Course Title: Advanced Database Design   **Credit: 3**

Course No: CSIT.423.2   **Number of period per week: 3+3**

Nature of the Course: Theory + Lab   **Total hours: 45+45**

Year: Fourth, Semester: Eighth

Level: B. Sc. CSIT

1. Course Introduction

Advanced database design is the course that focuses on principles and algorithms of designing database management systems. This course covers concepts of file structures, indexing, query processing and optimization techniques used by database management systems. Besides this, course has given emphasis on techniques of handling transaction, concurrency, and recovery.

2. Objectives

Upon completion of the course, the student can:

→ Understand techniques and algorithm used in DBMS design

→ Demonstrate each techniques and algorithm used in DBMS design.

→ Optimize queries by creating alternative evaluation plans.

→ Develop small scale DBMS.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Understand access characteristics of disks and performance parameters • Discuss role of buffer manager in performance of DBMS' • Exemplify different file organization used by database management systems	**Unit I: Storage and File Structures (8 hr)** 1.1. Physical Storage Media: Memory Hierarchy, Physical Characteristics of Disks, Performance Measures of Disks, Optimization of Disk Block Access, RAID 1.2. Storage Access, Buffer Manager, Buffer Replacement Policies 1.3. File Organization: Fixed Length Records, Variable Length Records, Organization of Records in Files, Data Dictionary Storage
• Understand need and importance of indices • Discuss different type of indices critically • Explain hashing and its applications critically	**Unit II: Indexing and Hashing (8 hr)** 2.1. Basic Concepts, Types of Indices, Factors for Evaluating Indices, 2.2. Ordered Indices, Primary Indices (Dense and Sparse), Multilevel Indices, Index update, Secondary Indices, Secondary Indices, B+ Tree Index 2.3. Static Hashing, Hash File Organization, Hash Functions, Bucket Overflow handling, Hash Indices, Dynamic Hashing, Index definition in SQL
	Unit III: Query Processing (8 Hrs)

• Understand steps of query processing • Exemplify algorithms used in performing different SQL operations • Discuss and exemplify process of evaluating SQL expressions	3.1. Steps Involved in Query Processing, Measure of Query Cost 3.2. Select Operation: Basic Algorithms, Selection using indices, Selection involving comparisons, Implementation of Complex Selections 3.3. Join Operation: Nested Loop Join, Block Nested Loop Join, Indexed Nested Loop Join 3.4. Other Operations: Duplicate Elimination, Projection Set Operations, Outer Join, Aggregation 3.5. Evaluation of Expressions, Materialized Evaluation, Pipelining Evaluation
• Discuss importance of optimizing queries • Exemplify size estimation of relations and its use in query optimization • Demonstrate transformation rules used in query optimization • Understand and compare cost base and heuristic query optimization	**Unit IV: Query Optimization (8 Hrs)** 4.1. Basic Concepts, Estimating Statistics of Expression Result, Catalog Information 4.2. Selection Size Estimation, Join Size Estimation, Size Estimation of other operations, Estimating Number of Distinct Values 4.3. Transformation of Relational Expressions, Equivalence Rules, Examples of Transformations 4.4. Cost Based Query Optimization, Heuristic Query Optimization, Optimization of Nested Queries
• Understand basic concept of transaction and interleaved processing • Discuss need of serailizable schedules • Exemplify serializability test procedure	**Unit V: Transaction Management (4 Hrs)** 5.1. Basic Concepts, ACID Properties, Transaction States, Concurrent Execution 5.2. Schedules, Types of Schedule on the Basis of Serializability, Testing Conflict Serializability, Types of Schedule on the Basis of Recoverability 5.3. Commit and Rollback
• Understand need of concurrency control • Discuss different protocols used in controlling concurrency and exemplify each of them • Exemplify techniques of handling deadlocks	**Unit VI: Concurrency Control(5 Hrs)** 6.1. Lock Based Protocols, Timestamp Based Protocols, Thomas write Rule 6.2. Validation Based Protocols, Granularity, Multiversion Protocols 6.3. Deadlock Prevention (wound-wait and wait-die), Deadlock Detection, Recovery from Deadlocks
• Discuss need of recovery techniques • Exemplify log based recovery schemes • Explain shadow paging technique of recovery	**Unit VII: Recovery System(4 Hrs)** 6.4. Types of Failures, Recovery Schemes, Log File, Write Ahead Logging 6.5. Log Based Recovery Techniques (undo/redo, no-undo/redo, undo/no-redo), Check pointing, Shadow Paging 6.6. Recovery in concurrency

Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weight age**	**Marks**	**Practical**	**Weight age**	**Mark**
End semester examination		Assignments	20%		Practical Report copy	25%	
(Details are given in the separate table at the end)	60	Quizzes	10%	20	Viva	25%	20
		Attendance	20%		Practical Exam	50%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

External evaluation

1. **End semester examination:**
   It is a written examination at the end of the semester. The questions will be asked covering all the units of the course. The question model, full marks, time and others will be as per the following grid.

2. **External Practical Evaluation:**
   After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the above mentioned evaluation. There will be an internal examiner to assist the external examiner. Three hours time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Full Marks: 100, Pass Marks: 45, Time: 3 Hrs

Nature of question	**Total questions to be asked**	**Total questions to be answered**	**Total marks**	**Weightage**
Group A: multiple choice*	20	20	20×1 = 20	60%
Group B: Short answer type questions	7	6	6×8 = 48	60%
Group C: Long answer type questions	3	2	2×16 =32	60%
			100	100%

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:
- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam. Unless and until the student clears one semester he/she will not be allowed to study in the following semesters.

Laboratory Work

Student should practice creation, modification and removal of indexes, need to implement different algorithms used for SQL operations. Students also need to practice query optimization schemes, transaction management, concurrency control algorithms, and recovery techniques.

Prescribed Text

- **Database System Concepts,** by Abraham Silberschatz,, Henary Korth, S. Sudarshan, McGraw-Hill Education, Sixth Edition, 2010

- Raghu Ramakrishnan, and Johannes Gehrke, Database Management Systems, 3rd Edition ,McGraw-Hill, 2007

- Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, 6th Edition, Pearson Addison Wesley; 2010