Distributed Systems and Algorithms

CSCI 4510/6510 – Fall 2024

Prof. Stacy Patterson

Course Description

This course explores the principles of distributed computing systems, emphasizing fundamental issues underlying the design of such systems: communication, coordination, synchronization, and fault-tolerance. We will study key algorithms and theoretical results and explore how these foundations play out in modern systems and applications like cloud computing, edge computing, and peer-to-peer systems.

Below is a list of course topics and a preliminary schedule. The instructor may change the order and the contents depending on students' backgrounds and other considerations.

Lecture 1: Introduction to Distributed Systems

Lecture 2: Primary-Backup Replication

Lectures 3-4: Clocks and the ordering of events in distributed systems

Lectures 5-6: The Replicated Log and Dictionary Problem

Lectures 7-10: Distributed Mutual Exclusion

Lectures 11-12: Distributed Snapshots

Lectures 13- 14: Consensus and Paxos

Lectures 15-16: Leader Election

Lectures 17-18: FLP Theorem

Lectures 19-21: Byzantine Agreement

Lectures 22-23: Commit Algorithms

Lectures 24-25: Broadcast Algorithms

Lectures 26-27: Distributed Hash Tables and Amazon Dynamo

Lecture 28: Blockchain

Pre-requisites

- CSCI-2300: Introduction to Algorithms
- CSCI-4210: Operating Systems

Learning Outcomes

Upon successful completion of this CSCI 4510 and 6510, a student is able to:

- Understand and apply different models and abstractions for distributed systems
- Describe and analyze key algorithms for distributed systems
- Identify fundamental limitations and impossibility results for distributed systems
- Implement distributed algorithms in real-world distributed computing platforms
- Understand and identify applications of distributed algorithms in real-world systems

In addition, on successful completion of CSCI 6510, a student is able to:

- Read and analyze research papers on distributed systems and algorithms
- Develop and analyze novel distributed algorithms

Textbook

Distributed Systems: Concepts and Design, 5th Edition by G. Coulouris, J. Dollimore, T. Kindberg and G. Blair.

Grading

Grades will be based on the following:

- Quizzes: 50%
- Homework: 50%
    - Homework 1: 10%
    - Homework 2: 10%
    - Homework 3: 15%
    - Homework 4: 15%

Quiz grades will be posted in Gradescope. Homework grading will be done in Submitty and Gradescope.

The following chart will be used as a starting point to assign course letter grades (grades will be rounded up to the nearest integer). The cutoff points may be lowered, and a different curve may be used for CSCI 4510 and CSCI 6510. Note that for students in CSCI 6510, any grade below a C- will be considered failing.

	B+: 87 – 89	C+: 77 – 79	D+: 67 – 69	F: 0 – 59
A: 93 – 100	B: 83 – 86	C: 73 – 76	D: 60 – 66	
A-: 90 – 92	B-: 80 – 82	C-: 70 – 72		

Quizzes

There will be five in-class quizzes, each worth 10% of the course grade. Each quiz will consist of 3 to 4 short-answer questions. Requests for quiz regrades must be made within 7 days of their return.

Homework

There will be four homework assignments. Each assignment will have a coding component and question component. The coding components may be done in groups of 1 or 2. The question components must be done individually. There may be different homework requirements and problems for students enrolled in CSCI-4510 and CSCI-6510. For the coding component of homework, CSCI 4510 students may pair up with CSCI 6510 students, but they must complete the CSCI 6510 requirements.

Student Accommodations

Federal law requires all colleges and universities to provide specified types of assistance to students with disabilities. If you have such special assistance, please obtain an authorizing memo from Disability Services for Students. Information about a student's special needs will be treated as confidential. Please submit a copy of your authorizing memo to the professor at least two weeks in advance of any affected assignment. Failure to do so may result in a lack of special accommodations.

Academic Integrity

Student-teacher relationships are built on trust. For example, students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that the assignments that students turn in are their own. Acts that violate this trust undermine the educational process. The Rensselaer Handbook of Student Rights and Responsibilities and The Graduate Student Supplement define various forms of Academic Dishonesty and you should make yourself familiar with these.

For the coding component of homeworks, discussion between teams is allowed, but code sharing is not. You must write your own code. You may use generative AI tools for help with small code fragments (e.g.,

how to create a UDP socket in Python). You must keep your code private, even after the homework deadline.

For the question/answer component of homework, discussion is allowed, but each student must formulate and write their own answers. You may not use generative AI for this component.

No collaboration is allowed on quizzes.

Violation of these policies will be considered a breach of academic integrity. The minimum penalty for any violation is a course letter grade reduction. Violations of academic integrity may also be reported to the Dean of Students. If you have any question concerning this policy before submitting an assignment, please ask for clarification. In addition, you can visit the following site for more information on our Academic Integrity Policy: Students Rights, Responsibilities, and Judicial Affairs.