MCA513-1 – ADVANCED DATABASE TECHNOLOGIES

Total Teaching Hours for Semester: 75
Max Marks: 100
Credits: 4

Course Description

The course Advanced Database Technologies, offers the concepts of database management systems, which include the conceptual model, relational design, normalization, transaction processing, distributed databases, and NoSQL systems. This enables students to conduct various practical exercises involving SQL and NoSQL to prepare them for current trends in data management.

Course Objectives

The course on Advanced Database Technologies is designed to equip students with a deep understanding of modern database systems, emphasizing both relational and non-relational paradigms. It covers advanced concepts in database design, query optimization, and transaction management while introducing cutting-edge topics such as distributed databases, NoSQL systems, and big data technologies. The course combines theoretical learning with hands-on practice to ensure students can effectively design, manage, and query databases to solve real-world problems.

Course Outcomes

CO1: Implement database system concepts, SQL commands, and ER modeling to design structured databases.

CO2: Compare normalization techniques to optimize database efficiency and integrity.

CO3: Assess transaction processing, concurrency control, and recovery mechanisms to maintain database consistency.

CO4: Design NoSQL-based distributed database solutions for scalable data management.

CO5: Construct optimized NoSQL data stores with indexing and ordering techniques for advanced querying.

Unit-1 **Teaching Hours: 15**

DATABASE SYSTEM CONCEPTS AND CONCEPTUAL MODELING, RELATIONAL DATA MODEL

Data models, schemas and instances- Using High-Level Conceptual Data Models for Database Design - Entity Types, Entity Sets, Attributes, and Keys - Relationship Types, Relationship Sets, Roles, and Structural Constraints, Enhanced Entity Relationship Model. SQL Basics, Intermediate and Advanced - Design Guidelines for Relation Schemas

Lab Exercises:

1. ER Diagram
2. DDL, DML, DCL and TCL commands, use of integrity constraints and referential integrity.

Unit-2 **Teaching Hours: 15**

NORMALIZATION, DATA STORAGE AND INDEXING: Functional Dependencies - Normal Forms Based on Primary Keys - 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 - Nulls and Dangling Tuples. Storing Data - Disk and files, File organization - indexes : Tree indexing - Hash based indexing

Lab Exercises:

3. Data Retrieval using JOINS, Subqueries and Correlated queries
4. Demonstrate Normalization with efficiency comparison

Unit-3 **Teaching Hours: 15**

TRANSACTION PROCESSING, CONCURRENCY CONTROL, AND RECOVERY

Transaction - Introduction to transaction processing- transaction and system concept- Desirable properties of the transaction- Transaction support in SQL- concurrency control techniques – Two-phase Locking techniques for concurrency- Concurrency Control Based on Timestamp Ordering. Recovery Concepts- NO-UNDO/REDO Recovery Based on Deferred Update- Recovery Techniques Based on Immediate Update- Shadow Paging.

Lab Exercises:

5. Implement the transaction Properties (ACID)
6. Implement timestamp ordering for concurrency control

Unit-4 **Teaching Hours: 15**

DISTRIBUTED DATABASES AND NOSQL SYSTEMS

Distributed databases: Distributed Database concepts- Types - Data Fragmentation- Replication- Allocation Techniques. Transaction Management - NOSQL Databases- Introduction to NOSQL Systems, CAP Theorem, Document-Based NOSQL Systems and MongoDB, NOSQL Key-Value Stores, Column-Based - NOSQL Graph Databases.

Lab Exercises:

7. NOSQL CRUD operations, Aggregate functions (MongoDB)
8. NoSQL data IMPORT and EXPORT

Unit-5 **Teaching Hours: 15**

NoSQL STORES AND INDEXING AND ORDERING DATA SETS

Accessing Data from Column-Oriented Databases Like HBase-Querying Redis Data stores-Querying in Neo4J-Changing Document Databases-Schema Evolution in Column-Oriented Databases. Indexing and Ordering Data Sets-Essential Concepts Behind A Database Index-Indexing and Ordering in MongoDB-Creating and Using Indexes in MongoDB-Indexing and Ordering in CouchDB-Indexing in Apache Cassandra-Indexing and Ordering in Neo4J.

Lab Exercises:

9. Create DB in casandra and perfom CRUD operations

10. Design a graph database using Neo4j

Text Books and Reference Books

[1] Elmasri & Navathe, Fundamentals of Database Systems, Addison-Wesley, 7th Edition, 2021. (Module 1, 2,3,4)

[2] Abraham Silberschatz, Henry F Korth and S Sudarshan, " DAtabase System Concepts", 7th Edition, Mc GrawHill, 2021, ISBN: 978-1-260-08450-4 (Module 2)

[3] Shashank Tiwari, "Professional NoSQL", Wrox Press, Wiley, 2021, ISBN : 978-0-470-94224-6 (Module 5)

Essential Reading / Recommended Reading

[1] O'neil Patric, O'neil Elizabeth, Database Principles, Programming and Performance, Argon Kaufmann Publishers, 2nd Edition, 2002.

[2] Ramakrishnan and Gehrke, Database Management System, McGraw-Hill, 3rd Edition, 2003.

[3] Gaurav Vaish, Getting Started with NoSQL, Packt Publishing, 2013.

Web Resources:

[1] https://learnsql.com/

[2] https://www.mongodb.com

[3] https://achouettz.firebaseapp.com › professional-NoSQL-by-Shashank-tiwari

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	2	2	1	1	2
CO2	3	3	3	2	1	1	1	2
CO3	3	3	3	2	1	2	2	2
CO4	3	3	3	3	2	2	2	3
CO5	3	3	3	3	2	2	2	3

Evaluation Pattern

50 %	50%
CIA	ETE