COURSE NAME: **Distributed Computing**

(A Program Elective for CSE students) L-T-P-C: 3 - 1 - 0 - 4

1. OUTLINE:

This course introduces general introductory concepts in the design and implementation of Distributed Systems, covering all theoretical and practical aspects of the major branches such as Cloud Computing, Grid Computing, Cluster Computing, Supercomputing, and Many-core Computing. The classes will cover theoretical aspects in Practice - Theory - Practice Mode. The corresponding projects will focus on the programming aspects of the course.

2. OBJECTIVES:

This course on distributed algorithms will illustrate the basic techniques needed to design and analyse efficient distributed algorithms and suitable data structures for various problems in various domains that need scalable approaches for handling a huge volume of data. This course will provide practical and theoretical knowledge on solving complex tasks that involve scalable data collections. It would also lay the foundation of building high performance systems.

3. PRE-REQUISITES:

Any course on the Design and Analysis of Algorithms, or its equivalent:

a) Must have sufficient exposure to various algorithm - analysis techniques such as asymptotic notations, recurrences and amortized analysis
b) Must be aware of basic algorithm design techniques, such as divide-and-conquer, greedy approaches and dynamic programming.
c) Must have a good knowledge in basic probability theory, and ability to handle basic data structures (for example, binary trees, heaps, and hashing).

4. COURSE OUTLINE (TOPICS):

The following list of topics is very tentative.
Based on available time slots, some topics may be dropped or added or reordered.

- Introduction
- Design issues and challenges
- A model of distributed computations
- Logical time
- Global state and snapshot recording algorithms
- Topology abstraction and overlays
- Message ordering and group communication
- Group communication

- Termination detection
- Distributed mutual exclusion algorithms
- Deadlock detection in distributed systems
- Distributed shared memory
- Checkpointing and rollback recovery
- Consensus and agreement algorithms
- Authentication in distributed systems
- Self-stabilization
- Peer-to-peer computing and overlay graphs

(a) Case Studies: Discrete Event Simulations
Token based Message passing
Distributed Sorting on a line network
Distributed routing algorithms

(b) Case Studies: GFS, HDFS, Map Reduce and Spark
Google File System and HDFS
Distributed Execution using Map Reduce
Introduction to Spark

(c) Case Studies: Authentication & Security in DS
Authentication in Distributed Systems
Security in Distributed Systems and BlockChain

5. BOOKS:

(A) TEXTBOOKS:

a) Ajay D. Kshemkalyani and Mukesh Singhal
Distributed Computing: Principles, Algorithms, and Systems
Cambridge University Press, 2008, Cambridge, UK, ISBN (e-Book): 978-0-511-39341-9

b) Gerard Tel
Introduction to Distributed Algorithms
Cambridge University Press, June 2012, ISBN (e-book): 9781139168724

(B) REFERENCE BOOKS:

a) Nancy A. Lynch
Distributed Algorithms
Morgan Kaufmann, USA, ISBN: 1-55860-348-4, 1996

b) Andrew S. Tanenbaum and Maarten Van Steen
Distributed Systems: Principles and Para: Principles and Paradigms

Pearson Education India; Second edition, 2015, ISBN: 978-9332549807

c) George Coulouris, Jean Dollimore and Tim Kindberg
Distributed Systems: Concepts and Design
Pearson Education India; 4th edition, 2008, ISBN: 978-8131718407

d) Sukumar Ghosh
Distributed Systems: An Algorithmic Approach, Second Edition
CRC Press, Taylor & Francis, 2007

6. COURSE GRADING - EVALUATION COMPONENTS:

Course grades will be based on the following weightage pattern. This is purely indicative and necessary modifications would be made by the faculty depending on the intensity of the different work assigned for various tasks.

a) EXAMINATIONS: 50%
Mid Semester Exam: 20%
End Semester Exam: 30%

b) RESEARCH WORK / TAKE HOME ASSIGNMENTS: 25%
Problem Understanding, design of approaches using DC approaches and implementation of the proposed solutions with 2 - 3 baseline state-of-the-art techniques.

c) CLASS PARTICIPATION (SURPRISE QUIZZES): 10%
This weightage is to provide different options for exploring new and innovative solutions for a given problem using Distributed Approaches.

d) SCHEDULED QUIZZES: 15%
This weightage is to provide different options for exploring new and innovative solutions for a given problem using Distributed Approaches.

7. ETHICS:

Please note down the following activities leading to a fair academic honesty:

a) All class work is to be done independently.
b) It is best to try to solve problems on your own, since problem solving is an important component of the course, and exam problems are often based on the outcome of the assignment problems.
c) You are allowed to discuss class material, assignment problems, and general solution strategies with your classmates. But, when it comes to formulating or writing solutions

you must work alone.

d) You may use free and publicly available sources, such as books, journal and conference publications, and web pages, as research material for your answers. (You will not lose marks for using external sources.)

e) You may not use any paid service and you must clearly and explicitly cite all outside sources and materials that you made use of.

f) The use of uncited external sources as portraying someone else's work as your own is a violation of the University's policies on academic dishonesty.

g) Such Instances will be dealt with harshly and typically result in a failing course grade.

8. RESOURCES:

a) Distributed Systems (6.824: Spring 2020)
By Robert Morris, CSAIL, MIT, USA
https://pdos.csail.mit.edu/6.824/

b) Distributed Systems (15-440, Fall 2012)
By David Andersen, Randy Bryant
Carnegie Mellon University, Pittsburgh, PA 15213-3891
Link: https://www.cs.cmu.edu/~dga/15-440/F12/index.html

c) Introduction to Distributed Computing (CS 495)
By Prof. Ioan Raicu, Illinois Institute of Technology
Link: http://www.cs.iit.edu/~iraicu/teaching/CS495-F12/index.html