

CS 634: Architecture of Database Systems

University of Massachusetts Boston - Fall 2026

Class Syllabus

Course Description

Our everyday activities, our business and government management activities, and scientific discovery today are heavily based on generating, storing, managing, and accessing massive amounts of data. **We live in a data-driven world.** Database systems provide the necessary infrastructure to manage huge data collections. Modern data-intensive applications rely on sophisticated database systems to deliver performance, scalability, and reliability. This course provides an in-depth study of the internal architecture of database systems, focusing on the principles and mechanisms that underpin their design and implementation. Topics include data modeling using entity-relationship models, query languages (SQL), bufferpool manager, file organization, storage and memory management, indexing, and query processing. The course also covers core system components such as buffer pool management, transaction management, concurrency control, and recovery mechanisms to ensure correctness and fault tolerance. In addition, students will explore current research directions and emerging trends in data management, including Big Data platforms and NoSQL systems, through reading and critically reviewing research papers.

Course Objective

The objective of this course is to develop a deep understanding of database system internals and design trade-offs. Students will learn how to model, store, and query data using relational databases and understand key database internals. Through hands-on, team-based projects, the course illustrates how modern database systems are designed and implemented. Further, the course introduces emerging trends such as Big Data, NoSQL systems, and cloud-based data management. By the end of the course, students will be able to analyze and reason about the architecture of database systems, understand how core components interact to provide performance and correctness.

Prerequisites

CS 310, CS 430/630. Knowledge of C++ and Java, data structures, and algorithms is required.

Instructor

Tarikul Islam Papon

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Lecture Times and Places

TBD

Textbooks and Readings

- R. Ramakrishnan, J. Gehrke, "Database Management Systems", 3rd edition.
- [Supporting Material \(Including solved exercises\)](#)
- [Architecture of a Database System](#), by J. Hellerstein, M. Stonebraker and J. Hamilton
- [The Design and Implementation of Modern Column-store Database Systems](#), by D. Abadi, P. Boncz, S. Harizopoulos, S. Idreos, S. Madden

Web Resources

- [SQL Tutorial](#)
- SQLPlus quick guide: http://www.oraFAQ.com/wiki/SQL*Plus_FAQ
- [PL/SQL User's Guide and Reference](#) (from Oracle)
- [Intro to PL/SQL](#) (from Stanford Infolab)
- PostgreSQL [[Website](#)] [[Github](#)]
- MongoDB [[Website](#)]
- [Database of Databases](#)

Course Requirements & Grading

The course grade will break down as follows (minor alterations may occur):

Class Participation	5%
3 Written Assignments	25%
Midterm 1	20%
Paper Presentation	10%
Midterm 2	20%
Project	20%

Written Assignments: Approximately every three weeks, there will be one written assignment based on concepts taught in class.

Paper Presentation: Each student (or small group) will present a selected research paper related to database systems. The presentation will focus on clearly explaining the problem, key ideas, and contributions of the paper, and ensure that the class is engaged in a meaningful debate.

Class Project: Students will work in small groups on a course project that involves designing, implementing, or evaluating a component of a database system or a related data management problem. The project will emphasize applying course concepts and may include a written report and a final presentation.

Important Dates for CS 634

TBD: submit assignment 1

TBD: submit assignment 2

TBD: midterm 1

TBD: submit assignment 3

TBD: paper presentation

TBD: midterm 2

TBD: project submission

Attendance Policy

Class attendance is mandatory, and students are expected to participate actively in class by asking and answering questions. In case of missed class, students are responsible to get up-to-date with course materials and announcements.

Collaboration Policy

You are strongly encouraged to collaborate with one another in studying the lecture materials. You may discuss ideas and approaches to the assignments and projects with others (provided that you acknowledge doing so in your solution), but such discussions should be kept at a high level, and should not involve actual details of the code or of other types of answers. **You must complete the actual solutions on your own.**

Academic Integrity Statement

Education at UMass Boston is sustained by academic integrity. Academic integrity requires that all members of the campus community are honest, trustworthy, responsible, respectful, and fair in academic work at the university. As part of being educated here, students learn, exercise, increase, and uphold academic integrity. Academic integrity is essential within all classrooms, in the many spaces where academic work is carried out by all members of the UMass Boston community, and in our local and global communities where the value of this education fulfills its role as a public good. Students are expected to adhere to the Student Code of Conduct, including policies about academic integrity, delineated here: https://www.umb.edu/life_on_campus/dean_of_students/student_conduct

Accommodation Statement:

UMass Boston is committed to creating learning environments that are inclusive and accessible. If you have a personal circumstance that will impact your learning and performance in this class, please let me know as soon as possible, so we can discuss the best ways to meet your needs and the requirements of the course. If you have a documented disability, or would like guidance about navigating support services, contact the Ross Center for Disability Services by email (ross.center@umb.edu), phone (617-287-7430), or in person (Campus Center, UL Room 211). To receive accommodations, students must be registered with the Ross Center and must request accommodations each semester that they are in attendance at UMass Boston. For more information visit: www.rosscenter.umb.edu. Please note that the Ross Center will provide a letter for your instructor with information about your accommodations only and not about your specific disability.

Tentative Schedule

Date	Topic	Deliverables Due
Lecture 1	Course Logistics & Overview	
Lecture 2	Database Systems Architectures – Part 1	
Lecture 3	Database Systems Architectures – Part 2	
Lecture 4	Entity-Relationship Model	
Lecture 5	Introduction to SQL	
Lecture 6	File Organization & Storage Layer	
Lecture 7	Log-Structured Merge Trees	Assignment 1
Lecture 8	B+ Trees & Hash-based indexing	
Lecture 9	External Sorting	
Lecture 10	Query Processing with Relational Operators	
Lecture 11	Nested-Loop, Sort-Merge and Hash Joins	Assignment 2
Lecture 12	Query Optimization	
Lecture 13	Overview of Transaction Management	
Lecture 14	Midterm 1	
	Breaks	
Lecture 15	Concurrency Control	
Lecture 16	Concurrency Control Contd.	

Lecture 17	Recovery	
Lecture 18	Recovery Contd.	
Lecture 19	Application Development: JDBC	
Lecture 20	Oracle PL/SQL	Assignment 3
Lecture 21	NoSQL Systems	
Lecture 22	Research Paper Presentation	
Lecture 23	Research Paper Presentation	
Lecture 24	Research Paper Presentation	
Lecture 25	Research Paper Presentation	
Lecture 26	Research Paper Presentation	
Lecture 27	Midterm 2	
Lecture 28	Project Demonstration	
Lecture 29	Final Review	Final Project Submission