COURSE TITLE: ADVANCED DATABASES			
Course Code:	**22PCA701-1**	**Course Type:**	**CC**
Teaching Hours / Week (L:T:P):	**3:0:2**	**Credits:**	**4**
Total Teaching Hours:	**45+0+30**	**CIE + SEE Marks:**	**50+50=100**

Preamble *(brief description).*

In today's data-driven world, the ability to design robust and efficient database systems is paramount. As a skilled professional in database management, and possess a comprehensive understanding of various database concepts and technologies essential for modern application development and data management

Course Outcomes

At the end of the course students will be able to…

CO1	Ability to design entity-relationship diagrams for various real-world scenarios and translate them into relational database schemas.
CO2	Proficiency in SQL for creating tables, inserting sample data, and performing basic data manipulation operations.
CO3	Understanding of parallel and distributed database architectures, including the ability to design and implement strategies for efficient data partitioning and query execution.
CO4	Compare and contrast different cloud database service providers, such as AWS RDS, Azure Cosmos DB, and Google Cloud Firestore.
CO5	Design efficient data models for web applications using MongoDB, considering document structures and relationships.

PO – CO mapping

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

Note: ‘-‘=Not Relevance; ‘1’=Low Relevance; ‘2’ = Medium Relevance; ‘3’=High Relevance

Course Content:

Theory

Unit 1 **15 Hours**

Advance Object Based Databases

Overview , Introduction to data warehouse and characteristics, Introduction to multimedia databases ,mobile databases and digital database. Complex data types, Structured types and inheritance in SQL, Table inheritance, Array and multiset types in SQL, Object identity (OI) and reference types in SQL, XML: Introduction, structure of XML data, XML document schema,Xpath, XQuery:FLOWER Expressions. Joins,Nested Queries, SortOO functions, Functions and types

Hands on / Case Study

1. Design a data model for the data warehouse, including tables for storing multimedia content, user engagement metrics, and platform metadata.
2. Implement the data model using SQL, incorporating features such as structured types, inheritance, and complex data types.
3. Populate the data warehouse with sample data from different platforms.

Unit 2 **15 Hours**

Parallel Databases and Architectures :

Architectures for Parallel, Query Evaluation, Data Partitioning, Parallelizing Sequential, Operator Evaluation Code, Parallelizing Individual Operations, Parallel Query Optimization

Distributed Databases: Features of Distributed Databases vs Centralized Databases**,** Distributed Database Management Systems (DDBMS)**,** Levels of Transparency**,** Reference, Architecture for DDB**,** Types of Data Fragmentation

Distributed Database Design: Framework for Distributed Database Design**,** Design of, Database Fragmentation**,** Allocation of Fragments**,** Distributed Query Processing**,** Equivalence of Transformations for Queries**,** Transforming Global Queries into Fragment Queries**,** Distributed Grouping and Aggregation Functions**,** Parametric Queries

Query Optimization in Distributed Databases, Framework for Query Optimization, Join Queries and General Queries, Non-Join Queries in a Distributed DBMS, Cost-Based Query Optimization

Hands on / Case Study

1. Design a parallel database architecture for a large e-commerce website handling millions of transactions per day.
2. Implement data partitioning strategies such as range partitioning or hash partitioning for distributing data across multiple nodes.
3. Write parallelized SQL queries to query data from the distributed database and compare the performance with sequential queries.

Unit 3 **15 Hours**

Object-Relational Database Management Systems (ORDBMS)

Introduction to ORDBMS , Database Design for ORDBMS, ORDBMS Implementation and Challenges, Comparison of RDBMS, OODBMS, and ORDBMS, Spatial Data Management,Types of Spatial Data and Queries, Spatial Indexes, Indexing Based on Space, Filling Curves,Grid Files,R-Trees

Deductive Databases : Recursive Queries**,** Theoretical Foundation**,** Recursive Queries with Negation**,** Efficient Evaluation of Recursive Queries**.**

Temporal and Sequence Databases**,** Information Visualization**,** Advanced Transaction Processing**,** Transaction-Processing Monitors**,** Transactional Workflows**,** Main-Memory Databases**,** Real-Time Transaction Systems**,** Long-Duration Transactions**,** Transaction Management in Multi-Databases

Hands on / Case Study

1. Design an object-relational database schema to store spatial data like geographic locations or maps.
2. Implement spatial indexing techniques like R-Trees or grid files to efficiently query and retrieve spatial data.
3. Develop a real-time transaction processing system using an ORDBMS and measure its performance for handling concurrent transactions.

Unit 4 **15 Hours**

MongoDB in Database systems

Introduction to NoSQL Databases: Overview of NoSQL databases, Characteristics of NoSQL databases, Comparison with traditional SQL databases.

MongoDB Overview: Introduction to MongoDB, Features of MongoDB, Document-oriented database model, BSON data format.

MongoDB Architecture: Components of MongoDB architecture, Storage engine, WiredTiger vs MMAPv1 storage engines.

CRUD Operations in MongoDB: Creating, Reading, Updating, and Deleting documents in MongoDB. Querying MongoDB: Query operators, Aggregation framework, Indexing in MongoDB.

Data Modeling in MongoDB: Schema design considerations, Embedding vs Referencing, One-to-One, One-to-Many, and Many-to-Many relationships.

Replication and High Availability: MongoDB Replica Set architecture, Configuration and setup of Replica Sets, Failover and recovery.

Hands on / Case Study

1. Install and configure MongoDB on a local machine or cloud server.
2. Design a data model for a web application using MongoDB, considering document structure and relationships.
3. Implement CRUD operations and various querying techniques in MongoDB.
4. Perform performance tuning and optimization by creating appropriate indexes.

Unit 5 **15 Hours**

Cloud Databases and Deployment

Introduction to Cloud Databases: Overview of cloud computing, Benefits of using cloud databases, Different cloud database service providers.

Deployment Options: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Choosing the right deployment option. Cloud Database Services: Amazon Web Services (AWS) RDS, Microsoft Azure Cosmos DB, Google Cloud Firestore, Database offerings from other cloud providers.

Database Migration to the Cloud: Strategies for migrating databases to the cloud, Considerations for data transfer, Compatibility and performance testing.

Scaling and Management: Autoscaling capabilities of cloud databases, Monitoring and performance optimization, Cost management strategies.

Hands-on / Case Study:

1. Deploy a relational database (e.g., MySQL) on a cloud platform (AWS, Azure, or Google Cloud).
2. Migrate an existing on-premises database to a cloud database service using migration tools.
3. Configure auto scaling and monitoring for the cloud database deployment.
4. Analyze cost implications and optimize resource usage for the cloud database deployment.

Text Books:

1. "Database Systems: The Complete Book" by Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom (2019) - This comprehensive book covers all aspects of database systems, including relational databases, XML, and NoSQL systems.
2. "Fundamentals of Database Systems" by Ramez Elmasri and Shamkant B. Navathe (7th Edition, 2015) - This widely-used textbook provides a solid foundation in database systems, covering topics such as ER modeling, relational algebra, and SQL.

Reference Books:

1. "Modern Database Management" by Jeffrey A. Hoffer, Ramesh Venkataraman, and Heikki Topi (13th Edition, 2020) - This book covers both traditional and emerging database technologies, including data warehousing, OLAP, and data mining.
2. "Database Systems: Concepts, Design, and Applications" by S. K. Singh (2019) - This book offers a comprehensive overview of database concepts, design principles, and practical applications, with a focus on relational databases and SQL.
3. "Big Data: Principles and Paradigms" edited by Rajk

Part B: Course Evaluation System

Evaluation weightages -Theory

Assessment System	Assessment Component	Description	Weightage	Marks
Theory Continuous Internal Evaluation (CIE)	CIE-I	Mid Semester Examination (MSE) –I of 1 hour duration for 25 marks	--	50
	CIE-II	Mid Semester Examination (MSE) –II of 1 hour duration conducted for 25 marks	--	
	--	Average of MSE-1 and MSE-II	25	
	CIE-III	Assignments/Quizzes/Case Analysis	10	
	CIE-IV	Publications/Seminar/Quiz etc.	10	
	CIE-V	Attendance*	5	
CIE (Theory)			**60%**	***30M**
Practical Continuous Internal Evaluation (CIE)	CIE-VI	Practical Test(s) of **30 Marks** with Marks Distribution for each test as follows: 1; Write Up- 25 % 2: Execution – 35 % 3: Modification/Testing – 25% 4: Viva – 15 % Continuos Evaluation in the form of Record Write Up, Viva ------ **20Marks**	50	
CIE (Practical)			**40%**	***20 M**
Semester End Evaluation (SEE)	**SEE**	**Written Examination conducted for 3 hours duration ****	**50%**	***50 M**
		TOTAL MARKS	**100%**	**100**

***Attendance Marks Allotment:** 90% and above : 5 Marks
85% to 89% : 4 Marks
80% to 84% : 3 Marks
75% to 79% : 2 Marks

** Semester End Examination to be conducted for 3 hours duration for Courses with 3 or more credits; 2 hours duration for Courses with 2 credits and 1 hour duration for Courses with 1 credit.

Question Paper Pattern:

The SEE question paper comprises 5 Modules/Units. Each Module/Unit will have 2 questions

carrying 20 marks each. Each question may have sub questions (a, b & c etc) for a total mark of 20. Students need to answer 5 questions selecting one FULL question from each module.