



# AMA COMPUTER ACADEMY DATABASE MANAGEMENT SYSTEM



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# OCOC Database Management System (DBMS)

## Introduction of the Course:

This course provides a comprehensive introduction to database management systems (DBMS), covering both theoretical concepts and practical skills. Students will learn about database design, SQL querying, transaction management, and advanced topics like NoSQL, cloud databases, and data analytics tools. The course equips learners with the knowledge to design, implement, and manage databases, preparing them for careers in database administration, data analytics, and application development.

## Objectives of the Course:

The course aims to provide students with a comprehensive understanding of database systems, focusing on both theoretical and practical aspects. It seeks to equip learners with the skills to design, implement, manage, and optimize relational and non-relational databases. Through the exploration of database languages, architectural principles, query design, and advanced concepts such as normalization, transaction management, and cloud databases, the course prepares students to handle real-world data management challenges.

Additionally, it introduces emerging trends and tools in database technology, including NoSQL databases, MongoDB, and business intelligence platforms, to enhance their readiness for diverse career paths in database technology and data analytics.

## Outcomes of the Course:

1. **Understand DBMS Fundamentals:** Purpose, advantages, and applications of DBMS.
2. **Design and Model Databases:** Use ER diagrams and relational schemas.
3. **Proficient in SQL:** Write complex SQL queries for data definition, manipulation, and control.
4. **Optimize Databases:** Apply normalization and ensure data integrity.
5. **Manage Transactions:** Understand ACID properties, concurrency, and recovery.
6. **Explore Advanced DB Concepts:** Use triggers, stored procedures, and sharding for optimization.
7. **Work with NoSQL Databases:** Gain proficiency in MongoDB operations and data modelling.
8. **Develop Database Applications:** Integrate databases with programming languages like Java.
9. **Learn Modern Database Technologies:** Understand cloud, key-value, and graph databases.
10. **Use Data Analytics Tools:** Work with Power BI, Tableau, and other BI platforms.
11. **Solve Real-World Problems:** Apply database techniques to practical scenarios.
12. **Career-Ready Skills:** Prepare for roles in database technology and data analytics.

## Course Syllabus:

Topic	Sub-Topics
Introduction to Database	Introduction
	History of DBMS
	Purpose of Database Systems
	Advantages of using the DBMS approach
	Disadvantages of using the DBMS approach
	DBMS and its applications: Enterprise Information & Banking and Finance
	Example of a Database
Database Languages and Architecture	Architecture of DBMS
	Data Models, Schemas and Instances
	Categories of Data Models
	Database Schema vs Database State
	Data-Manipulation Language (DML)
	Data-Definition Language (DDL)
	Database Administrators and Database Users
	Database Users and User Interfaces
	The Database System environment
	Database System Utilities
	Centralized and Client/Server Architecture for DBMS
Conceptual Design using ERD	High-Level Conceptual Data Models
	Introduction to ER Model
	Symbols in ER Diagram
	Entity types

	Entity sets
	Attributes
	Entity-Set and Keys
	Relationship
	Relational Model Integrity
	CONSTRAINTS
	Keys in DBMS
	ER DIAGRAM
	Naming Conventions
	ER Design Issues
	Structural constraints Weak entity types
	Generalization
	Specialization
Relational Model	Relational Model Concepts
	Informal Definitions
	Formal Definitions
	Structure of Relational Databases
	Database Schema
	Characteristics of Relations
	Relational Integrity Constraints
	Other Types of Data Constraints
	Domains, Attributes, Tuples and Relations
	Represent all the Entities and Relationships in Tabular Fashion
Relational Algebra	PRELIMINARIES

	Selection and Projection
	Unary Operations
	The SELECT Operation
	PROJECT Operation
	Sequences of Operations and the RENAME Operation with an Example
	Set Theory Operations
	The UNION, INTERSECTION and MINUS Operations - Examples
	The CARTESIAN PRODUCT (CROSS PRODUCT) Operation
	Binary Relational Operations and additional relational operations
	List of Operators with Purpose
	Additional Relational Operations and Generalized Projection
Mapping Conceptual Design into a Logical Design	Relational Database Design using ER-to-Relational mapping
	Procedure to Create a Relational Schema from an Entity-Relationship (ER)
	Mapping of Binary 1: N Relationship Types
SQL	Introduction
	SQL Data Definition and commands
	Operators and Expressions
	MYSQL Installation - Demo
	Schema and Catalog Concepts in SQL
	The CREATE TABLE Command in SQL
	Attribute Data Types and Domains in SQL
	Specifying Attribute Constraints and Attribute Defaults
	Basic Retrieval Queries in SQL

	Ambiguous Attribute Names, Aliasing, Renaming and Tuple Variables
	Tables as Sets in SQL
	Order of Query Execution
	Ordering of Query Results
	Error Codes
	INSERT, DELETE, and UPDATE Statements in SQL
	Additional Features of SQL
	Create a Table Called Employee with the 2-Column Table Structure
	Create Department Table with the 2-Column Table Structure
	Queries Using DDL and DML
	Design SQL Queries for Suitable Database Application Using SQL DML Statements
Advanced SQL Queries	Comparisons Involving NULL and Three-Valued Logic
	Nested Queries, Tuples and Set or Multi-Set Comparisons
	Correlated Nested Queries
	Functions
	The EXISTS and UNIQUE Functions in SQL
	Explicit Sets and Renaming of Attributes in SQL
	Join - Introduction
	Cross Join
	INNER Join
	SELF Join
	LEFT OUTER Join
	RIGHT OUTER Join and FULL OUTER Join
	Join - Examples

	Join - Alternate Syntax
	Multi Way Join
Explore More on Queries	Design and Develop SQL DDL statements which demonstrate the use of SQL objects such as Table, View, Index, Sequence
	Example of a simple query on one relation- Retrieve the birth date and address of the employee
	Consider the schema for a Library Database: Write SQL queries to Retrieve details of all books in the library
	Consider the schema for an Order Database of Salesman's: Create a view that finds the salesman who has the customer with the highest order of a day.
	Querying (using ANY, ALL, IN, Exists, NOT EXISTS, UNION, INTERSECT, Constraints etc.) - for railway ticketing
	Using NESTING OF QUERIES- Retrieve the name and address of all employees who work for the 'Research' department.
	Design at least 10 SQL queries for suitable database application using SQL DML statements: all types of Join, Sub-Query and View.
	Aggregate Functions in SQL
	Order by Clause
	Grouping
	Specifying General Constraints as Assertions in SQL
	Perform Query Using Aggregate Function
	Write a PL/SQL Block of code
Triggers in SQL	Introduction to Triggers in SQL_1
	Assertions vs Triggers
	Views in SQL
	The DROP Command
	The ALTER Command
	List Data Definition Languages (DDL) Commands of Base Table and View
	List Data Manipulation Language (DML) Of Base Tables and Views
	SQL Query Using Grouping Functions

	Insert, Delete and Update Triggers
	Database Trigger on Library Table
Database Application Development	Accessing Databases from Applications
	Cursors
	Introduction to JDBC
	JDBC Classes and Interfaces
	JDBC Driver Management
	Connections
	Executing SQL Statements
	Result Sets
	Matching Java and SQL Data Types
	Exceptions and Warnings
	Examining Database Metadata
	SQL in Java (SQLJ)
	Stored procedures
	SQL/PSM
	Write a SQL block
Database Design Theory	Introduction and Objectives to DB Design
	Informal Design Guidelines for Relation Schema
	Redundant Information in Tuples and Update Anomalies
	Generation of Spurious Tuples
	Functional Dependencies - Definition and Diagrammatic Notations
	Normal Forms based on Primary Keys
	Boyce-Codd Normal Form

	Multivalued Dependency and Fourth Normal Form
	Join Dependencies and Fifth Normal Form
Normalization Algorithms	Inference Rules, Equivalence and Minimal Cover
	Inference Rules for Functional Dependencies
	Equivalence of Sets of Functional Dependencies
	Properties of Relational Decompositions
	Algorithms for Relational Database Schema Design
	Nulls, Dangling Tuples and Alternative Relational Designs
	Inclusion and Template Dependencies
	Functional Dependencies Based on Arithmetic Functions and Procedures
	Domain-Key Normal Form
Transaction Processing	Features and Types of Transaction Processing
	Single-User vs Multiuser Systems
	Transactions, Database Items, Read and Write Operations and DBMS Buffers
	Transaction and System Concepts
	ACID Properties
	Commit Point of a Transaction
	DBMS Specific Buffer Replacement Policies
	Characterizing Schedules Based on Recoverability & Serializability
	Transaction Support in SQL
	Introduction to Concurrency Control
	Two-Phase Locking Techniques for Concurrency Control
	Variations of Two-Phase Locking
	Dealing with Deadlock and Starvation

	Deadlock Detection
	Concurrency Control Based on Timestamp Ordering
	Multiversion Concurrency Control Techniques
	Granularity of Data Items and Multiple Granularity Locking
	Recovery Concepts
	NO - UNDO or REDO Recovery Based on Deferred Update
	Recovery Techniques Based on Immediate Update
	Shadow Paging
	Database Backup and Recovery from Catastrophic Failures
Key value Database	Working of Key-Value Databases
	Features and Functions of Key-Value Databases
	Schema Design to Support Key Value
	Key - Value Database Vs Cache
Graph Database	The Property Graph Model
	Why Data Relationships Matter
	Why Other NoSQL Databases don't Fix the Problem Either
	Relational vs Graph Data Modelling Match-Up
	Example Data Model - Fraud Detection in Email Communications
	Database Query Language
Cloud Databases	Difference Between Cloud and Database
	Cloud Database Deployment Models
	Key Benefits of Cloud Databases
	When to Use a Cloud Database
	Additional Considerations of Cloud Database

	Some Large Cloud Providers and Databases
Database Clustering and Sharding	Advantages of Sharding
	Shared - Nothing Architecture
	Shared - Disk Architecture
	Sharding
	Sharded Cluster Components
	Considerations Before Sharding
	Sharded and Non-Sharded Collections and Connecting to a Sharded Cluster
Data Analytics and BI Tools	Introduction, Benefits of Business Intelligence Tools
	Best data analytics and BI tools
	Welcome To Microsoft Power BI
	Tableau
	Qlik Sense
	Sisense
	Best BI tool for developing and deploying analytics apps
	Looker – data analytics and BI tool for start-ups and mid-sized businesses
	Oracle
	Domo BI
	SAS Analytics
MongoDB –Overview	Relationship of RDBMS Terminology with MongoDB
	Sample Document
	Key Components of MongoDB Architecture
	MongoDB - Advantages
	Functionality of MongoDB

	MongoDB - CAP Approach
	MongoDB - Hierarchical Objects
	MongoDB - Environment
	MongoDB Processes and Configuration
	Install MongoDB on Windows
	Install MongoDB on Ubuntu
	MongoDB Statistics
	CRUD Operations in MongoDB
MongoDB - Data Modelling and Documentation	Data Modelling
	Some Considerations While Designing Schema in MongoDB
	Create Database
	Drop Database
	Create Collection
	Data Types
	Insert Document
	Query Document
	Update Document
	Delete Document
	Design and Develop MongoDB Queries using CRUD operations
	Projection
	Limiting Records
	Sorting Records
	Aggregation - Examples

	Authentication Mechanisms in MongoDB
	Bulk Operations with Examples
	Indexing
	Replication
	Program to Implement Aggregation and Indexing in MongoDB
	Create Backup of Sharded Cluster
	SQL vs Mongo DB Entities
	Consistency of Data
	Query through API
	Exercise on Student Database Agenda
Advanced MongoDB	MongoDB – Deployment
	Typical MongoDB Deployment, Read Preference and Write Concern_1
	Operation Performance and Partition
	Relationships
	Database References
	List of Drivers Supported by DBRefs
	MongoDB - Map Reduce
	Using MongoDB as a Service: mLab
	Execute the Query and Study its Execution Plan
Type of Career verticals In Database Technology	Careers in Database Technology

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