

CSCI 5673/ECEN 5673: Distributed Systems Spring 2021

Instructor

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Short Description

A distributed system is comprised of multiple computing devices interconnected with one another via a loosely-connected network. Almost all computing systems and applications today are distributed in nature for a variety of reasons, including resource sharing, fault tolerance, performance, security and geography. This course provides an in-depth coverage of the underlying principles and practices involved in the design, implementation and evaluation of a distributed system. The course will be divided into two parts. The first part will focus on the foundations of distributed system design, and the second part will focus on the current, state-of-the-art distributed systems technologies, including Internet-based services as well as distributed services built using small, mobile computing devices.

Prerequisite

- CSCI 5273 or a course in Computer Networks.

Reading Material

Selected papers from literature.

Class webpage

Please see <https://canvas.colorado.edu/>

Lectures and Office hours

This is a remote/online course. All lectures will be delivered live via Zoom and all office hours will be held over Zoom. Zoom links will be provided on the Canvas course page. Lecture recordings will be posted on Canvas course page.

Grading (*Weights assigned are tentative*)

- Homework and programming assignments: 50%
- Course Project: 25%
- Exams and quizzes: 25%

- Homework assignments comprised of questions from lecture material and papers will be posted on Moodle every two or three weeks. You will typically have one week to submit the answers after an assignment has been posted.
- Course project will be a semester-long team project. Details will be provided in class.

POLICIES

Please see an accessible online version

at <https://www.colorado.edu/academicaffairs/student-syllabus-statements>

ACCOMMODATION FOR DISABILITIES

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

CLASSROOM BEHAVIOR

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression,

veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

PREFERRED STUDENT NAMES AND PRONOUNS

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

HONOR CODE

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu; 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

SEXUAL MISCONDUCT, DISCRIMINATION, HARASSMENT AND/OR RELATED RETALIATION

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

RELIGIOUS HOLIDAYS

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please notify me of any anticipated conflicts due to religious obligations as early in the semester as possible (at least two weeks before) so that there is adequate time to make necessary arrangements.

See the [campus policy regarding religious observances](#) for full details.

CLASS ATTENDANCE

You are expected to attend all lectures and stay up-to-date with the material posted on the class webpage. If you miss a lecture, you are responsible for finding out the material covered in that lecture. If you miss an exam or a quiz, a grade of zero will be assigned, unless the you explicitly receive a permission from the instructor. The instructor will grant permissions for only valid reasons.

REQUIREMENTS FOR COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert [CU Boulder Medical Services](#).

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policies on [COVID-19 Health and Safety](#) and [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

All students who are new to campus must complete the [COVID-19 Student Health and Expectations Course](#). Before coming to campus each day, all students are required to complete the [Buff Pass](#).

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Course Content

- ❖ Introduction
- ❖ Interprocess Communication
 - Review of TCP/IP
 - Remote Procedure Calls (RPC)
 - Local procedure calls – a review
 - Stub functions, parameter passing, server binding, Data representation
 - RPC: When things go wrong
 - IDL, RPC compilers
 - RPC Case Studies
 - Sun RPC, DCE RPC
 - DCOM, CORBA, JAVA RMI
 - SOAP/.NET webservices
 - XML RPC
 - gRPC
- ❖ Event Ordering
 - Happened before relation
 - Logical clocks
 - Vector clocks
- ❖ Clock Synchronization
 - Clock drift and clock skew
 - NTP and SNTP
- ❖ Consensus
 - Synchrony and failure models
 - Byzantine Generals problems
 - Consensus under different failure/synchrony models
 - Impossibility of consensus in asynchronous systems – FLP result
- ❖ Message Ordering
 - Group Communications – atomic broadcast protocols, group membership protocols
 - Gossip
 - FIFO, Causal and Total orders
 - Replicated state machines
 - Group communication systems from 80's and 90's
 - Raft, Paxos
- ❖ CAP Theorem
- ❖ Virtual Machines and Cloud Computing
 - Full virtualization vs para-virtualization
 - SaaS, IaaS and Paas
- ❖ Google File System
- ❖ Map Reduce and Hadoop
- ❖ Pregel, Spark, Storm
- ❖ Chubby, BigTable, ZooKeeper and ZAB

- ❖ Peer to Peer Systems
 - Napster, Gnutella, KaZaA, Skype
 - Bit Torrent, Darknet
 - Distributed Hash Tables: CAN, Chord, Kademlia, Pastry, Tapestry
- ❖ Large Scale Distributed Storage
 - Dynamo
 - Cassandra
 - Facebook's Haystack
- ❖ Current Research Topics