Database Management System

Course Title: Database Management System
Course No: CSC260
Nature of the Course: Theory + Lab
Semester: IV

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: The course covers the basic concepts of databases, database system concepts and architecture, data modeling using ER diagram, relational model, SQL, relational algebra and calculus, normalization, transaction processing, concurrency control, and database recovery.

Course Objective: The main objective of this course is to introduce the basic concepts of database, data modeling techniques using entity relationship diagram, relational algebra and calculus, basic and advanced features SQL, normalization, transaction processing, concurrency control, and recovery techniques.

Detail Syllabus:

Unit 1	**Database and Database Users**	**Teaching Hours (2)**
Introduction	Traditional file processing system; Definition of database and database management system with example	1 hr
Characteristics of the Database Approach	Self-describing nature of a database system; Insulation between programs and data, and data abstraction; Support of multiple views of the data; Sharing of data and multiuser transaction processing	
Actors on the Scene	Database administrators; Database designers; End users; System Analysts and Application Programmers	
Workers behind the Scene	DBMS system designers and implementers; Tool developers; Operators and maintenance personnel	1 hr
Advantages of Using the DBMS Approach	Controlling redundancy; Restricting unauthorized access; Providing persistent storage; Providing storage structures and search techniques for efficient query processing; Providing backup and recovery; providing multiple user interfaces; Enforcing integrity constraints; Reduced application development time; Flexibility; Availability of up-to-date information; Economies of scale	
Unit 2	**Database System – Concepts and Architecture**	**Teaching Hours (3)**
Data Models, Schemas, and Instances	Definition of data abstraction and data model; Categories of data models (high level, low level, and representational data models) – Introduction to entity-relationship model, relational data model, network data model, hierarchical model, network model, object data model, and self-describing data models; Concept of schema and instance	1 hr

Three-Schema Architecture and Data Independence	Concept of three-schema architecture; Logical and physical data independence	1 hr
Database Languages and Interfaces	Concept of DDL, SDL, VDL, DML, procedural and non-procedural languages; Concept of interfaces	
The Database System Environment	Concept of database system environment	
Centralized and Client/Server Architectures for DBMSs	Basics of centralized and client/server architectures	1 hr
Classification of Database Management Systems	Classification based on data models, number of users, number of sites, cost and type of access path	
Unit 3	**Data Modelling Using the Entity-Relational Model**	**Teaching Hours (6)**
Using High-Level Conceptual Data Models for Database Design	Concept of conceptual design	2 hrs
Entity Types, Entity Sets, Attributes, and Keys; Relationship Types, Relationship Sets, Roles, and Structural Constraints	Concept of entity types, entity sets, attributes, and keys; Concept of relationship types and relationship sets, roles and constraints	
Weak Entity Types	Concept of weak entity types and partial keys	
ER Diagrams, Naming Conventions, and Design Issues	Drawing ER diagrams using ER notations, naming conventions and design issues	2 hrs
Relationship Types of Degree Higher Than Two	Concept of higher degree relationships	
Subclasses, Superclasses, and Inheritance	Concept of enhanced ER (EER) model, superclasses, subclasses and subclasses	2 hrs
Specialization and Generalization	Concept of specialization and generalization	
Constraints and Characteristics of Specialization and Generalization	Different constraints and characteristics of specialization and generalization	
Unit 4	**The Relational Data Model and Relational Database Constraints**	**Teaching Hours (3)**
Relational Model Concepts	Concept of domain, attributes, tuples, and relations; Characteristics of relations; Relational model notation	2 hrs
Relational Model Constraints and Relational Database	Different categories of constraints; Domain constraints; Key and NULL values constraints;	

Schemas	Relational databases and relational database schemas; Entity integrity, referential integrity, and foreign key	
Update Operations, Transactions, and Dealing with Constraint Violations	Concept of insert, delete, and update operations; Concept of transactions	1 hr
Unit 5	**The Relational Algebra and Relational Calculus**	**Teaching Hours (5)**
Unary Relational Operations: SELECT and PROJECT	Concept and example of SELECT and PROJECT operations; Sequences of operations; RENAME operation	3 hrs
Relational Algebra Operations from Set Theory	Concept and example of UNION, INTERSECTION, MINUS, and CARTESIAN PRODUCT operations	
Binary Relational Operations: JOIN and DIVISION	Concept and example of JOIN operation and its variations; Concept and example of DIVISION operation	
Additional Relational Operations	Concept of generalized projection, aggregate functions, OUTER JOIN operations, and OUTER UNION operation	2 hrs
the Tuple Relational Calculus	Introduction to tuple relational calculus with examples	
the Domain Relational Calculus	Introduction to domain relational calculus with examples	
Unit 6	**SQL**	**Teaching Hours (8)**
Data Definition and Data Types	CREATE TABLE command; Attribute data types and domains; ALTER and DROP commands	1 hr
Specifying Constraints	Attribute constraints and attribute defaults; Key and referential integrity constraints	1 hr
Basic Retrieval Queries	SELECT-FROM-WHERE structure; Ambiguous attribute names, aliasing, renaming, and tuple variables; Unspecified WHERE clause and use of asterisk (*); Pattern matching and arithmetic operators	5 hrs
Complex Retrieval Queries	Comparisons involving NULL; Nested queries	
INSERT, DELETE, and UPDATE Statements	Concept and example of INSERT, DELETE, and UPDATE commands	1 hr
Views	Concept of views; CREATE VIEW command	
Unit 7	**Relational Database Design**	**Teaching Hours (7)**
Relational Database Design Using ER-to-Relational Mapping	Converting ER / EER models to relations with examples	1 hr
Informal Design Guidelines for Relational Schemas	Imparting clear semantics to attributes in relations; Redundant information in tuples and update anomalies; NULL values in tuples; Generation of	2 hrs

	spurious tuples	
Functional Dependencies	Definition and concept of functional dependencies with example	2 hrs
Normal Forms Based on Primary Keys	Concept of normalization; Practical use of normal forms; Keys and attributes participating in keys; Concept of first, second, and third forms with example	
General Definitions of Second and Third Normal Forms	General definitions of second and third normal forms	1 hr
Boyce-Codd Normal Form	Concept and example of boyce-codd normal form	
Multivalued Dependency and Fourth Normal Form	Definition and concept of multivalued dependencies with example; Concept of fourth normal form	1 hr
Properties of Relational Decomposition	Dependency preservation property and nonadditive (lossless) join property	
Unit 8	**Introduction to Transaction Processing Concepts and Theory**	**Teaching Hours (4)**
Introduction to Transaction Processing	Single-user versus multiuser system; Transactions, Database items, Read and write operations, and DBMS buffers; Why do we need concurrency control? Why do we need recovery?	1 hr
Transaction and System Concepts	Transaction states and operations; The system log; Commit point; Buffer replacement policies	1 hr
Desirable Properties of Transactions	Desirable properties of transactions	
Characterizing Schedules Based on Recoverability	Concept of schedule; Characterizing schedules based on recoverability	2 hrs
Characterizing Schedules Based on Serializability	Conflict serializability; Testing for conflict serializability; View equivalent and view seializability; How serializability is used for concurrency control	
Unit 9	**Concurrency Control Techniques**	**Teaching Hours (4)**
Two-Phase Locking Technique	Concept of two-phase locking; Types of locks and system lock tables; Lock conversion; Guaranteeing serializability by two-phase locking; Basic, conservative, strict, and rigorous two-phase locking; Dealing with deadlock and starvation	2 hrs
Timestamp Ordering	Timestamp ordering concurrency control concept; Basic and strict timestamp ordering; Thomas's Write rule	2 hrs
Multiversion Concurrency Control	Concept of multiversion concurrency control technique; Multiversion technique based on timestamp ordering; Multiversion locking using certify locks	
Validation (Optimistic) Techniques and Snapshot Isolation Concurrency Control	Concept of validation (optimistic) techniques and snapshot isolation concurrency control	

Unit 10	**Database Recovery Techniques**	**Teaching Hours (3)**
Recovery Concepts	Recovery outline and categorization of recovery algorithms; Caching (Buffering) of disk blocks; Write-ahead logging, steal/no-steal, and force/no-force; Checkpoints and fuzzy checkpointing; Transaction rollback and cascading rollback	2 hrs
NO-UNDO/REDO Recovery Based on Deferred Update	Concept of no-undo/redo recovery based on deferred update	
Recovery Technique Based on Immediate Update	Concept of recovery technique based on immediate update	
Shadow Paging	Concept of Shadow Paging	1 hr
Database Backup and Recovery from Catastrophic Failures	Concept of database backup and recovery from catastrophic failures	

Laboratory Works:
The laboratory work includes writing database programs to create and query databases using basic and advanced features of structured query language (SQL) like

- Data definition and data Types
- Specifying constraints (primary key, foreign key, referential integrity etc.)
- Basic and complex retrieval queries
- Aggregate functions
- INSERT, DELETE, and UPDATE Statements
- Using join and views

Text Books:

1. Fundamentals of Database Systems; Seventh Edition; Ramez Elmasri, Shamkant B. Navathe; Pearson Education
2. Database System Concepts; Sixth Edition; Avi Silberschatz, Henry F Korth, S Sudarshan; McGraw-Hill

Reference Books:

1. Database Management Systems; Third Edition; Raghu Ramakrishnan, Johannes Gehrke; McGraw-Hill
2. A First Course in Database Systems; Jaffrey D. Ullman, Jennifer Widom; Third Edition; Pearson Education Limited

Model Question

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Section A (Long questions)
Attempt any two questions. (2 × 10 = 20)

1. Consider the following database and write SQL as given:
   Customer (Cno, Cname, Caddress, Ccontact)
   Purchase (Cno,Pid)
   Product (Pid, Pname, price, quantity) (5 × 2 = 10)
   a. Find the names of all products having price 1000.
   b. Find the name of those customers who purchased Dell Laptop.
   c. Find the total number of products purchased by customer 'Ram'
   d. Increase price of all products by 5 %
   e. Find total price of Apple Mobiles
2. What are the benefits of using normalization? Discuss 1NF, 2NF, and 3NF with suitable example. (2.5 + 7.5 = 10)
3. Define Relational Algebra (RA) and explain its six fundamental operations with suitable example. (2 + 8 = 10)

Section B (Short questions)
Attempt any eight questions. (8 × 5 = 40)

4. What database schema? What are functions of database administrator? (2 +3 = 5)
5. Construct an E-R diagram for online course registration where students register courses online.(5)
6. Discuss referential integrity with example. (5)
7. What is functional dependency? Why do we need inference rules? (2 + 3 = 5)
8. Why do we need concurrency control? Discuss two phase locking protocol. (2 + 3 = 5)
9. Why do we need database recovery? Discuss shadow paging technique for database recovery. (2 + 3 = 5)
10. Differentiate concept of Centralized and Client/Server Architectures for DBMSs with suitable example. (5)
11. Define Transaction and explain its desirable properties. (5)
12. Explain constraints and characteristics of Specialization and Generalization of data model. (5)