

Micro Syllabus of Database Management System

Course no:

Full Marks: (60+20+20=100)

Credit hours: 3

Pass Marks: (24+8+8=40)

Course Description: This is the first database course for B.Sc. Computer Science and Information Technology students. It introduces the fundamentals of database technology. Topic covered include: database concepts, Database System Architecture, E-R model, relational model, database design theory, database languages, transaction management, concurrency control and database recovery.

Course Objective: There are two principle objectives for this course.

- To introduce the fundamental concepts and methods necessary for the design and use of a database systems.
- To provide the practical experience in applying these concepts and methods using commercial database management systems.

Unit-1

19 hrs

- Why Data Management is important
- When Data becomes information
- Database Management System
 - Definition
 - Primary goal of DBMS: is to store and manage data
 - Related data
 - Integrated Data
- Database Management Systems and Database Systems
- Example usages of Database Management Systems
- History
- Simplified Database System Organization
- Example of Relational Database: Student Records(any)
- Approaches to management of data
 - Database approach
 - File system approach
- File layout for the student records (any)
- Database Vs. File Systems Approaches
 - Data Abstraction
 - Reliability
 - Efficiency/ Performance
- Data Models(in chronological order)
 - Hierarchical
 - Network
 - Relational
 - Entity Relationship
 - Objected Oriented

- Database Schema& instances
- Data Abstraction... Views
- 3-level Architecture (ANSI/APARC Architecture)
- Advantages of the 3 schema representation
- Mapping
- Data independence
- Drawback of using file systems to store data
- Advantages of Database Processing
 - Extracting Information from Data
 - Sharing of Data
 - Standards
 - Controlled Redundancy
 - Integrity Control
 - Security
 - Economy of scale
 - Data Independence
- Additional Advantages of DB approach
 - Expandability/ Flexibility
 - Reduce applications development time
 - Economy of Scale
 - Centralized control by the DBA
- Applicability
 - When DBMS is needed?
 - When a DBMS is Inappropriate?
- DBMS Languages
- Database System Components
 - Data
 - Hardware
 - Software
 - Users
- Data Administration and Database Administration
- Tasks of DBA
- DB End Users
- DB Developers
- Database System Structure
 - The storage manager
 - The query processor components
- The Data Communications Manager
- DBMS Interface
- Database System Utilities
- Centralized and Client-Server Architectures
 - Two Tier Client-Server Architecture
 - Three Tier Client-Server Architecture

- Classification of DBMSs
- Variations of distributed environments
- Database System Life Cycle
- Design
 - Functional Design
 - Database Design
 - Conceptual Database Design
 - Logical Database Design
 - Physical Database Design
- Entities and Attributes
- Two Semantics primitives
 - Entities
 - Relationships
 - Attribute types & Entity types
- Uniqueness or Key Constraint
- Key Attributes
- Domains of Attributes
- Relationships
- Constrains on Relationship Types
- Cardinality ratios
- Participation Constrains
- Attributes of Relationship Types
- Strong and Weak Entities
- Identifying Relationships
- ER-Diagrams with one case study
- EER model: Enhanced / Extended ER Model
- Subclasses and Super classes
- Specialization and Generalization
- Relational Model Concepts
- Definition Formal and Informal

Characteristics of Relations

- Relational Integrity Constrains
 - Key Constraints
 - Entity Integrity
 - Referential Integrity
 - Semantic Integrity Constraints
- Update Operations on Relations
 - INSERT a tuple
 - DELETE a tuple
 - MODIFY a tuple
- Relational Algebra

- Unary Relational Operations
- Relational Algebra Operations From Set Theory, Type Compatibility
- Binary Relational Operations
- Additional Relational Operations
- Examples of Queries in Relational Algebra
- Relational Calculus
 - Tuple Relational Calculus
 - Well-formed Formula
 - Safety to Expressions
 - Equivalent Expressions
 - Examples of Queries in Tuple Relational (Basic operations only)
 - Domain Relational Calculus (Basic operations only)
- Overview of the QBE language
- Relational Commercial languages
 - SQL (DDL, DML, Views)
- ER-to-Relational Mapping Algorithm
 - Step 1: Mapping of Regular Entity Types
 - Step 2: Mapping of Weak Entity Types
 - Step 3: Mapping of Binary 1: 1Relation Types
 - Step 4: Mapping of Binary 1: N Relationship Types.
 - Step 5: Mapping of Binary M: N Relationship Types.
 - Step 6: Mapping of Multivalued attributes.
 - Step 7: Mapping of N-ary Relationship Types.

Unit – 2

12 hrs

- Constrains in SQL
 - Key constraints
 - Attribute constraints
 - Tuple constraints
 - Trigger and assertions
 - ECA rules
- Authorization and Privileges
- GRANT and REVOKE authorizations
- Data encryption (basic concept only)
- Functional Dependencies (FD)
- Trivial and non-trivial FDs, closure of a set of FDs, attribute closure FDs, irreducible set of FDs
- First, Second, and Third normal forms
- Transitivity, Reflexivity and Augmentation properties of FDs
- BCNF and decomposition into BCNF

Unit -3

14 hrs

- Introduction to Transaction Processing

- Transaction and System Concepts
- Desirable Properties of Transactions(ACID)
- Characterizing Schedules based on Recoverability
- Characterizing Schedules based on Serializability
- Transaction Support in SQL
- Database Concurrency Control
 - Purpose of Concurrency Control
 - Two-Phase locking
 - Limitations of CCMs
 - Timestamp-based protocols
 - Commit protocols
 - Index Locking
 - Lock Granularity
 - Time stamp ordering multi version concurrency control,
 - Deadlock handling – detection and resolution
- Databases Recovery
 - Purpose of Database Recovery
 - Types of Failure
 - The Storage Hierarchy
 - Buffer Management
 - Transaction Log
 - Data updates
 - Data Caching
 - Transaction Roll-back (undo) and Roll-Forward
 - Check pointing, shadow paging
 - Recovery schemes(WAL Write-Ahead Logging Protocol)
 - Failure with Loss of Non-volatile storage (general concepts)
 - Recovery in Multidatabase System

Prerequisite: Be familiar with at least one high-level programming language such as C, C++ or Java. Introduction to Operating Systems, Data Structures and Algorithms.

Textbooks: A. Siberschatz, H.F.Korth, and S. Sudarshan, Database System Concepts, 4th edition, McGraw Hill

References:

1. C.J. Date, An Introduction to Database Systems, 8th edition, Addison Wesley
2. Raghu Ramakrishnan, and Johannes Gehrke, Database Management Systems, McGraw Hill, 2003. (ISBN: 0-07-246563-8)
3. Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database System, Forth Edition, Pearson Addition Wesley; 2003, (ISBN: 0321122267)

Laboratory Projects: The course involves a mini project using any one of the popular Commercial Database packages like Oracle, MySql, MS SQL Server, MS Access etc.

Homework Assignments: Homework assignments can be given according to the course covered throughout the semester.

Computer Usage: Windows and Linux based PC or workstation, Commercial database package installed in the Database server.

Category Content: Science Aspects: 60%

Design Aspects: 40%

Model Question Paper of Database Management System

B.Sc. in Computer Science and Information Technology, IOST, TU

Time: 3 hours

Full Marks: 60

Pass Marks: 24

Attempt all questions

1. Answer the following questions in short. (5x2=10)
 - a) What is database management system? Compare it with File system.
 - b) Explain the difference between physical and logical data independence.
 - c) What do you mean by instance and schema of the database?
 - d) What is the difference between a strong and weak entity set? What type of integrity constraint a weak entity set represents.
 - e) Explain the three levels of abstraction of data?
2. (a) Give an ER diagram for a database showing University. The University maintains data about Affiliated Colleges, Course, and Students. (6)
(b) Describe the Fundamental operations of Relational Algebra. (4)
3. a) The following is a relational database. **Customer** (Cname, Cstreet, Ccity), **Account** (bname, acno, balance), **Depositor** (Cname, acno) Loan (bname, lbanno, amount), **Borrower** (Cname, loanno), and **Branch** (bname, bcity, assets). Express the following in SQL:
 - a. Find the customer who lives in "Kathmandu".
 - b. Find all customers who have an account but not a loan.
 - c. Find the largest account balance in the bank.
 - d. Find all the customers who have an account at all branches located in "Pokhara".(5)
b) What are constraints? Explain the various constraints with their uses. (1+4)
4. a) Describe the advantages of using first, second and third normal forms in relational database design. (4)
b) Suppose that we decompose the schema R= (A, B, C, D, E) into (A, B, C) and (A, D, E). Show that the decomposition is a loss less join decomposition if the following set F of functional dependencies hold
A ->BC
CD -> E
B -> D
E -> A (6)

Or

Why certain functional dependencies are called trivial functional dependencies? Explain with Proper example. (6)
5. a) Define a Transaction and list of ACID properties. Explain the usefulness of each. (1+2+2)

b) Explain the distinction between the terms serial schedule and serializable schedule. (5)
6. a) What benefit is provided by strict two phase locking? What disadvantages result? (3+2)

b) Indicate how the recovery scheme works in a single user environment if the system fails.

- I. After the transaction starts and before the read.
- II. After the read and before the write.
- III. After the write and before the commit.
- IV. After the commit and before all databases, entries are flushed onto disk. (5)