an Engineering solution to some complex computational problems which is efficient and cost effective
	PO3	Design of System components to meet the specific needs
	PO12	Gain ability to be prepared for life-long learning in the broadest context of technological change
	Tools	Lectures, Presentations, Practical Sessions, Assignment I & IV
	Target	2.7
CSC802.2	Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.	
	PO1	Specialized solutions to some complex computational problems
	PO3	Design of System components or mini models to meet the specific needs
	PO4	Implementation concepts of RPC, RMI and MPI
	PO5	Apply appropriate techniques and tools
	Tools	Lectures, Presentations, Practical Sessions
	Target	2.7
CSC802.3	Analyze the various techniques used for clock synchronization and mutual exclusion	
	PO1	An Engineering solution to some complex computational problems
	PO2	Formulate solutions considering the several design issues
	PO3	Design solutions by developing components and processes
	PO4	Experimental approach to design solutions and valid conclusions

	Tools	Lectures, Presentations, Practical Sessions, Seminars
	Target	2.7
CSC802.4	Demonstrate the concepts of Resource and Process management and Fault tolerant solutions	
	PO1	Specialized solutions to some complex computational problems
	PO3	Design of System components or mini models to meet the specific needs
	PO4	Apply appropriate techniques and tools for solutions
	Tools	Lectures, Presentations, Practical Sessions, Seminars
	Target	2.7
CSC802.5	Assess the significance of Consistency and Replication Management	
	PO1	An Engineering solution to some complex computational problems
	PO2	Formulate solutions considering the several design issues
	PO3	Design solutions by developing components and processes
	Tools	Lectures, Presentations, Practical Sessions, Seminars
	Target	2.7
CSC802.6	Apply the knowledge of Distributed File System to analyze various file systems like NFS, AFS and the experience in building large-scale distributed applications	
	PO1	An Engineering solution to some complex computational problems
	PO2	Formulate solutions considering the several design issues
	PO3	Design solutions by developing components and processes
	Tools	Lectures, Presentations, Practical Sessions, Seminars
	Target	2.7

Modes of delivery

Most of the time is spent on teaching the principles of Distributed Computations.

Modes of Delivery	**Brief description of content delivered**	**Attained COs**	**Attained POs**
Class room lectures and Presentations	All modules	ALL	PO1, PO2, PO3, PO4, PO12
Supported by Lab Experiments	Modules 2-6	CO2, CO3, CO6	PO1, PO2, PO3, PO4, PO5, PO12
Students' presentations	Module 1,3,5	CO5	PO1, PO10
Case Study	DCE, CORBA, HADOOP, NFS	CO6	

CO Assessment Tools:

Course Outcome	***Assessment Method***								
	Direct Method (80 %)								***Indirect Method (20%)***
	Unit Tests		Assignments				SEE	Laboratory Practical	Course exit survey
	1	2	1	2	3	4			
CO1	30%		30%				40%		100%
CO2	20%	20%		20%			40%		100%
CO3								100%	100%
CO4		30%			30%		40%		100%
CO5		30%				30%	40%		100%

Assignments:

Four assignments will be given on completion the modules as follows:

Assignment No.1	On completion of the 1st module
Assignment No.2	On completion of 2nd and 3rd module
Assignment No.3	On completion of the 4th module
Assignment No.4	On completion of 2nd and 3rd module
Assignment No.5	On completion of the 1st module

Rubrics for Assignment Grading:

Indicator				
Timeline (2)		More than one session late (0)	One sessions late (1)	On time (2)
Level of content (4)	Just Managed (1)	Major points are addressed minimally (2)	Only major topics are covered(3)	Most major and some minor criteria are included. Information is Adequate (4)
Reading and Understanding (4)	Just Managed (1)	Superficial at most (2)	Understood concepts but no related topics (3)	Understood concepts and related topics (4)

Laboratory Experiment

Total ten number of laboratory experiments will be performed in the practical session as per the time schedule in the time table.

Rubrics for Laboratory Experiment Grading:

Indicator				
Timeline (3)	More than two sessions late (0)	Two sessions late (1)	One sessions late (2)	On time (3)
Knowledge (4)	Not adequate (1)	Superficial at most (2)	Understood concepts but no related topics (3)	Understood concepts and working (4)
skill (3)	Just Managed (1)	Just Managed (1)	Few steps are not appropriate (2)	Structured and optimum performance (3)

Teaching schema

Program Structure for Fourth Year Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
CSC801	Distributed Computing	3	--	3	--	3
CSDC 801X	Department Level Optional Course -5	3	--	3	--	3
CSDC 802X	Department Level Optional Course -6	3	--	3	--	3
ILO 801X	Institute Level Optional Course -2	3	--	3	--	3
CSL801	Distributed Computing Lab	--	2	--	1	1
CSDL 801X	Department Level Optional Course -5 Lab	--	2	--	1	1
CSDL 802X	Department Level Optional Course -6 Lab	--	2	--	1	1
CSP801	Major Project 2	--	12#	--	6	6
Total		**12**	**18**	**12**	**9**	**21**

Examination schema

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC801	Distributed Computing	20	20	20	80	3	--	--	100
CSDC 801X	Department Level Optional Course -5	20	20	20	80	3	--	--	100
CSDC 802X	Department Level Optional Course -6	20	20	20	80	3	--	--	100
ILO 801X	Institute Level Optional Course -2	20	20	20	80	3	--	--	100
CSL801	Distributed Computing Lab	--	--	--	--	--	25	25	50
CSDL 801X	Department Level Optional Course -5 Lab	--	--	--	--	--	25	25	50
CSDL 802X	Department Level Optional Course -6 Lab						25	25	50
CSP801	Major Project- 2	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	--	**175**	**125**	**700**

Textbooks and References

T1	Andrew S. Tanenbaum and Maarten Van Steen, “Distributed Systems: Principles and Paradigms”, 2 nd edition, Pearson Education.
T2	Mukesh Singhal, Niranjan G. Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", MC Graw Hill education.
T3	Pradeep K. Sinha, "Distributed Operating System-Concepts and design", PHI.
R1	M. L. Liu, ―Distributed Computing Principles and Applications, Pearson Addison Wesley, 2004
R2	George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005
R3	Andrew S. Tanunbaum “Distributed Operating system” Low price edition, Pearson Education.
	Useful Links
L1	https://nptel.ac.in/courses/106106107
L2	https://nptel.ac.in/courses/106106168
L3	http://csis.pace.edu/~marchese/CS865/Lectures/Chap7/Chapter7fin.htm
L4	https://nptel.ac.in/courses/106104182

Module No	Unit No	Topics	Books	Portion (From Book)
1	**Introduction to Distributed Systems CO1**		**4 Hrs**	
	1.1	Characterization of Distributed Systems: Issues, Goals, Types of distributed systems, Grid and Cluster computing Models, Hardware and Software Concepts: NOS, DOS	**T1** **R3**	**1.1, 1.2, 1.3.1** **1.3,1.4**

	1.2	Middleware: Models of middleware, Services offered by middleware	**R2**	**1.1-1.5**
2	**Communication**	**CO2**	**4 Hrs**	
	2.1	Interprocess communication (IPC): Remote Procedure Call (RPC), Remote Method Invocation (RMI)	**T1** **R2**	**4** **(2.1-,2.3)**
	2.2	Message Oriented Communication, Stream Oriented Communication, Group Communication. (ordering)	**T1** **T3**	**4** **3.10**
3	**Synchronization**	**CO3**	**10 Hrs**	
	3.1	Clock Synchronization: physical clock, Logical Clocks, Election Algorithms, Distributed Mutual Exclusion algorithms, Requirements of Mutual Exclusion Algorithms, Performance measure, Non- token Based (Lamport Algorithm, Ricart–Agrawala's Algorithm, Maekawa's Algorithm), Token based (Suzuki-Kasami's Broadcast Algorithms ,Raymond's Tree based Algorithm) and Comparative Performance Analysis.	**T1** **T2**	**6.1, 6.2, 6.5** **6.3 to 6.14**
	3.2	Deadlock: Introduction, Centralized, Chandy - Misra_Hass Algorithm.	**R3**	**3.5**
4	**Resource and Process Management**	**CO4**	**10 Hrs**	
	4.1	Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach	**T3**	**7**
	4.2	Introduction to process management, process migration, Code Migration	**T3** **T1**	**8.2** **3.5**
5	**Replication, Consistency and Fault Tolerance**		**8 Hrs**	**CO5**
	5.1	Distributed Shared Memory: Architecture, design issues.	**T3**	**5.2,5.3**
	5.2	Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management.	**T1** **/ L3**	**7**
	5.3	Fault Tolerance: Introduction, Process resilience, Recovery.	**T1**	**8.1, 8.2, 8.6**
6	**Distributed File Systems**	**CO6**	**8 Hrs**	
	6.1	Introduction and features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Case Study: Network File System (NFS).	**T1** **R2**	**9.1 to 9.7** **8**
	6.2	Designing Distributed Systems: Google Case Study.	**R2**	**9**

Lesson Plan

Teacher-in-Charge: Merly Thomas

Class	***BE (Computer Engineering) Semester VIII***		
Academic term	**Jan – May 2023**		
Subject	***Distributed Computing***		
Subject Code	***CSC 801*** ***CSL 802***		
No of Students	***71***		
Periods (Hours) per week	***Lecture***	***3***	
	Practical	***2***	
	Tutorial	***--***	
Evaluation System		***Hours***	***Marks***
	Theory examination	3	80
	Internal Assessment	1+1	20
	Practical Examination	--	--
	Oral Examination	--	25
	Term work	--	25
	Total	--	150

Time Table w.e.f 23/01/2023 to 21/04/2023

Time Table	***Day***	***Time***
(Theory)	Wednesday	11.15-12.15 pm
	Thursday	12.15-1.15 pm
	Friday	10.00 – 11.00 am
(Practicals)	Tuesday	1.45-3.45 pm (A Batch)
	Tuesday	1.45-3.45 pm (D Batch)
	Wednesday	1.45-3.45 pm (C Batch)
	Thursday	1.45-3.45 pm (B Batch)

Course Content and Lesson plan: **Distributed Computing**					
Module 1: **Introduction to Distributed Systems**					
01	**Lecture No.**	**Date**		**Topic**	**Remarks(If any)**
		Planned	**Actual**		
1.1	1	10/01/2023	10/01/2023	Characterization of Distributed Systems: Issues of distributed systems	
	2	11/01/2023	11/01/2023	Goals, and types of distributed systems	
	3	13/01/2023	13/01/2023	Distributed System Models, Hardware concepts,	
1.2	4	17/01/2023	17/01/2023	Software Concept	
	5	19/01/2023	19/01/2023	Middleware: Models of Middleware	
	6	20/01/2023	20/01/2023	Services offered by middleware	
	7	20/01/2023		Client Server models	Assignments Seminars
Module 2 : **Communication**					
2.1	8	25/01/2023	25/01/2023	Layered Protocols, Inter process communication (IPC)	
	9	27/01/2023	27/01/2023	Remote Procedure Call (RPC)	
	10	01/02/2023		Remote Object Invocation, Remote Method Invocation (RMI)	
	11	02/02/2023		MPI – Message Passing Interface	
	12	03/02/2023		Message Types, Message Oriented Communication	
2.2	13	08/02/2023		Stream Oriented Communication	
	14	09/02/2023		Group Communication	
	15	10/02/2023		DCE	Case Study
		10/02/2023		Group Communication	
Module 3: **Synchronization**					
3.1	16	15/02/2023		Clock Synchronization, Logical Clocks	

	17	16/02/2023		Election Algorithms, Mutual Exclusion	
	18	17/02/2023		Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithms	Flipped Class Room
	19	22/02/2023		Requirements of Mutual Exclusion Algorithms, Performance measure.	
3.2	20	23/02/2023		Non Token based Algorithms: Lamport Algorithm, Ricart-Agrawala's Algorithm, Maekawa's Algorithm	
	21	24/02/2023		Non Token based Algorithms: Comparative Performance Analysis	
3.3	22	02/03/2023		Token Based Algorithms: Suzuki-Kasami's Broadcast Algorithms,	
	23	03/03/2023		Singhal's Heuristics Algorithm, Raymond's Tree Based Algorithm	
	24	08/03/2023		Token Based Algorithms: Comparative Performance Analysis	
Module 4: **Resource and Process Management**					
4.1	25	09/03/2023		Desirable Features of global Scheduling algorithm, Task assignment approach	
	26	10/03/2023		Load balancing approach	
	27	15/03/2023		Load sharing approach	
4.2	28	16/03/2023		Introduction to process management, process migration, ,	
		17/03/2023		Threads, Virtualization	
		22/03/2023		Clients, Servers, Code Migration	
Module 5: **Consistency, Replication and Fault Tolerance**					
	29	23/03/2023		Introduction to replication and consistency, Data-Centric Consistency Models, Replica	

				Management	
	30	24/03/2023		Client- Centric Consistency Models, Replica Management	
	31	29/03/2023		Fault Tolerance: Introduction, Process resilience,	
	32	30/03/2023		Reliable client-server and group communication, Recovery	
Module 6: **Distributed File Systems and Name Services**					
	33	31/03/2023		Introduction, good features of DFS,	
	34	05/04/2023		File models, File Accessing models	
	35	06/04/2023		File-Caching Schemes, File Replication	
	36	07/04/2023		Network File System(NFS)	Case Study
	37	08/04/2023		Hadoop Distributed File System and Map Reduce	Case Study
	38	12/04/2023		Designing Distributed Systems: Google Case Study.	
	39	13/04/2023		Introduction to Name services and Domain Name System, Directory Services	
	40	14/04/2020			Case Study Seminar