SCS 1309 – Database Management Systems

Credits – 4 (3L + 1P)

Course Description

This course explores database management systems (DBMS), essential for efficiently organizing and managing large volumes of data. By the end of the course, students will have gained practical abilities in database design and querying, enabling them to use these skills effectively in real-world scenarios, thus promoting critical thinking and problem-solving abilities.

Number of Credits: 4 Credits (3L,1P)

Evaluation Criteria: Continuous Assessments: 40%, Final Examination: 60%

Intended Learning Outcomes:

ILO1: Demonstrate a solid understanding of database management systems (DBMS), including their structure, functions, and the differences between DBMS and traditional data storage methods.

ILO2: Develop proficiency in data modeling techniques, including identifying entities, relationships, and different types of relationships such as binary, unary, ternary, and special relationships.

ILO3: Apply principles of entity-relationship diagrams (ERDs) and relational model to design efficient and effective databases, considering conceptual, logical, and physical design aspects.

ILO4: Apply normalization techniques up to 4th normal form to ensure data integrity and minimize redundancy in database design.

ILO5: Utilize relational algebra and calculus to perform operations such as selection, projection, joins, division, set operations, and renaming on relational data.

ILO6: Demonstrate proficiency in SQL, including writing and executing basic to complex SQL statements, understanding aggregation operators, nested queries, handling null values, and implementing views, relations, stored procedures, and triggers.

ILO7: Apply critical thinking and problem-solving skills to real-world scenarios involving database management, including identifying and resolving issues related to database design, and querying.

Course Content

1. **Introduction to Database Management System (DBMS)**
    - 1.1. What is Data?
    - 1.2. Data storage methods: File Systems v DBMS
    - 1.3. Structure of DBMS
        - 1.3.1. Pros and cons of DBMS vs. Traditional Methods
        - 1.3.2. Roles in DBMS
    - 1.4. Advantages and Disadvantages of DBMSs
    - 1.5. Three-Level ANSI-SPARC Architecture

1.6. Database Languages
    1.6.1. Data Definition Language (DDL)
    1.6.2. Data Manipulation Language (DML)
1.7. Functions of a DBMS
1.8. Components of a DBMS

2. Data Modeling

2.1. Entities, Attributes, and Relationships
2.2. Binary relationships
2.3. Unary relationships
2.4. Ternary relationships
2.5. Special relationships

3. Database Design

3.1. Entity-Relationship Diagrams
3.2. Relationships and Relationship Sets
3.3. Conceptual Database Design
3.4. Enhanced Entity-Relationship (EER) Modeling
    3.4.1. Subclasses and Superclasses
    3.4.2. Specialization and Generalization
    3.4.3. Inheritance and Constraints

4. Relational Model

4.1. Fundamental idea of the relational model
4.2. Integrity constraints over relations and enforcement
4.3. Querying relational data

5. Logical Database Design: ER to Relational Mapping

5.1. Converting ER Model to Tables
5.2. Integration of EER Concepts

6. Database Normalization

6.1. Introduction to data normalization and normal forms
6.2. 1^{st}, 2^{nd}, 3^{rd} and 4^{th} Normal Forms
6.3. Normalization considerations
    6.3.1. Denormalization, Performance Considerations, Design Trade-offs

7. Relational Algebra and Calculus

7.1. Selection and Projection
7.2. Joins and Division
7.3. Set Operations and Renaming
7.4. Relational Calculus

8. **Structured Query Language**
    8.1. Basic syntax and execution of SQL statements
    8.2. Union, interaction, and except
    8.3. Aggregation operators
    8.4. Nested queries
    8.5. Null values
    8.6. What are Views?
    8.7. Deleting and Altering relations and views
    8.8. Complex integrity constraints
    8.9. Stored procedures
    8.10. Triggers

Recommended Textbooks

- Elmasri, R. and Navathe, S.B., 2015. *Fundamentals of database systems*. 7th Edition, Addison-Wesley.
- Ramakrishnan, R. and Gehrke, J., 2003. *Database management systems* (Vol. 3). New York: McGraw-Hill.
- DeBarros, A., 2022. Practical SQL: A Beginner's Guide to Storytelling with Data. No Starch Press.

Software Tools

- MS SQL Server