Course Title: Database Management Systems **Credit: 3**
Course No: CSIT.223 **Number of period per week: 3+3**
Nature of the Course: Theory + Lab **Total hours: 45+45**
Year: Second, Semester: Fourth
Level: B. Sc. CSIT

1. Course Introduction

The purpose of this course is to introduce the fundamental concepts of database management, including aspects of data models, database languages, and database design. At the end of this course, a student will be able to understand and apply the fundamental concepts required for the use and design of database management systems.

2. Objectives

Through this course, students shall

- become proficient at modelling databases at conceptual and logical levels of design,
- be able to develop database schemas with principled design that enforce data integrity,
- become knowledgeable in the creation, altering, and manipulation of tables, indexes, and views using relational algebra and SQL,
- become proficient at casting queries in SQL,
- and at writing database application programs with an understanding of transaction management, concurrency control, and crash recovery.

3. Specific Objectives and Contents

Specific Objectives	**Contents**
• Identify data management approaches and their values. • Define terms related to database management systems. • Understand benefits of database management systems. • Describe different data models and their usefulness. • Understand the concept of data abstraction and data independence. • Explain database systems structure and database users.	**Unit I: Database System Introduction(5)** 1.1. Basic Terminologies: Data vs Information, Data Hierarchy, Database, Database Management System, Database System, Relational Database Management Systems. 1.2. Data Management Approaches: File Management Systems, Database Management Systems, Limitations, Advantages, and Applications. 1.3. Database Schema and Instance, Data Abstraction (views of Data), Data Independence, Database Languages, Database Users and Administrator, Transaction Management. 1.4. Data Models: Hierarchical, Network, Entity Relationship, Relational, and object oriented data model 1.5. Database System Structure, Database Application

	Architecture, Classification of DBMSs
• Explain use and importance of ER model. • Describe components of ER diagrams. • Use ER diagrams to design databases. • Learn concepts used in EER modeling • Explain concept behind Relational model. • Learn conversion of ER diagrams into Relational model.	**Unit II: Entity Relationship Data Modeling (5)** 2.1. ER Model and ER Diagrams, Components of ER Model, Types of Attributes. 2.2. Degree of Relationship, Constraints on ER Model (Mapping Cardinalities and Participation Constraints), Keys and Types of Keys, Weak Entity Sets. 2.3. Extended ER Modelling: Subclass/Superclass Relationship, Specialization and Generalization, Constraints on Specialization/Generalization Aggregation, Hierarchies, Lattices, Shared Subclasses, Categories. 2.4. Relational Model: Introduction, Structure of Relational Databases, Schema Diagram, Mapping ER Model to Relational Database.
• Understand why relational algebra? • Use basic operations of relational algebra. • Discuss and use additional relational algebra operations and extended relational algebra operations. • Understand and use database modification through relational algebra. • Apply the concept behind NULL values and three-valued logic. • Know basic concepts of Relational Calculus and QBE.	**Unit III: Relational Algebra and Relational Calculus (8)** 3.1. Introduction of Relational Algebra (RA), Fundamental Operation of RA: Select, Project, Set Union, Set Difference, Cartesian Product and Rename Operations. 3.2. Additional Relational Algebra Operations: Set Intersection, Natural Join, Division and Assignment Operation. 3.3. Extended Relational Algebra Operations: Generalized Projection, Outer Join and Aggregate Functions 3.4. Database Modification: Insert, Delete and Update Operation 3.5. Null Values, Advantages and Limitations of Relational Algebra 3.6. Relational Calculus: Introduction and Expressive Power of Relational and Domain Calculus, Sample Queries Using Relational and Domain Calculus. 3.7. Introduction to Query by Example (QBE) and Sample Queries.
• Explain structure of SQL queries. • Use SELECT, FROM and WHERE clauses efficiently. • Understand concept behind join operations. • Discuss and Use aggregate functions and subqueries. • Apply database modification statements. • Explain and use DDL statements.	**Unit IV: Structured Query Language (8)** 4.1. Introduction: Basic Structure of SQL Query, SELECT, FROM and WHERE clause, Using Multiple Relations 4.2. Strings and Pattern Matching, Ordering the Display of Tuples, Join Operations: Join Types and Join Conditions. 4.3. Nested Queries: Set membership Test, Set Comparison and Test for Empty Relations. 4.4. Aggregate Functions, Group by Clause and Having Clause 4.5. Database Modifications: Insert, Delete and Update Operations

• Understand concept behind views and use them.	4.6. Data Definition Language: Domain Types in SQL, Create, Alter and Drop statements 4.7. View and Modification of Views, Embedded and Dynamic SQL
• Understand importance of integrity constraints. • List and discuss different types of integrity constraints. • Use Integrity constraints for maintaining for achieving correctness of data. • Compare and contrast between assertions and triggers	**Unit V: Integrity Constraints (3)** 5.1. Concept and Importance of Integrity Constraints, Data Integrity. 5.2. Domain Constraints: Not Null Constraints, Unique Constraints, Primary key Constraints, Check Constraints. 5.3. Referential Integrity: Using Referential Integrity, Cascading Actions 5.4. Assertions and Triggers: Creating and Deleting Assertions, Creating and Deleting Triggers, Assertions vs Triggers.
• Exemplify database modification anomalies. • Explain why normalization is needed? • Understand and exemplify functional dependencies. • Discuss and exemplify conversion of unnormalized relations into normalized forms.	**Unit VI: Relational Database Design (4)** 6.1. Introduction, Database Modification Anomalies, Functional Dependencies (FDs), Types of FD's, FD Inference Rules. 6.2. Closure of Set of FD's, Closure of Set of Attributes, Covers. 6.3. Normalization: Purpose and Concept of Normalization, Forms of Normalization: 1-NF, 2-NF, 3-NF, BCN 6.4. Lossless Decomposition
• Differentiate between authentication and authorization. • Apply the concept in database management systems. • Understand concept behind roles and apply it.	**Unit VII: Authentication and Authorization (2)** 7.1. Authentication vs, Authorization, Classification of DB Security, Levels of DB Security. 7.2. Types of Authorization, Creating Users, Granting and Revoking Authorizations in SQL, CASCADE and RESTRICT 7.3. Concept of Roles, Authorization using Roles.
• Understand the concept behind indexing. • Demonstrate different types of indices. • Compare and contrast between dense and sparse indices. • Understand indexing evaluation factors	**Unit VIII: Indexing (2)** 8.1. Concept of Indexing, Index File vs Data File, Index key Structure 8.2. Types of Indices: Ordered vs Unordered Indices, Primary vs Secondary Indices. 8.3. Primary Indices: Dense and Sparse Indices with their Strengths and Drawbacks, Indexing Evaluation.
• Understand the concept of transaction and schedules • Discuss and exemplify serial and serializable schedules. • Understand the problems behind concurrent execution of	**Unit IX: Transaction and Recovery (6)** 9.1. Transaction Processing: Desirable Properties of Transactions, Concurrent Executions, Schedules and Recoverability, Testing for Serializability. 9.2. Concurrency Control: Overview of Concurrency Control, Locking Techniques, Lock-Based Protocols,

transactions • Describe and exemplify concurrency control techniques • Discuss need of recovery in database management systems. • Explain different database recovery techniques.	Timestamp-Based Protocols, Commit Protocols, Granularity of Data Items, Time Stamp Ordering Multi Version Concurrency Control. 9.3. Database Recovery: Failure Classification, The Storage Hierarchy, Transaction Model, Log-Based Recovery Techniques, Buffer Management, Checkpoints, Shadow Paging, Failure with Loss of Non-volatile Storage.

Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Practical**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Practical Report copy	25%	20
(Details are given in the separate table at the end)		Quizzes	10%		Viva	25%	
		Attendance	20%		Practical Exam	50%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

External evaluation

1. **End semester examination:**
   It is a written examination at the end of the semester. The questions will be asked covering all the units of the course. The question model, full marks, time and others will be as per the following grid.

2. **External Practical Evaluation:**
   After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the above mentioned evaluation. There will be an internal examiner to assist the external examiner. Three hours time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Full Marks: 100, Pass Marks: 45, Time: 3 Hrs

Nature of question	Total questions to be asked	Total questions to be answered	Total marks	Weightage
Group A: multiple choice*	20	20	20×1 = 20	60%
Group B: Short answer type questions	7	6	6×8 = 48	60%
Group C: Long answer type question/long menu driven programs	3	2	2×16 =32	60%
			100	100%

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes

- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam. Unless and until the student clears one semester he/she will not be allowed to study in the following semesters.

Laboratory Work

Student should design ER diagrams of organization or particular subsystem with the organization. Tools like Visio or any other should be used for drawing ER diagrams. Those ER diagrams should be converted into relational model and create database schema by using DDL. Finally populate the relations with some data and write some queries that cover all features of DML discussed in class. Creating views and indices for the database should also be appreciated. For laboratory work students can use DBMS systems like Oracle, Mysql, SQL server etc. But MS access should not accepted as Laboratory work platform.

Prescribed Text

- Silberschatz, H.F. Korth, and S. Sudarshan, Database System Concepts, 6th Edition, McGraw Hill, 2010

Reference

- Raghu Ramakrishnan, and Johannes Gehrke, Database Management Systems, 3rd Edition ,McGraw-Hill, 2007
- Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, 6th Edition, Pearson Addison Wesley; 2010.