Course	Advanced Database Organization - CS 525 - 04/05
Instructor	Yousef M Elmehdwi
Term	Fall 2024
Meetings	MW 10:00 am - 11:15 am, SB 104

Instructor's Contact Information

Office Location 206B, Stuart Building

yelmehdwi At iit Dot edu

Office Hours W: 12:45 - 01:45 pm or by appointment

TA's Contact Information

TBA

Course Description

Databases management systems are a crucial part of most large-scale industry and open-source systems. This course provides comprehensive coverage of issues associated with database system development and an in-depth examination of structures and techniques used in contemporary database management systems (DBMSs). Students will learn about the inner workings of these exciting systems: Which algorithms are used? What are typical architectures used to build a system as complex as a DBMS? What are implementation strategies? These questions and more will be answered during the course.

The course is highly applied, emphasizing practical skills and habits through a series of programming assignments during which students will develop their own tiny DBMS like engine. We will cover the most important aspects/components of a DBMS: **storage and buffer management, indexing, query optimization, query execution**, and **concurrency control** and **recovery**.

This course is graduate-level introduction to the design and implementation of data management systems.

Prerequisite(s)

- Courses: CS425
- Programming experience in C/C++
- Unix OS and file system knowledge is helpful

Recoded Lectures

- All lectures will be recorded and uploaded to course Canvas right after each class. Students can access the recorded lectures whenever they need them.

Course Objectives

After attending the course students should:

- Understand the design decisions behind textbook DBMS architectures
- Know the trade-offs of various storage organization techniques
- Be able to build parts of a small-sized data processing system from scratch
- Understand the basics of query optimization
- Know standard implementations of relational operators such as join, aggregation, and set operations
- Be able to estimate the cost of executing an operator/query based on DB statistics
- Know standard database indexing techniques
- Understand concurrency control and recovery mechanisms

Suggested Texts, Readings, & Materials

The following text books will be helpful for following the course and studying the presented material. All four textbooks have their merits, but any one should be sufficient as reading material.

- Garcia-Molina, Ullman, and Widom, Database Systems: The Complete Book, 2nd Edition, Prentice Hall, 2008
- Elmasri and Navathe , Fundamentals of Database Systems, 6th Edition , Addison-Wesley , 2003
- Silberschatz, Korth, & Sudarshan, Database System Concepts, 6th Edition, McGraw Hill, 2010

Course Details:

Major topics will be covered in the course:

- Disk Storage and Buffer Management
- Indexing and Hashing
- Query Optimization
- Query Execution
- Concurrency control and Recovery
- Advanced Topics (if time permits)

Workload and Grading Policies

Programming Assignments: There will be several programming assignments during the course. Starting from a storage manager you will be implementing your own tiny database-like system from scratch. You will explore how to implement the concepts and data structures discussed in the lectures and readings. The assignments will require the use of skills learned in this course as well as other skills you have developed throughout your program. Each assignment will build upon the code developed during the previous assignment. In the end there will be an optional assignment for extra credit. Each of the regular assignments will have optional parts that give extra credit. All assignments have to be implemented using `C/C++`.

- **Assignment 1 - Storage Manager:** Implement a storage manager that allows read/writing of blocks to/from a file on disk.
- **Assignment 2 - Buffer Manager:** Implement a buffer manager that manages a buffer of blocks in memory including reading/flushing to disk and block replacement (flushing blocks to disk to make space for reading new blocks from disk).
- **Assignment 3 - Record Manager:** Implement a simple record manager that allows navigation through records, and inserting and deleting records.
- **Assignment 4 - B$^+$-Tree Index:** Implement a disk-based B$^+$-tree index structure.
  - Implement a disk-based B$^+$-tree index structure.

Mid Term and Final Exam: There will be a mid term and a final exam covering the topics of the course.

Quizzes: There will be two take home quizzes during the course. The main objective of the quizzes is to assess and evaluate your understanding of the topics covered in the course and prepare you for the exams. Quiz solutions have to submitted to Canvas.

Grading Policies Each student work product will be graded, and the student's final grade will be determined by assigning each category of work a weighted score according to the following distribution:

Programming Assignments	45% (10% + 10% + 12.5% + 12.5%)
Quizzes	5%
Mid Term Exam	20% 10/23/2024
Final Exam	30%

Letter Grade Distribution

Points	Grade
85 - 100	A
75 - 84	B
60 - 74	C
0 - 59	E

- No extra credit.
- Exams will be individual work, closed book, closed notes, no electronic devices, no bathroom breaks.

Other Policies

Ethics:

- Any behavior on any assignment or exam that could be considered copying or cheating will result in an immediate zero on the assignment for all parties involved, failure in the class, and notification of the Undergraduate or Graduate Dean's Office.
- We will check for plagiarism. *Conducting plagiarism is unethical and it has consequences including a lower grade, automatically failing a course etc.*
- Please see the IIT Code of Academic Honesty `https://web.iit.edu/student-affairs/handbook/fine-print/code-academic-honesty`.

Make-up Exams

- Only for officially proven health reasons.

Students with Disabilities:

- Reasonable accommodations will be made for students with documented disabilities.
- In order to receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources.
- The Center for Disability Resources (CDR) is located at 3424 S. State Street - 1C3-2 , 312 567.5744 or disabilities@iit.edu

Tentative Course Outline

The weekly coverage might change as it depends on the progress of the class.

Week	Content
Week 1	Introduction/ Hardware
Week 2	File and System Structure
Weeks 3-4	Indexing and Hashing
Weeks 5-8	Query Processing
Weeks 9-10	Crash Recovery
Weeks 11-12	Concurrency Control
Weeks 13-14	Transaction Processing
Week 15	Advanced topics

Important Dates

Week	Content
08/21	Coding Assignment 1 handed out
09/15	Coding Assignment 1 due
09/16	Coding Assignment 2 handed out
10/06	Coding Assignment 2 due
10/07	Coding Assignment 3 handed out
11/01	Coding Assignment 3 due
11/02	Coding Assignment 4 handed out
12/01	Coding Assignment 4 due
10/11	Quiz 1 handout
10/13	Quiz 1 due
11/15	Quiz 2 handout
11/17	Quiz 2 due
10/23	MidTerm Exam
TBA	Final Exam, During Final week

Illinois Tech's Sexual Harassment and Discrimination Information

- Illinois Tech prohibits all sexual harassment, sexual misconduct, and gender discrimination by any member of our community. This includes harassment among students, staff, or faculty. Sexual harassment of a student by a faculty member or sexual harassment of an employee by a supervisor is particularly serious. Such conduct may easily create an intimidating, hostile, or offensive environment.
- Illinois Tech encourages anyone experiencing sexual harassment or sexual misconduct to speak with the Office of Title IX Compliance for information on support options and the resolution process.
- You can report sexual harassment electronically at iit.edu/incidentreport, which may be completed anonymously. You may additionally report by contacting the `Title IX Coordinator, Virginia Foster` at `foster@iit.edu` or the Deputy Title IX Coordinator at `eespeland@iit.edu`.
- For confidential support, you may reach Illinois Tech's Confidential Advisor at `(773) 907-1062`. You can also contact a licensed practitioner in Illinois Tech's Student Health and Wellness Center at `student.health@iit.edu` or `(312)567-7550`
- For a comprehensive list of resources regarding counseling services, medical assistance, legal assistance and visa and immigration services, you can visit the Office of Title IX Compliance website at `https://www.iit.edu/title-ix/resources`.