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Resource Person:

Module:

Course Title: Distributed Database Systems

Course Code:

Course Type: MCS

Pre-Requisite: Database System

Counseling Hours: Class Time

Program Head: Sir Imran Saleem

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|  | **Name** | **Signature** | **Date** |
| **Prepared By**  (Resource Person) |  |  |  |
| **Checked By**  (Program Head) |  |  |  |
| **Approved By**  (Director SPA) |  |  |  |

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**Course Description& Format**

Distributed Database Systems (DDBSs), however, are generally implemented in relatively large organizations and need better understanding of the database and networking concepts. The same two concepts provide the foundation of this course. The emphasis in this course is on the design and management issues of a DDBS and at the same time on the implementation issues. The course starts with the basic definitions of DDBS and related concepts. Then the background concepts of database systems and networking are discussed. After that the major architectures of the DDBSs are discussed followed by design issues of a DDBS. This part of DDBS design concentrates on the fragmentation and its different types. In order to give a better and clearer understanding of the fragmentation, different examples using leading DDBMSs are presented. The second alternative for the implementation of DDBSs is replication, which is discussed with examples. After that, the issues related to DDBS administration is discussed, like, Failure recovery, transaction management and concurrency control. Advanced topics like Parallel Databases, Object Distributed Databases, and Multi-databases are discussed for the interested students something to think and work on. The environment used for demonstration will be Oracle used as tools.

**Course Instructional Objectives**

* Learn the design and system issues related to distributed database systems
* Learn the usage of different design strategies for distributed databases.
* Learn query processing techniques and algorithms as well as transaction management and concurrency control concepts used in such systems.
* Learn Design and implementation issues related to multi-database systems

**Course Student Objectives**

* Understand major architectures of the DDBSs.
* Understand design issues of a DDBS.
* Understand fragmentation and its different types.
* Understand the concepts of replication.
* Understand administration issues of DDBS, like failure recovery, transaction management and concurrency control.
* Develop basic concepts of parallel databases, object distributed databases, and multi-databases.

**Course Contents:**

Following is the session-wise breakup of the course:

**Session 1: Distributed Data Processing**

* Introduction to Distributed Database Systems and History
* Distributed Computing and objectives
* Promises of DDBS
* Theoretical Aspects of DDBS
* Reliability Through Distributed Transactions

**Learning Outcomes**

The main learning objective of the reading is to provide a basic and conceptual understanding of Distributed Data Processing.

**Activities:**

* Home Task

**Session 2: Distributed Database Design**

* Definitions of Distributed Database System and Decentralized Database
* The Concept and Role of the Transaction in Distributed Computing
* Performance Improvement and Complicating Factors of DDBS

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**Learning Outcomes**

The main learning objective of the reading is to provide a basic and conceptual understanding of Distributed Database design.

**Activities:**

* 1st Assignment

**Session 3: Distributed Concurrency Control**

* Computer Networks Concepts and DDBMS Architecture
* Reliability and Promises of Distributed DBMS
* Replication

**Learning Outcomes**

The main learning objective of the reading is to introduce different types of Distributed concurrency control mechanism.

**Activities:**

* 1st Quiz

**Session 4: Distributed DBMS Architecture**

* Architectural Model
* A Generic Centralized DBMS Architecture
* Architectural Models for Distributed DBMSs
* Distribution

**Learning Outcomes**

The main learning objective of these sessions will be to understand Architecture of DDMS.

**Activities:**

* 2nd Assignment

**Session 5: Multi-Database System Architecture**

* Client/Server Systems
* Peer-to-Peer Systems

**Learning Outcomes**

The students will learn about some advanced topics related to Multi database Architecture.

**Activities:**

* 2nd Quiz

**Session 6: Relational DBMS**

* Relational Data Model, keys, tables, Normalization
* Dependencies Structure
* Relational Database Concepts
* Relational Data Languages

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**Learning Outcomes**

The students will learn about relational database theories and relational language to perform DDL and DML operation.

**Activities:**

* Practice Questions

**Session 7: Fragmentation**

* Fragmentation Alternatives
* Degree of Fragmentation
* Correctness Rules of Fragmentation
* Horizontal and Vertical Fragmentation
* Advantages and Disadvantages of Fragmentation

**Learning Outcomes**

The students will learn about fragmentation concepts, degree of fragmentation and different rules of fragmentation.

**Activities:**

* Review Session before Midterm

**Session 8: MIDTERM**

**Session 9: Transaction in DDBS**

* Transaction Management and Properties of Transaction
* ACID properties, Types of Transactions, Transaction in DDBS
* Locking Based Concurrency Controller(CC), Time Stamp Ordering Based CC

**Learning Outcomes**

The students will learn about Transaction in DDBS, different concurrency control techniques and schema.

**Activities:**

* Midterm Reviewed and Solution discussed

**Session 10: Data and Access Control**

* Serializability Theory in DDBS
* View Management
* Views in Centralized DBMSs

**Learning Outcomes**

The students will learn about the major concern of access control about DDMS and management of views of DDMS.

**Activities:**

* 3rd Quiz

**Session 11: Data Security**

* Discretionary Access Control
* Multilevel Access Control
* Distributed Access Control

**Learning Outcomes**

The major learning outcome of this session is to secure data from unauthorized access.

**Activities:**

* 3rd Assignment

**Session 12: Overview of Query Processing**

* Query Optimization
* Query Processing Problem
* Complexity of Relational Algebra Operations
* Characterization of Query Processors

**Learning Outcomes**

The students will learn about query processing methods and discuss about characterization of query processors.

**Activities:**

* 4th Quiz

**Session 13: Distributed Query Optimization**

* Query Decomposition and its Phases
* Localization of distributed data
* Centralized Query Optimization
* QO in distributed environment
* Query Optimization and issues

**Learning Outcomes**

The students will learn about query optimization approach for distribution. They will also able to learn about dynamic, static and hybrid techniques.

**Activities:**

* 4th Assignment

**Session 14: Distributed DBMS Reliability**

* Reliability Concepts and Measures
* System, State, and Failure in DDBMS
* Distributed Reliability Protocol

**Learning Outcomes**

In this session the students will learn about how they can develop a reliable DDMS and why system fails under some circumstances.

**Activities:**

* Practice Questions and Discussion

**Session 15: Parallel Database Systems**

* Parallel Database Systems
* Parallel Processing Basics
* Parallel DBMS Architectures
* PDBS Issues

**Learning Outcomes**

In this session the students will learn about the architecture of parallel database system and parallel query processing.

**Activities:**

* Review Session

**Session 16: FINALTERM**

**Recommended Book (s):**

**Textbook:**

1. M. T. Oszu and P. Valduriez, Principles of Distributed Database Systems, 2nd ed., Prentice-Hall,

**Reference Book:**

1. Distributed Database Management Systems, Author(s): Saeed K. Rahimi, Frank S. Haug

**ASSESSMENT METHODOLOGY**

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| **Distribution** | |
| Quiz | 20 |
| Assignments | 20 |
| Class Participation | 05 |
| Mid Term | 20 |
| Final Term Exam | 35 |
| Total | 100 |

**CALENDAR OF ACTIVITIES**

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| **Session** | **Topic** | **Readings** | **Activities** |
| 1 | **Distributed Data Processing**   * Introduction to Distributed Database Systems and History * Distributed Computing and objectives * Promises of DDBS * Theoretical Aspects of DDBS * Reliability Through Distributed Transactions | Lecture slides | Home Task |
| 2 | **Distributed Database Design**   * Definitions of Distributed Database System and Decentralized Database * The Concept and Role of the Transaction in Distributed Computing * Performance Improvement and Complicating Factors of DDBS | Lecture slides | 1st Assignment |
| 3 | **Distributed Concurrency Control**   * Computer Networks Concepts and DDBMS Architecture * Reliability and Promises of Distributed DBMS * Replication | Lecture slides | 1st Quiz |
| 4 | **Distributed DBMS Architecture**   * Architectural Model * A Generic Centralized DBMS Architecture * Architectural Models for Distributed DBMSs * Distribution | Lecture slides | 2nd Assignment |
| 5 | **Multi-Database System Architecture**   * Client/Server Systems * Peer-to-Peer Systems | Lecture slides | 2nd Quiz |
| 6 | **Relational DBMS**   * Relational Data Model, keys, tables, Normalization * Dependencies Structure * Relational Database Concepts * Relational Data Languages | Lecture slides | Practice Questions |
| 7 | **Fragmentation**   * Fragmentation Alternatives * Degree of Fragmentation * Correctness Rules of Fragmentation * Horizontal and Vertical Fragmentation * Advantages and Disadvantages of Fragmentation | Lecture slides | Revision Session |
| 8 | **MIDTERM** | | |
| 9 | **Transaction in DDBS**   * Transaction Management and Properties of Transaction * ACID properties, Types of Transactions, Transaction in DDBS * Locking Based Concurrency Controller(CC), Time Stamp Ordering Based CC | Lecture slides | Midterm Reviewed and Solution discussed |
| 10 | **Data and Access Control**   * Serializability Theory in DDBS * View Management * Views in Centralized DBMSs | Lecture slides | 3rd Quiz |
| 11 | **Data Security**   * Discretionary Access Control * Multilevel Access Control * Distributed Access Control | Lecture slides | 3rd Assignment |
| 12 | **Overview of Query Processing**   * Query Optimization * Query Processing Problem * Complexity of Relational Algebra Operations * Characterization of Query Processors | Lecture slides | 4th Quiz |
| 13 | **Distributed Query Optimization**   * Query Decomposition and its Phases * Localization of distributed data * Centralized Query Optimization * QO in distributed environment * Query Optimization and issues | Lecture slides | 4th Assignment |
| 14 | **Distributed DBMS Reliability**   * Reliability Concepts and Measures * System, State, and Failure in DDBMS * Distributed Reliability Protocol | Lecture slides | Practice Questions and Discussions |
| 15 | **Parallel Database Systems**   * Parallel Database Systems * Parallel Processing Basics * Parallel DBMS Architectures * PDBS Issues |  | Revision of the course |
| 16 | **FINALTERM** | | |