

DATABASE MANAGEMENT SYSTEMS

1. Introduction

Objective: The course mainly covers database design and the use of databases in applications, with a short introduction to back-end structure of database systems. It includes extensive coverage of the relational model, relational algebra, and SQL. The course also features database design, and relational design principles based on dependencies and normal forms. Many additional key database topics from the design and application-building perspective are also covered: indexes, views, transactions, authorization, integrity constraints, triggers, Emerging NoSQL systems like Cassandra and MapReduce will also be covered

Credits: 3-0-0

2. Course Outline

UNIT - I: Introduction

Characteristics of the Database Approach , Advantages of Using the DBMS Approach, A Brief History of Database Applications, Data Models, Schemas, Instances, Three-Schema Architecture and Data Independence , Database Languages and Interfaces, The Database System Environment, Centralized and Client/Server Architectures for DBMS, Classification of Database Management Systems

UNIT - II: Data Modeling using the ER/EER model (If needed)

Entity Types, Entity Sets, Attributes, and Keys , Relationship Types, Relationship Sets, Roles, Structural Constraints, Weak Entity Types, ER Diagrams, Naming Conventions, and Design Issues , Relationship Types of Degree Higher than Two, Subclasses, Superclasses, and Inheritance , Specialization and Generalization, Constraints and Characteristics of Specialization and Generalization Hierarchies, Modeling of UNION Types Using Categories.

UNIT - III: Relational model (ER/EER to relational mapping)

The relational model, Relational Model Constraints, Relational Database Schemas, Update Operations, Transactions, and Dealing with Constraint Violations, Querying relational databases, Relational Database Design Using ER-to-Relational Mapping, Mapping EER Model Constructs to Relations.

UNIT - IV: Relational Algebra

Relational Algebra operations from set theory, Binary Relational Operations: join and division, Additional Relational Operations, Examples of Queries in Relational Algebra, The Tuple Relational Calculus, the Domain Relational Calculus(Select, project, join) (Set operators, renaming, notation).

UNIT - V: Functional Dependencies & Normalisation

Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form , Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal form, Inference Rules, Equivalence, and Minimal Cover Properties of Relational Decompositions, Algorithms for Relational Database Schema Design, About Nulls, Dangling Tuples, and Alternative Relational Designs Further Discussion of Multivalued Dependencies and 4NF, Other Dependencies and Normal Forms.

UNIT - VI: SQL

Introduction to SQL, Basic SELECT statement, Table variables and set operators, Subqueries in WHERE clause, Subqueries in FROM and SELECT, The JOIN family of operators, Aggregation, NULL values, Data modification statements, Constraints and Triggers, Constraints of several types, Referential integrity, Views, Defining and using views, View modifications – introduction, View modifications using triggers, Automatic view modifications, Materialized views.

UNIT - VII: Concurrency and Parallelism

Transactions, properties of transactions, scheduling definitions, Locking, Lock based concurrency control, using strict 2phase locking and serialisability, Deadlocks, deadlock prevention/detection, multiple granularity locking.

UNIT - VIII: Indexing

Index motivation, what is stored in an index, operations on an index, datafile with several index files, high level of index structures, B-trees, Hash tables, B+trees, clustered vs unclustered index, sorting.

UNIT - IX: NoSQL, NewSQL, and Not-yet-SQL

Distributed storage using DHT's (Routing, joining, replication), NoSql overview (ACID vs BASE, Datamodel, Key value stores, Document stores, Extensible Record stores, Scalable relational systems, sort case studies-Dynamo, Cassandra)

OLAP and Cubes and Graph Processing are other topics which could be addressed if we take out ER/EER module.

3. Reading Material

Text Books

Fundamentals of Database Systems (6th edition) by Elmasri and Navathe

Reference Books

1. A First Course in Database Systems (3rd edition) by Ullman and Widom (same material and sections as Database Systems: The Complete Book (2nd edition) by Garcia-Molina, Ullman, and Widom)
2. Database Management Systems (3rd edition) by Ramakrishnan and Gehrke
3. Database System Concepts (6th edition) by Silberschatz, Korth, and Sudarshan