# Course Syllabus: Computing Systems and Concurrency - CS 240

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| **Division** | Computer, Electrical and Mathematical Sciences & Engineering |
| **Course Number** | CS 240 |
| **Course Title** | Computing Systems and Concurrency |
| **Academic Semester** | Fall |
| **Academic Year** | 2019/2020 |
| **Semester Start Date** | 08/25/2019 |
| **Semester End Date** | 12/10/2019 |
| **Class Schedule** (Days & Time) | 02:30 PM - 04:00 PM \| Sun Wed |

## Instructor(s)

| Name | Email | Phone | Office Location | Office Hours |
|---|---|---|---|---|
| Marco Canini | marco@kaust.edu.sa | +966128080489 | 4418, 1, Al-Khawarizmi (bldg. 1) | By appointment only. |

## Teaching Assistant(s)

| Name | Email |
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| TBA | TBA |

## Course Information

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| **Comprehensive Course Description** | This course covers introductory material on the design and implementation of computer-based systems, with an emphasis on distributed systems. Students will gain an understanding of the principles and techniques behind the design of modern, reliable, and high-performance systems. Topics include server design, network programming, naming, transactions, concurrency and locking, consistency models and techniques, security, data-intensive computing and fault tolerance. Modern techniques and systems employed at some of the largest Internet sites (e.g., Google, Facebook, Amazon) will also be covered. Through programming assignments, students will gain practical experience in designing, implementing, and debugging real distributed systems. |
| **Course Description from Program Guide** | Operating systems design and implementation. Basic structure; synchronization and communication mechanisms; implementation of processes, process management, scheduling and protection; memory organization and management, including virtual memory; I/O device management, secondary storage and file systems. Concurrency at the hardware, programming language, and operating system level. |
| **Goals and Objectives** | -To give a sound foundation in fundamentals of computing systems<br>    › Theory<br>    › Practice<br>-To be exposed to the latest research results<br>-To put into practice what has been learned<br>    › As we believe the best way to learn the material is to build it, there will be a series of hands-on programming projects |

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| **Required Knowledge** | The equivalent of:<br>- An undergraduate course in computer system architecture.<br>- An undergraduate course in operating systems.<br>- An undergraduate course in concurrency control.<br>- Good programming skills.<br>- Knowledge and comfort with systems programming.<br>- Some knowledge of how computer networks function (TCP/IP) and experience with socket programming. |
| **Reference Texts** | No textbook is required for this class. We will make course material (slides, notes, readings) available from the course website and point out relevant references widely available. The following textbooks may be used for supplementary course material or as references for optional reading.<br>Textbooks<br><br>1. Distributed Systems: Principles and Paradigms by Andrew S. Tanenbaum and Maarten Van Steen, Second Edition, Prentice Hall<br><br>2. Guide to Reliable Distributed Systems by Kenneth P. Birman, Springer<br><br>3. Distributed Systems: Concepts and Design by George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, Fifth Edition, Addison Wesley<br><br>4. Introduction to Reliable and Secure Distributed Programming by Christian Cachin, Rachid Guerraoui, Luís Rodrigues, Springer<br><br>5. Principles of Computer System Design, by J.H. Saltzer and M.F. Kaashoek, ISBN 978-0-12-374957-4. |
| **Method of evaluation** | **50.00**% - Course Project(s)<br>**15.00**% - Midterm exam<br>**35.00**% - Final exam |
| **Nature of the assignments** | Each student will perform:<br>- Four projects.<br>- Two examinations.<br>The weights of the individual projects will vary slightly by the difficulty of the project.<br>The midterms will be in-class, open-notes exams. You can consult the following course materials: *slides, handouts (including labs and assigned readings), lecture notes.* Anything else is not allowed (except linguistic dictionaries). The final exam will be a open-notes exam, covering material from the whole semester, with slight emphasis on material covered since the last midterm. |
| **Course Policies** | - Cheating: Zero tolerance. If you cheat you will face severe sanctions, the least of which is an automatic F in the course and the strong possibility of dismissal from the university. Cheating includes but is not limited to:<br><br>1. Copying code from the Internet or other sources without instructor's prior knowledge and authorization.<br><br>2. Copy and paste from papers.<br><br>3. Not using the appropriate reference for one's.<br>When in doubt, ask the instructor and remain on the safe side.<br>- Lectures: You are expected to attend all lectures. If you will be absent, please inform the instructor. You are responsible for covering the material. I will not give additional lecture simply because you chose to miss class. During lectures, you need to turn off your phone and your laptops. You are required to abstain from eating or bringing food with you (water or other drinks are OK). You are expected to refrain from side discussions.<br>- Preparation: Certain lectures require a preparatory reading to be made prior to the lecture. You are expected to have done so.<br>- Late work: You should submit your work on an assignment (electronically) before its due time. All assignments will be due at 11:59pm on their selected days.<br>You have a total of 72 late hours to use throughout the semester (but not beyond December 6). After you have used up your late hours, each additional day late will incur a 10% lateness penalty (1 minute late counts as 1 day late). Submissions late by 3 days or more will no longer be accepted. Friday and Saturday both count as days. (Late days are tracked automatically, so you don't need to email before using one.)<br>We will grant no-penalty extensions only in the case of illness (with a doctor's note) or extraordinary circumstances (with the involvement of the dean of student affairs). If illness or an extraordinary circumstance will cause you to submit an assignment late, then you should discuss the matter with your instructor as soon as possible.<br>Please plan your work on the assignments so that travel, interviews, athletics, touring, student clubs, extracurricular activities, holidays, etc. do not cause you to submit it late. None of the above reasons nor a heavy academic workload constitute an extraordinary circumstance. |
| **Additional Information** | For a more up to date version of this syllabus, you are required to see the version of the syllabus on the class's web page. The class Web page will be announced on the first lecture. The class online discussion forum will be offered on the Piazza system. This instructor does not use Blackboard. |

| | | Tentative Course Schedule |
| | | *(Time, topic/emphasis & resources)* |
| Week | Lectures | Topic |
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| 1 | Sun 08/25/2019<br>Wed 08/28/2019 | Course overview<br>Case study: GFS |
| 2 | Sun 09/01/2019<br>Wed 09/04/2019 | Network communication and Remote Procedure Calls<br>Network file systems |
| 3 | Sun 09/08/2019<br>Wed 09/11/2019 | Time synchronization and logical clocks<br>Vector clocks and distributed snapshots |
| 4 | Sun 09/15/2019<br>Wed 09/18/2019 | Primary-backup replication<br>Two-phase commit, introducing safety and liveness |
| 5 | Sun 09/22/2019<br>Wed 09/25/2019 | University holiday<br>Consensus I: FLP Impossibility, Paxos |
| 6 | Sun 09/29/2019<br>Wed 10/02/2019 | Consensus II: Replicated State Machines, Raft<br>Byzantine Fault Tolerance |
| 7 | Sun 10/06/2019<br>Wed 10/09/2019 | Strong consistency and CAP Theorem |
| 8 | Sun 10/13/2019<br>Wed 10/16/2019 | Midterm review<br>Midterm |
| 9 | Sun 10/20/2019<br>Wed 10/23/2019 | Peer-to-Peer Systems and Distributed Hash Tables<br>Eventual consistency |
| 10 | Sun 10/27/2019<br>Wed 10/30/2019 | Mid-semester break<br>Scale-out key-value storage, Dynamo |
| 11 | Sun 11/03/2019<br>Wed 11/06/2019 | Concurrency Control |
| 12 | Sun 11/10/2019<br>Wed 11/13/2019 | Virtualization and Cloud computing |
| 13 | Sun 11/17/2019<br>Wed 11/20/2019 | Data-intensive computing |
| 14 | Sun 11/24/2019<br>Wed 11/27/2019 | Performance evaluation |
| 15 | Sun 12/01/2019<br>Wed 12/04/2019 | Security |
| 16 | Sun 12/08/2019 | Exams |

**Note**

The instructor reserves the right to make changes to this syllabus as necessary.