**Course Information**

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| **Course Title: Database Systems** | | **Code:** SET 211 |
| **Program:** BSc Computer/ Software Engineering Technology | **Semester:** 3rd | **Credit Hours:** 2+1  **Lecture:** 32  **Practical:** 14 |
| **Knowledge Area** (as per HEC curriculum template) | Computer/ Software Engineering Technology | |

1. **Course Description:**

This course provides an in-depth introduction to database systems, covering key concepts, architectures, and techniques for designing, managing, and optimizing databases. Topics include the relational data model, relational algebra, SQL, normalization, and ER modeling. Advanced areas such as query optimization, security, concurrency control, and NoSQL are also explored. Hands-on labs offer practical experience in data manipulation, transaction management, recovery techniques, and working with front-end and back-end database systems.

1. **Course Objectives:**

* Understand and differentiate between basic database concepts and traditional file-based systems, including various database architectures and the three-level schema approach.
* Gain proficiency in relational data models, including attributes, schemas, tuples, keys, and integrity constraints, along with the fundamentals of relational algebra and calculus.
* Develop skills in SQL for data manipulation and querying, including joins, sub-queries, and aggregation, while also exploring concepts of normalization and functional dependencies.
* Explore advanced topics such as database security, concurrency control, backup and recovery, query optimization, and an introduction to NoSQL systems.

1. **Course Learning Outcomes (CLOs):**

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| --- | --- | --- | --- | --- |
| **CLO No.** | **CLO Description** | **Domain and Taxonomy level** | **PLO mapped**  **(i to xii)** | **Level of emphasis of the PLO**  **(1=High; 2=Medium; 3=Low)** |
| 1. | Explain fundamental database concepts. | C2 | I | 1 |
| 2. | Apply conceptual, logical and physical database schemas using different data models. | C3 | II | 2 |
| 3. | Apply functional dependencies and resolve database anomalies by normalizing database tables. | C3 | I | 2 |
| 4. | Apply Structured Query Language (SQL) for database definition and manipulation in any Database Management System DBMS. | C3 | III | 2 |

***\*Note:***

* *C 🡪 Cognitive, P 🡪 Psychomotor, A 🡪 Affective domains and ‘n’ is the taxonomy level.*
* *It is strongly suggested that one CLO should be mapped to one PLO and one domain only.*

**Teaching Plan**

1. **Weekly Lecture Breakdown**

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| --- | --- | --- |
| **Week #** | **Topic(s) to be covered** | **CLO**  **#** |
| 1 | Introduction to Database Systems   * Introduction * Types of Database Systems * Database System Complete Environment * DBMS Functions | 1 |
| 2 | Data Models Overview   * Different Database Models * The Relational Model (in detail) | 1 |
| 3 | Entity-Relationship (ER) Modeling - Part 1   * The Entity Relationship Model * Entities, Attributes, and Relationships | 2 |
| 4 | ER Model Notations   * ER Model Notation Overview * Chen Notation * Crow Notation * UML Notation | 2 |
| 5 | Keys and Relational Database Model   * Keys * Types of Keys   Relationships within Relational Databases | 2 |
| 6 | Relational Algebra and ER Diagram Development   * Relational Algebra * Developing an ER Diagram | 2 |
| 7 | Entity Relationship (ER) Modeling - Part 2   * Relationship Strength * More practice on ER Diagrams | 2 |
| 8 | Normalization of Database Tables - Part 1   * Why we need to normalize databases * The process of Normalization * Conversion to First Normal Form (1NF) | 3 |
| **Midterm Examination** | | |
| 9 | Normalization of Database Tables - Part 2   * Conversion to Second Normal Form (2NF) * Conversion to Third Normal Form (3NF) | 2 |
| 10 | Introduction to SQL - Part 1   * Introduction to SQL * Creating Databases * Database Schema | 4 |
| 11 | Introduction to SQL - Part 2   * Data Types * Data Manipulation Commands (DML) | 4 |
| 12 | Database Design   * Information Systems * System Development Lifecycle * Complete Database Lifecycle | 1 |
| 13 | Database Administration   * The Data-Information Decision Cycle * Database Administrator Activities * Database Administrative Tools | 1 |
| 14 | Database Security   * Security Policies * Security Vulnerabilities * Database Security | 1 |
| 15 | Processing Techniques, Cost Estimation, and Query Optimization   * Processing techniques and cost estimation * Query Optimization | 1 |
| 16 | NoSQL Systems   * Introduction to NoSQL database systems and their applications | 1 |

**Lab-Work Plan**

1. **Experiment/Practical Breakdown**

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| **S.NO** | **TITLE** | **CLO**  **#** |
| 01 | Overview of the features of SQL and SQL\*Plus | 1 |
| 02 | Basic data retrieval operations in SQL\*Plus. | 1 |
| 03 | Single-row and multiple-row functions in SQL | 4 |
| 04 | Data retrieval operations in SQL using join operation | 3 |
| 05 | Creating and managing tables | 2 |
| 06 | Data manipulation operations in SQL | 2 |
| 07 | Subqueries and compound queries in SQL | 3 |
| 08 | Creating views | 3 |
| 09 | Creating sequences, indexes and synonyms | 4 |
| 10 | Database triggers (i) | 4 |
| 11 | Database triggers (ii) | 4 |
| 12 | Stored procedures | 4 |
| 13 | Basic features of PL/SQL Programming | 4 |
| 14 | Using control structures, exceptions and cursors in PL/SQL | 4 |

1. **Syllabus and Books:**

* **Database Fundamentals and Architecture**
* Basic database concepts and comparison to file-based systems
* Database architecture, including three-level schema and data independence
* Relational data model: attributes, schemas, tuples, domains, relation instances, and keys
* **Data Modeling and Design**
* Entity-relationship (ER) modeling: entity sets, attributes, relationships, and ER diagrams
* Normalization and functional dependencies (1NF, 2NF, 3NF)
* Relational algebra and calculus: operations like selection, projection, Cartesian product, and joins
* **Structured Query Language (SQL) and Data Manipulation**
* SQL basics: database creation, data types, schema, joins, sub-queries, grouping, and aggregation
* Advanced SQL concepts: data integrity constraints and relational data manipulation techniques
* **Database Management and Optimization**
* Concurrency control, transaction management, and database backup and recovery
* Indexes, processing techniques, cost estimation, and query optimization
* **Advanced Database Systems and Security**
* Front-end and back-end database systems
* Database security measures, including encryption and access control
* Introduction to NoSQL systems and their applications

**Text/Reference Books:**

1. *Coronel, Carlos, and Steven Morris. Database systems: design, implementation, & management. Cengage Learning, 2016.*
2. *Kim, Won, David S. Reiner, and Don Batory, eds. Query processing in database systems. Springer Science & Business Media, 2012.*
3. *Elmasri, Ramez, and Sham Navathe. Fundamentals of database systems. Vol. 7. Pearson, 2017.*
4. *Elmasri, Ramez, and Shamkant B. Navathe. Database systems. Vol. 9. Boston, MA: Pearson Education, 2011.*
5. *Pavlo, Andrew, et al. “Self-Driving Database Management Systems.” CIDR. Vol. 4. 2017*
6. **Percentage of theoretical background, problems analysis and solution design**

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| --- | --- |
| **Elements covered in the course** | **Percentage of full course coverage** |
| Theoretical background | 40% |
| Problem analysis | 30% |
| Solution design | 30% |

1. **Teaching and learning methods:**
   1. Lecture
   2. Class discussion/ Videos
   3. Presentation
   4. Activities
   5. Homework
2. **Student assessment methods:**
   1. Quiz
   2. Assignment
   3. Exams (Theory)
   4. Presentation
   5. Project
   6. Activities etc.
3. **Assessment schedule:**
4. Quiz throughout the semester
5. Assignment throughout the semester
6. Exams
7. Midterm exam Week 9
8. Final theory exam Week 18
9. Presentation Week 11,17
10. Activities Week 4,8,15,16
11. **Weighting of assessments:**

**Theory:**

1. Quizzes/Activities 10 Marks
2. Assignments/Presentation 20 Marks
3. Midterm examination 20 Marks
4. Final term examination 50 Marks

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**Total 100 Marks**

1. **Facilities required for teaching and learning**
2. Computer Usage
3. Software
4. Online board + online ppt writing
5. YouTube

**Course Group Leader Name:**

**Engr. Muhammad Talha Zia (Theory / Lab)**

**Signature:**

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| **S. No.** | **Course group member (if any)** | **Theory/Lab** | **Signature** |
| 1 | Mr. Muhammad Talha Zia | Theory |  |
| 2 | Mr. Muhammad Talha Zia | Lab |  |