Distributed Systems and Algorithms
CSCI 4510/6510 – Fall 2021
Prof. Stacy Patterson
http://www.cs.rpi.edu/~pattes3/dsa/

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 4-6: The Replicated Log and Dictionary Problem
Lectures 7-10: Distributed Mutual Exclusion
Lectures 11-12: Distributed Snapshots
Lectures 13-14: Commit Protocols
Lecture 15-17: Paxos
Lectures 18: Leader Election
Lectures 19-20: Impossibility of Consensus
Lectures 21-23: Byzantine Agreement
Lectures 24-25: Broadcast Algorithms
Lectures 26-27: Replication 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
There is no required textbook for this course. All course material will be presented in the lectures, and conference and journal papers related to this material will be posted on the course web site.

This text may describe different algorithm variations than those presented in class. You are responsible for learning the algorithms versions and content presented in lecture.

**Grading**

Grades will be based on the following:

- Exams: 60%
- Projects: 40%
  - Project 1: 5%
  - Project 2: 15%
  - Project 3: 20%

Exam grades will be posted in Gradescope. Project grading will be done in Submitty.

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.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>93 – 100</td>
</tr>
<tr>
<td>A-</td>
<td>90 – 92</td>
</tr>
<tr>
<td>B</td>
<td>83 – 86</td>
</tr>
<tr>
<td>B-</td>
<td>80 – 82</td>
</tr>
<tr>
<td>C</td>
<td>73 – 76</td>
</tr>
<tr>
<td>C-</td>
<td>70 – 72</td>
</tr>
<tr>
<td>D</td>
<td>67 – 69</td>
</tr>
<tr>
<td>D-</td>
<td>60 – 66</td>
</tr>
<tr>
<td>F</td>
<td>0 – 59</td>
</tr>
</tbody>
</table>

**Exams**

There will be five exams, each worth 12% of the course grade. Each exam will consist of 3 to 5 short-answer questions.

Requests for exam regrades must be made within 7 days of their return. Makeup exams are generally not allowed, but please contact the professor if you encounter extenuating circumstances.

**Programming Projects**

There will be three programming projects in which you will implement applications using algorithms studied in class. There may be different project requirements for students enrolled in CSCI 4510 and CSCI 6510. For team projects, CSCI 4510 students must pair up with other CSCI 4510 students and CSCI 6510 students must pair up with other CSCI 6510 students.

**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 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**

For exams, no collaboration is allowed. For programming assignments, discussion is allowed, but you must write all of your own code unless explicitly given permission to do otherwise.

Violation of the policies for projects 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."