NATIONAL UNIVERSITY
of Computer & Emerging Sciences, Lahore

FAST School of Computing

CS2005 – Database Systems

Spring 2025

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Course Information
Program: BS **Credit Hours:** 3+1 **Type:** Core
Pre-requisites: CS2001 - Data Structures

Program Learning Outcomes (PLOs)
This course covers the following PLOs:

PLO#	PLO Name	PLO Description
PLO 2	Knowledge for Solving Computing Problems	Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the 16 abstraction and conceptualization of computing models from defined problems and requirements.
PLO 4	Design/ Development of Solutions	Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PLO 5	Modern Tool Usage	Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations

Course Learning Outcomes (CLOs)
This course is an introduction to relational databases management Systems. The course will cover fundamental concepts of databases with an emphasis on modeling, designing and implementation of database systems. The theory will be augmented with hands-on exercises on database system. A project will be conducted in the database system lab that runs in parallel with the course. In project, the students will develop a data-centric application with complete set of business transactions and appropriate user interface using a popular programming language and a popular database management system.
By the end of the course, students should be able to achieve the following CLOs:

CLO#	CLO Description	Taxonomy Level	PLO #
CLO 1	**Describe** the storage and retrieval mechanism in different databases	**C2 (Understanding)**	**PLO 2**
CLO 2	**Design** a conceptual model using ER Model for an enterprise	**C6 (Creating)**	**PLO 4**
CLO 3	**Develop** a normalized relational design to remove anomalies in a set of relations	**C6 Creating)**	**PLO 4**
CLO 4	**Implement** the database schema developed against the designed conceptual model	**C3 (Applying)**	**PLO 4**
CLO 5	**Author** queries using relational algebra and SQL	**C6 (Creating)**	**PLO 5**

Textbook

- Ramez Elmasri, Fundamentals of Database Systems (7th Edition)

Reference Books

- Raghu Ramakrishnan, *Database Management Systems* (3rd Edition)
- C. J. Date, *An Introduction to Database Systems* (8th Edition)

Grading Scheme (Absolute)

Midterms (30%), Quizzes (10%), Assignments/Class Participation (10%), Final (50%)

Grading

- Minimum eligibility to pass this course is to get 50% marks.
- Academic integrity is expected of all the students. Plagiarism or cheating in any assessment will result in at least an **F** grade in the course, and possibly more severe penalties.

Project

Students will design, implement, demonstrate, and document a database system. The project is to be done in groups of 3/4 students. Pick your partner as soon as possible. The groups are self-policing (e.g., each group is responsible for its own division of labor, scheduling, etc.). A separate handout will be provided describing the project requirements in the 2nd week of the classes.

Tentative Course Outline and Lecture Plan

Week	Topics to be covered	Topics Detail		Readings (Textbook)	No of Lec.	Asst.
1	Introduction to Databases	• Databases and Database Users • Characteristics of the Database Approach • Advantages of Using the DBMS Approach • Data Models, Schemas, Instances • Architecture and Components of a DBMS		Ch 1,2	2	
2-3	Relational Data Model	RA	SQL	Ch 5, 6	4	A1
		• Relational Model Concepts o Domain, Attributes, Tuples, Relations o Characteristics of Relations • Relational Model Constraints o Domain, Keys, Integrity • Update Operations and Dealing with Constraint Violation	• Data Definition Statements (DDL) o Create, Alter, Drop, Rename • Specifying Constraints o Attribute, Key, Referential Integrity, Tuple-Based Using CHECK • Data Modification Statements (DML) o Insert, Update, Delete			
4-6	Formal Query Language: Relational Algebra and The Database Language: SQL	RA	SQL	Ch 6, 7, 8	6	A2, A3
		o Unary Relational Operations o SELECT, PROJECT, RENAME	o Retrieval Queries o Basic Queries: SELECT-FROM-WHERE o Ordering, Arithmetic Operations, Substring Comparison			
		o Binary Operations o Union, Intersection, Difference, Division	o Set Operations			
		o Cartesian Product, JOIN o Outer Join, Outer Union, Full	o Joining, Full, outer, inner, Cross			
		o Aggregate Functions and Grouping	o Aggregate Functions and Grouping			
		Query Tree	o Nested Queries o Correlated Nested Queries			
		--	o Views (Virtual Tables), Stores Procedures, Assertions and Triggers			
7-9	Database Design Theory and Normalization	• Design Anomalies • Informal Design Guidelines for Relational Databases • Functional Dependencies (FDs) o Convert Business statements into Dependencies o Armstrong's Inference Rules for FDs o Algorithm for computing Attribute Closure o Minimal Cover of FDs o Equivalence of Sets of FDs • Normalization for Relational databases o Normalization and De-Normalization o Normal Forms: 1NF, 2Nf, 3NF, BCNF, 4NF, 5NF • Overview of Relational Database Design Algorithms		Ch 14, 15	6	A4

10-12	Data Modeling Using Entity-Relationship (ER) Model	• Entity Types, Entity Sets, Attributes, Keys • Relationship Types, Relationship Sets, Roles • Constraints on Relationship Types • Relationship Types of Degree Higher than Two • Enhanced Entity-Relationship (EER) Model Concepts • Subclasses, Superclasses, Inheritance • Specialization and Generalization • Constraints and Characteristics of Specialization and Generalization • Shared and UNION Type subclasses	Ch 3, 4	5	A5
12-13	Relational Database Design by ER- and EER-to-Relational Mapping	• Mapping ER Model Constructs to Relations • Mapping EER Model Constructs to Relations	Ch 9	2	
13-14	Transaction Processing Concepts	• Issues in Transaction Processing • Why Concurrency Control is Needed • Why Recovery is Needed • Transaction States and Operations, System Log, Commit Point of a Transaction • ACID Properties of Transactions • Characterizing Schedules based on Recoverability • Characterizing Schedules based on Serializability • Transactions Isolation Levels and Possible Violations • Basic Two-Phase Locking Technique for Concurrency Control	Ch 20	3	