Academia International College

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%

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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)