Lahore University of Management Sciences

CS 382 – Network Centric Computing
Spring 2022

Instructor	Zafar Ayyub Qazi
Room No.	SBASSE 9-G24A
Class timings	3:00pm-4:15pm Wednesdays and Fridays
Zoom meeting link for class lectures	
Email	zafar.qazi@lums.edu.pk
Office hours	TBA
TA	TBA
TA Office Hours	On LMS
Course URL (if any)	http://lms.lums.edu.pk

Course Teaching Methodology

- Live lectures twice a week during class timings on Zoom
- Lectures will be recorded, and recordings shared with students after each class. Recordings will be uploaded on YouTube.
- We will use piazza for course-related discussions; you can post questions related to lectures on piazza. Live questions will be taken over Zoom during the lectures
- The instructor and the TA will be holding online office hours per week via zoom

Note:
(1) Please create a zoom account with your **LUMS email address** if you don't have one already. You would NOT be able to attend lectures otherwise
(2) Make sure to familiarize yourself with features of zoom (https://zoom.us/) such as chat, raising a hand, and breakout rooms if you haven't already done so

Piazza Information
We will be using Piazza for class discussions and announcements. The system is highly catered for getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, post your questions on Piazza. Please signup on piazza using the following ink: piazza.com/lums.edu.pk/spring2022/cs382

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 minutes
Recitation/Lab (per week)	Nbr of Lec(s) Per Week		Duration	
Tutorial (per week)	Nbr of Lec(s) Per Week		Duration	

Course Distribution	
Core	
Elective	Yes
Open for Student Category	All
Close for Student Category	None

COURSE DESCRIPTION

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The main goal of this course is to introduce students to fundamental principles and concepts in designing large networked systems. The first part of the course covers network communication fundamentals, with the Internet as the case study; in this part, we cover the design of different layers in the network stack. In the second part of the course, we cover fundamental concepts in designing scalable and fault tolerant distributed applications. The course will provide students with hands-on experience to apply learnt concepts through multiple programming assignments.

COURSE PREREQUISITE(S)	
	• CS 200 (Introduction to Programming)

COURSE OBJECTIVES	
	• To teach students fundamental networking principles, concepts and protocols. • Study the principles and techniques behind the design of distributed systems. • Study the application of these principles and concepts in various real large scale distributed systems

Learning Outcomes	
	At completion of the course students should be able to: • Appreciate the key principles behind the design of the Internet • Articulate the organization of the Internet • List and define appropriate network terminology • List the differences and the relation between names and addresses in a network • List the factors that affect the performance of reliable delivery protocols • Implement a simple client-server socket-based application. • Design and implement a simple reliable protocol • Describe the organization of the network layer • Describe how packets are forwarded in an IP network • Describe the different approaches for intra-domain routing and inter-domain routing • List the scalability benefits of hierarchical addressing • Describe the congestion problem in a large network • Distinguish network faults from the other types of faults • Write a program that perform any required marshaling and conversion into message units, such as packets, to communicate interesting data between two hosts • Explain why perfect time synchronization is impossible over real networks • Explain how and when logical clocks can be used to solve coordination in distributed applications • Describe how consistent hashing works and what properties it provides. • Explain why no distributed system can be simultaneously consistent, available, and partition tolerant • Write a distributed program, to handle load distribution, coordination, replication, and failures • Describe how the MapReduce framework works, and decompose a problem (e.g., counting the number of occurrences of some word in a document) via map and reduce operations.

Grading Breakup and Policy

Programming Assignment(s): 35%
Quizzes: 35% (N-2 policy) (in-class, announced)
Final examination (comprehensive): 30% (synchronous exam)

This Spring, CS 382 will be run entirely online. Below, we describe how each type of assessment will be conducted.

Quizzes

- Quizzes will be announced, in-class, and follow N-2 policy.

- We will have a total of 9 quizzes in the course but only your best 7 quizzes will count towards your grade. An important purpose of having N-2 quizzes is to account for all issues (e.g., Internet connectivity, electricity outage, sickness, etc.) that may prevent you from taking the quiz. No request for a makeup quiz will be entertained if you miss up to 2 quizzes irrespective of the reason. In the exceptional situation in which you end up missing more than 3 quizzes, we will consider a makeup quiz only if there is a valid justification. In that case, we reserve the right to determine the mode of the quiz, which may be oral or textual.
- All quizzes will take place during class timings.
- All quizzes will be announced.

Exam

- There will be a comprehensive exam and will be conducted synchronously.
- The final exam will take place during the final exam week.

Programming Assignments

- Programming assignments are an integral part of this course and intended to provide students hands-on experience to apply learnt concepts. The assignments will be in Python language. There will be three programming assignments spread throughout the semester.
- Please note the following policies regarding the programming assignments. You are responsible adhering to these policies.
    - All deadlines are hard
    - All assigned work must be done individually (unless specified otherwise)
    - Re-grading can be requested within 2 days after grade reporting
    - Students must not share actual program code with other students.
    - Students must be prepared to explain any program code they submit.
    - Students must indicate with their submission any assistance received.
    - All submissions are subject to plagiarism detection.
    - Students cannot copy code from the Internet.
    - Students are strongly advised that any act of plagiarism will be reported to the Disciplinary Committee
- *Late Submission:* You should submit your work on an assignment on LMS before its due time. Most of the assignments will be divided into two parts, with split deadlines. If you submit your work late for any assignment (part), we will award you a fraction of the score you would have earned on the assignments had it been turned in on time, according to this sliding scale:
    - 90% for work submitted up to 24 hours late
    - 80% for work submitted up to 2 days late
    - 70% for work submitted up to 3 days late
    - 60% for work submitted up to 4 days late
    - 50% for work submitted after 5 days late

For example, if you should have earned 8/10 points but submitted 36 hours late, you will instead earn 6.4 points.

Besides the above policy, you are allowed five "free" late days during the semester (that can be applied to one of the assignments).

However, note that the last day to do any late submission is the final day of classes, even if you have free late days remaining.

Academic Honesty

The principles of truth and honesty are recognized as fundamental to a community of teachers and students. This means that all academic work will be done by the student to whom it is assigned without unauthorized aid of any kind. Plagiarism, cheating and other forms of academic dishonesty are prohibited. Any instances of academic dishonesty in this course (intentional or unintentional) will be dealt with swiftly and severely. Potential penalties include receiving a failing grade on the assignment in question or in the course overall. For further information, students should make themselves familiar with the relevant section of the LUMS student handbook.

Harassment Policy

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SSE, LUMS and particularly this class, is a harassment free zone. There is absolutely zero tolerance for any behaviour that is intended or has the expected result of making anyone uncomfortable and negatively impacts the class environment, or any individual's ability to work to the best of their potential. In case a differently-abled student requires accommodations for fully participating in the course, students are advised to contact the instructor so that they can be facilitated accordingly.

If you think that you may be a victim of harassment, or if you have observed any harassment occurring in the purview of this class, please reach out and speak to me. If you are a victim, I strongly encourage you to reach out to the Office of Accessibility and Inclusion at oai@lums.edu.pk or the sexual harassment inquiry committee at harassment@lums.edu.pk for any queries, clarifications, or advice. You may choose to file an informal or a formal complaint to put an end of offending behavior. You can find more details regarding the LUMS sexual harassment policy here. To file a complaint, please write to harassment@lums.edu.pk

SSE Council on Equity and Belonging

In addition to LUMS resources, SSE's Council on Belonging and Equity is committed to devising ways to provide a safe, inclusive and respectful learning environment for students, faculty and staff. To seek counsel related to any issues, please feel free to approach either a member of the council or email at cbe.sse@lums.edu.pk

Rights and Code of Conduct for Online Teaching

A misuse of online modes of communication is unacceptable. TAs and Faculty will seek consent before the recording of live online lectures or tutorials. Please ensure if you do not wish to be recorded during a session to inform the faculty member. Please also ensure that you prioritize formal means of communication (email, LMS) over informal means to communicate with course staff.

Makeup Policy

- Please refer to Student Handbook 2019-20, page 37, article 25, titled "Makeup Policy for Graded Instruments".
- *"In case N-X policy is implemented for an instrument having multiple sub instruments then petitions will not be accepted for that instrument".*

Examination Detail	
Midterm Exam	Yes/No: No
Final Exam	Yes/No: Yes Combine Separate: Duration: Exam Specifications:

Code of Conduct

1. When attending classes, please ensure that your video is turned off and your mic is muted unless you are asked to do so.
2. Only authenticated users will be to join class lectures on zoom – please make you join the zoom lectures through an account based on your LUMS email address.
3. All quizzes will be announced, and students must ensure that their devices are charged, and they have a stable internet connection (including smartphones).
4. All assessments including quizzes and the final exam will be timed. Make sure that you are able to start them on time.

5. During assessments students should be ready to open their video for invigilation by the course staff.

Schedule

Lecture	Topics	Recommended Readings	Assessments
1	Introduction		
2	Overview of the Internet	• Kurose and Ross (K&R) 8th edition: 1.1	
	Network Fundamentals and Design Principals		
3	Network Fundamentals	• Kurose and Ross (K&R) 8th edition: 1.3-1.4	
4	Network Design Principles	• Kurose and Ross (K&R) 8th edition: 1.5	
	Application Layer: Sockets, Web, HTTP, DNS, and Video Streaming		
5	Principles of Networked Applications	• Kurose and Ross (K&R) 8th edition: 2.1	**Quiz 1**
6	Web and HTTP	• Kurose and Ross (K&R) 8th edition: 2.2	
7	Domain Name Service (DNS)	• Kurose and Ross (K&R) 8th edition: 2.4	
8	Video Streaming and CDNs	• Kurose and Ross (K&R) 8th edition: 2.6	**Quiz 2**
	Transport Layer: Reliability and Congestion Control		
9	Overview of Transport Layer	• Kurose and Ross (K&R) 8th edition: 3.1, 3.2, 3.3	
10	Reliable Transport	• Kurose and Ross (K&R) 8th edition: 3.4	
11	Reliable Transport (Cont'd)	• Kurose and Ross (K&R) 8th edition: 3.4	
12	TCP Reliability	• Kurose and Ross (K&R) 8th edition: 3.5	**Quiz 3**
13	Congestion Control	• Kurose and Ross (K&R) 8th edition: 3.6	
14	Congestion Control and TCP	• Kurose and Ross (K&R) 8th edition: 3.7	**Quiz 4**
	Network Layer: Routing, Forwarding, and Addressing		
15	Fundamentals of Routing	• Kurose and Ross (K&R) 8th edition: 4.1	

16	Routing Approach: Link State Routing	• Kurose and Ross (K&R) 8th edition: 5.2.1	
17	Routing Approach: Distance-Vector Routing	• Kurose and Ross (K&R) 8th edition: 5.2.2	**Quiz 5**
18	Routing Approach: Distance-Vector Routing (Cont'd)	• Kurose and Ross (K&R) 8th edition: 5.2.2	
19	Addressing and Forwarding on the Internet	• Kurose and Ross (K&R) 8th edition: 4.3 & 4.4	**Quiz 6**
20	Border Gateway Protocol	• Kurose and Ross (K&R) 8th edition: 5.4	
21	SDN and Middleboxes	• Kurose and Ross (K&R) 8th edition: 4.4, 4.5, and 5.5	
Distributed Storage: DHTs, Consistent Hashing and Lookups			
22	Scalable Storage: DHTs and Consistent Hashing	Refer to slides	
23	Lookup Services	Refer to slides	**Quiz 7**
Coordination: Time Synchronization and Leader Election			
24	Time synchronization	• Tanenbaum (3rd Edition), Chapter 6.1	
25	Election algorithms	• Tanenbaum (3rd Edition), Chapter 6.3-6.4	**Quiz 8**
Replication, Consistency and Fault Tolerance			
26	Replication and Consistency	• Tanenbaum (3rd Edition), Chapter 8.1	
27	Fault Tolerance	• Tanenbaum (3rd Edition), Chapter 8.1	**Quiz 9**
Case Study: Big Data Processing Distributed System			
28	Scalable Big data processing with MapReduce	MapReduce paper by Google	
29	Last Lecture		
Textbook(s)/Supplementary Readings			

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Required Text

- Computer Networking: A Top-Down Approach, 8th Edition, by Jim Kurose and Keith Ross
- Distributed Systems: Principles and Paradigms, 3rd Edition, by Andrew S. Tanenbaum and Maarten Van Steen

Optional Texts

- Computer Networks: A Systems Approach, 5th edition, by Larry Peterson and Bruce Davie
- Distributed Systems: Concepts and Design – 4th Ed., George Colouris, Jean Dollimore, Tim Kindberg. Pearson 2006

Please note the syllabus above is tentative and can be subject to some changes.