Distributed Systems and Algorithms
CSCI 4510/6510 – Fall 2018

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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
> **Lectures 2-3**: Clocks and the ordering of events in distributed systems
> **Lectures 4-5**: The Distributed Log Problem
> **Lectures 6-9**: Distributed Mutual Exclusion
> **Lectures 10-11**: Global Snapshots
> **Lectures 12-17**: Distributed Agreement
> **Lectures 18-19**: Byzantine Agreement
> **Lecture 20**: Commit Protocols
> **Lectures 21-22**: Broadcast Algorithms
> **Lecture 23**: Leader Election
> **Lectures 24-26:** Consistency Models and Replication Algorithms
> **Lectures 26-27**: Consistent Hashing and Distributed Hash Tables
> **Lecture 28**: Amazon Dynamo

Pre-requisites

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

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

There is no required textbook for this course. All course material will be presented in lecture, and conference and journal papers related to this material will be posted on the course web site.

An optional, supplementary textbook is: *Distributed Systems: Concepts and Design, 5th Edition* by G. Coulouris, J. Dollimore, T. Kindberg and G. Blair.
This text may describe different algorithm variations than those I present in class. You are responsible for learning the algorithms versions and content presented in lecture.

Grading

Grading will be based on the following:
- Quizzes: 50%
- Take-home Final Exam: 15%
- Programming Project 1: 15%
- Programming Project 2: 20%

Grades for quizzes and the final exam will be posted in Gradescope. Grades for the programming projects will be posted in Submitty.

The following chart will be used to assign course letter grades. Grades will be rounded to the nearest integer. I may lower the cutoff points, and a different curve may be used for CSCI 4510 and CSCI 6510.

	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 5 in-class quizzes. Each quiz will be about 45 minutes. Quizzes will be announced at least 1 week before the quiz date (usually 2 weeks). Requests for quiz regrades must be made within 7 days of their return. Quiz makeups will only be given if you have an excused absence from RPI.

Final Exam

The final exam will be a comprehensive, take-home exam. It will be an open notes exam, and it will be due in the last week of classes. More details will be given closer to the end of the semester.

Programming Projects

There will be two programming projects in which students will implement applications using algorithms studied in class. The projects will be done in groups of two, unless the professor approves otherwise. There will be slightly different project requirements for CSCI 4510 and CSCI 6510.

 For each project, students must submit their code and a project report and give a demonstration of their application. Late code, reports, and demonstrations will not be accepted.

Students with Special Needs

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 me at least two weeks in advance of any affected assignment. Failure to do so may result in a lack of special accommodations.

Academic Integrity

For programming assignments, discussion is allowed, but you must write all of your own code. Unless otherwise specified by the instructor, quizzes will be closed book and will be done independently. The policy for the final exam will be announced closer to the exam date.

Violation of the policies for projects, quizzes, or exams will be considered a breach of academic integrity, and the student will be subject to penalties outlined in The Rensselaer Handbook of Student Rights and Responsibilities, including "an academic (grade) penalty administered by the professor and/or disciplinary action through the Rensselaer judicial process described in this handbook."