Database Management Systems

DSAA 2031

3 Credits

Prerequisite: DSAA 2043

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Office Hours: Wednesday 9:00-10:00 am, E3 601

Course Description

Topics include: principles of database systems; conceptual modeling and data models; logical and physical database design; query languages and query processing; database services including concurrency, crash recovery, security and integrity. Hands-on DBMS experience.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Demonstrate a fundamental understanding of database conceptual design, ER-diagram, schema design.

2. Demonstrate a fundamental understanding of functional dependencies and relation normalization.

3. Understand and know how to use relational algebra and relational calculus.

4. Understand and know how to use SQL.

5. Understand and know how to use indexing structures.

6. Understand and know query processing and optimization.

7. Understand basic concept of transaction management and synchronization.

8. Understand database failure and recovery mechanisms.

Weekly Schedule and Weekly ILOs

Week	Topics	Weekly ILOs
1	Introduction to DBMS and basic SQL languages	ILO1, ILO4
2	SQL joins, subqueries, and aggregations	ILO4
3	Database creation, updates and constraints	ILO4
4	Accessing database with programming languages	ILO4
5	Advanced SQL queries and relational algebra	ILO3
6	Query optimization and ER models	ILO6

7	Database dependencies	ILO2
8	Database normalization	ILO2
9	Database indexes	ILO5
10	Transaction and concurrency control	ILO7
11	Recovery	ILO8
12	Advanced topics: vector databases	ILO1
13	Advanced topics: graph databases	ILO1

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Mid-term test	30%	11/04/2026
Written assignment	30%	18/05/2026
Final exam	40%	29/05/2026

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks

[add to/delete table as appropriate]

Assessed Task	Mapped ILOs	Explanation
Mid-term test	ILO1, ILO3, ILO4, ILO6	This task assesses students' ability to explain and apply design databases (ILO 1), use relational algebra and relational calculus (ILO 3), query databases (ILO 4), and optimize query optimization (ILO 6).
Final-exam	ILO1, ILO2, ILO3, ILO4, ILO5, ILO6, ILO7, ILO8	Besides ILOs 1, 3, 4, 6 explained in Mid-term test, final-exam will further test relational normalization using functional dependencies (ILO 2), database index structures (ILO 5), understand transaction management (ILO 7), and database recovery mechanism (ILO 8)
Written assignment	ILO1, ILO4, ILO5, ILO6	This is mainly done in labs, which is to ensure the students can be hands-on for writing code to interact, manage, and implement DBMSs

Grading Rubrics

Mid-term test grading rubrics

- Database Conceptual Design (ILO1)

Demonstrates understanding of ER-diagrams, schema design, and data modeling principles. (0-40 points)

- Relational Algebra & Calculus (ILO3)

Accurately applies relational algebra and relational calculus to solve problems. (0-30 points)

- SQL (ILO4)

Correctly writes and executes SQL queries to retrieve and manipulate data. (0-40 points)

- Query Optimization (ILO6)

Understands and applies indexing structures and query optimization techniques. (0-30 points)

Total: 100 points

Final-Exam Grading Rubric

- Database Conceptual Design (ILO1)

Demonstrates understanding of ER-diagrams, schema design, and data modeling principles. (0-20 points)

- Functional Dependencies & Normalization (ILO2)

Correctly identifies functional dependencies and normalizes relations. (0-20 points)

- Relational Algebra & Calculus (ILO3)

Accurately applies relational algebra and relational calculus to solve problems. (0-10 points)

- SQL (ILO4)

Correctly writes and executes SQL queries to retrieve and manipulate data. (0-15 points)

- Indexing Structures (ILO5)

Understands and applies indexing structures to improve query performance. (0-20 points)

- Query Optimization (ILO6)

Applies query optimization techniques to improve performance. (0-20 points)

- Transaction Management (ILO7)

Understands basic concepts of transaction management and synchronization. (0-10 points)

- Database Recovery Mechanisms (ILO8)

Understands database failure and recovery mechanisms. (0-15 points)

Total: 100 points

Written Assignment Grading Rubric

- Implement the basic storage of a relational database (ILO1)

Correctly implement database basic storage model (0-25 points)

- Implement database index methods (ILO5)

Correctly implement database index structures (e.g., B+-tree and hash) (0-25 points)

- Implement the query processing of a relational database (ILO6)

Correctly implement a database query processing module (Volcano Model) (0-25 points)

- Use SQL queries to query the database (ILO4)

Applying given SQL queries over the implemented database can efficiently return correct results (0-25 points)

Total: 100 points

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.
F	Fail	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

Authorized Use with Conditions: AI tools are allowed in written assignments, but with the following conditions:

- Statement of Use: Students must clearly state the extent to which they have used an AI tool in their assignment. This may include a percentage of the content generated by AI, or a detailed description of the specific tasks for which AI was used.

- Assessment of Understanding: Instructors and tutors reserve the right to ask follow-up questions to ensure that students fully understand the content of their assignments. Students should be able to explain the   AI tool's output and reproduce the results independently if necessary.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include specific details, e.g., strengths, areas for improvement. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Resubmission Policy

Required Texts and Materials

-   Database Systems: The Complete Book
    Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom (2nd Edition)
-   Database Management Systems
    Raghu Ramakrishnan, Johannes Gerhrke (3rd Edition)

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST(GZ)'s Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Regulations for Academic Integrity and Student Conduct for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

[Optional] Additional Resources

NA