

## DATABASE MANAGEMENT SYSTEM

### ENCT 301

Year/Part: III/I

Teaching Schedule				Examination Scheme						Total
L	T	P	Total	Theory			Practical			
				Assessment Marks	Final		Assessment Marks	Final		
					Duration (Hrs)	Marks		Duration (Hrs)	Marks	
3	1	3	7	40	3	60	50	0	0	150

**Depth Codes**

E-Explanation	C-Circuit	D-Definition	DM-Demonstration
DV-Derivation	DW-Drawing	P-Proof	I-Illustration
NUM-Numerical	PRG-Programming	S-State	ACT-Activity-based Learning
MP- Mini Project	EXP-Experiment	REV-Review / Recap	PS- Problem Solving
QA- Question Answer	Q- Quiz	ST- Surprise Test	MT-Mid Term Test

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
<b>1</b>	<b>Introduction</b>			<b>3</b>	<b>1</b>	<b>3</b>	<b>1</b>
	1.1 Application and evolution of database	D, E	- Definition of data, database and database management systems - Discussion of application and significance of databases and DBMS - History of databases and evolution to recent trends	1.5		3	
	1.2 Data abstraction (Physical, logical, and view level) and data independence	D, E, I	- Description of data abstraction levels along with block diagram and their significance - Principal of physical data independence along with practical significance	1			
	1.3 Schema and instances	D, E, I	- Definition of schema and instances along with practical examples	0.5	1		
	Evaluation	QA					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
<b>2</b>	<b>Data Models</b>			<b>7</b>	<b>2</b>	<b>6</b>	<b>2, 3</b>
	2.1. Introduction to data models (Entity-relationship, relational, object model, hierarchical, network, graph data models)	D, E, I	- Description and significance of data models - Brief description of each type of data model - Illustrative example of each data model	0.5			2

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
	2.2 E-R model 2.2.1 Entities and entity sets 2.2.2 Attributes and keys 2.2.3 Strong and weak entity sets 2.2.4 Relationship and relationship sets (Mapping cardinalities) 2.2.5 Specialization, generalization and aggregation	D, E, I, DW, ACT	- Description and illustration of various concepts and notations in ER models - Illustration with ER diagram examples - Discussion of alternate notation and conventions - Exercises with mini-cases to design ER diagrams - Group activities to study real cases and design ER models (This can be done for their mini course project) - Drawing ER diagrams using CASE tools	3.5	1	3	2
	2.3 Relational model 2.3.1 Concept of relational model, key constraints 2.3.2 Converting ER model into relational model	D, E, I, DW, ACT	- Definition and description of the relational model and key terminologies - Description and illustration of different types of keys and foreign key constraint - Notational conventions and drawing of relational schema diagrams - Converting ER diagrams to relational schemas for different cases (eg, one-to-many relations, many-to-many relations, etc.) - Group activity/mini-project may be continued to convert the develop ER diagram to relational schema diagram	3	1	3	3
	Evaluation	QA, Q, MP					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
<b>3</b>	<b>Relational Query Languages</b>			<b>7</b>	<b>3</b>	<b>9</b>	<b>4,5,6</b>
	3.1 Relational algebra	D, E, PS	- Description and usage of relational algebra operators with examples - Selection, projection, Cartesian product, various types of join, rename operations - Set operations - Modification of relations with assignment operator - Example queries with relational algebra - Practice problems with given cases/schema	1.5	1		
	3.2 Concept of DDL, DML and DCL	D, E	- Description/distinction of DDL, DML and DCL queries along with examples in SQL	0.5	1	3	
	3.3 Overview of the SQL query language-DDL and DML queries	D, E, PS	- Description of SQL and basics - Relation with relational algebra - DDL queries and DML queries with examples - Practice examples	0.5			
	3.4 Set operations	D, E, PS	- Set operations in SQL queries along with examples and problem solving	0.5			
	3.5 Aggregate functions – GROUP BY – HAVING	D, E, PS	- Aggregate operations in SQL queries along with examples and problem solving	0.5			
	3.6 Joins and types of joins	D, E, PS	- Description of various types of joins in SQL along with example - Practice with given problems	0.5		3	

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
	3.7 Nested sub queries	D, E, PS	- Description of various types of nested SQL queries along with examples and problem solving	0.5	1		
	3.8 Database modification (Insert, update, delete)	D, E, PS	- Description and examples of insert, update and delete queries in SQL for database modification. - Practice with given problems	0.5			
	3.9 Views	D, E, PS	- Concept of views and its significance in databases - Creating and using views in SQL - Examples and practice problems - Managing access control with views - Updating views - Materialized views	1		3	
	3.10 Triggers and stored procedures	D, E, PS	- Creating and using triggers along with examples and problems - SQL functions and language constructs for stored procedures - External language routines	0.5			
	3.11 Privilege and roles management – GRANT and REVOKE statements	D, E	- Description of privilege and role based access control in DBMS - Description of GRANT and REVOKE commands, creation of users and roles, along with examples - Authorization graph for database administration	0.5			
	Evaluation	QA, PS, Q, MP					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
<b>4</b>	<b>Database Constraints and Normalization</b>			<b>6</b>	<b>2</b>	<b>6</b>	<b>7, 8</b>
	4.1 Integrity constraints and domain constraints	D, E	- Description of integrity and domain constraints along with examples in SQL - Relational integrity and key constraints	0.5	1	3	
	4.2 Assertions	D, E	- Creating and using assertions in SQL along with examples	0.5			
	4.3 Functional dependencies	D, E, PS	- Functional dependency theory and concepts - Concepts and examples of functional dependency and attribute closures, Armstrong's axioms, algorithms and tests related to closures, etc. - Examples and problems related to functional dependencies / attribute closures	2			
	4.4 Different normal forms (1NF, 2NF, 3NF, BCNF)	D, E, PS	- Definition and significance of database normalization - Definition and criteria for different normal forms along with examples - Algorithms/procedures for achieving database relations in the above normal forms - Lossless decomposition of relations - Examples and exercises for obtaining the normalized forms using given	3	1	3	

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
			algorithms/procedures - Properties and comparison of 3NF and BCNF				
	Evaluation	QA, Q, MP					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
<b>5</b>	<b>Query Processing and Optimization</b>			<b>4</b>	<b>1</b>	<b>3</b>	<b>9</b>
	5.1 Query processing, optimization and evaluation	D, E	- Description and significance of query processing and optimization - Description of various stages of query processing along with block diagram	1			
	5.2 Transformation of relational expressions	D, E, I	- Transformation of relational expressions to equivalent forms using various rules - Examples and exercises	0.5	1		
	5.3 Techniques of implementing query optimization - Cost based optimization and heuristic optimization	D, E, I	- Description of Cost-based optimization and heuristics along with illustrative examples - Description of parameters and statistics used for cost estimations	0.5			
	5.4 Query evaluation - Materialization and pipelining	D, E, I, DM	- Description of query evaluation and execution plan - Description of materialization and pipelining schemes along with comprehensive examples - Demand-driven and Producer-driven pipelining - Demonstration of query execution plan using a DBMS platform (like MS SQL server)	0.5			
	5.5 Denormalization for performance	D, E	- Description of denormalization used for performance along with practical examples	0.5			
	5.6 Materialized view	D, E, DM	- Description and significance of materialized views - Demonstration using a DBMS platform (like PostgreSQL)	0.5			
	5.7 Performance tuning	D, E, DM	- Description of database performance degradation and significance of database tuning - Description of performance tuning operations in DBMS like profiling, preparing workload, using performance tuning wizards, etc. - Demonstration using platforms like MS SQL server or PostgreSQL	0.5		3	
	Evaluation	QA, Q					
<b>6</b>	<b>File Structure and Hashing</b>			<b>5</b>	<b>2</b>	<b>6</b>	<b>10, 11</b>
	6.1 Disks and storage	D, E	- Description of various physical storage systems including technologies like RAID	1			

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
	6.2 Records organizations	D, E, I	- Description of file organization - Fixed and variable length records - Sequential record organization - Multi-cluster record organization - Database buffer management	1			
	6.3 Ordered indices	D, E, I	- Description of ordered indices along with illustrative examples - Primary and secondary indices - Dense vs Sparse indices - Searching keys in ordered indices - Insertions and deletions in ordered indices - Multi-level sparse indices	1	1	3	
	6.4 B+ tree index	D, E, I	- Description of B+ tree index structure along with rules and examples - Searching keys in B+ tree index - Properties and advantages of B+ tree index - Comparison with B tree index	1			
	6.5 Hashing concepts - Static and dynamic hashing	D, E, I	- Basics of hash functions - Description of hash index with examples - Static hashing concepts – search and inserting keys - Overflow buckets - Concept of dynamic hashing using extendable hash index - Bitmap indices	1	1	3	
	Evaluation	QA, Q					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
<b>7</b>	<b>Transaction Processing and Concurrency Control</b>			<b>5</b>	<b>2</b>	<b>6</b>	<b>12, 13</b>
	7.1 Transaction and transaction model - State diagram	D, E	- Definition and significance of transactions along with practical examples - Description of states of a transaction along with a state transition diagram	0.5		3	
	7.2 ACID properties	D, E, I	- Description of ACID properties (Atomicity, Consistency, Isolation and Durability) - Illustrative example of each property	1	1		
	7.3 Concurrent execution of transactions	D, E, I	- Description of concurrent execution of transactions and the importance of concurrency along with examples - Challenges in concurrent transactions execution maintaining ACID properties	0.5		3	
	7.4 Serializability (Conflict and view serializability)	D, E, I, PS	- Concept of schedules and serializability of transactions - Conditions for conflict serializability and view serializability along with illustrative examples - Solving example problems of serializability	1	1		
	7.5 Lock based protocols	D, E, I	- Description of locks, types and their compatibility matrix - Description of two-phase locking protocol	1			

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
			along with example - Implementation of locking using lock table				
	7.6 Deadlock handling and prevention	D, E, I	- Introduction to deadlock in transactions along with examples - Description of Deadlock prevention strategies - Deadlock detection with wait-for-graph - Deadlock recovery	1			
	7.7 Multiple granularity	D, E, I	- Description of multiple granularity – coarse and fine level along with example diagram.				
	Evaluation	QA, Q					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
<b>8</b>	<b>Crash Recovery</b>			<b>4</b>	<b>1</b>	<b>3</b>	<b>14</b>
	8.1 Failure classification	D, E	- Types of system failures - Stable storage implementation - Block-level data access	0.5			
	8.2 Recovery and atomicity	D, E, I	- Basic concept of recovery and atomicity	0.5			
	8.3 Log-based recovery	D, E, I, DM, PS	- Detailed working mechanism of log-based recovery along with examples - Immediate and deferred database modification - Undo and Redo operations, recovering from failure, recovery algorithm - Log-based recovery with Checkpointing along with examples - Demonstration of Log-based backup and recovery using DMBS platform like MS SQL server.	1.5	1	3	
	8.4 Shadow paging	D, E, I	- Basic introduction to shadow paging along with block diagram and example - Advantages and disadvantages of shadow paging	0.5			
	8.5 High availability using remote backup systems	D, E, I, DM	- Introduction to remote backup systems along with block diagram - Transfer of control - Types of remote backup systems - Demonstration of remote backup systems in data centers if possible	1			
	Evaluation	QA, Q					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
<b>9</b>	<b>Advanced Database Concepts</b>			<b>4</b>	<b>1</b>	<b>3</b>	<b>15</b>
	9.1 Concept of object-oriented databases	D, E	- Basic concepts of object-based databases - Object-relational data model - Complex data types and nesting - Persistence	1			

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
			- Object-relational mapping (ORM)				
	9.2 Distributed database model	D, E	- Basic concepts of database partitioning and replication - Homogeneous and heterogeneous distributed database systems - Basic concepts of distributed file systems	1			
	9.3 Concept of data warehousing and online analytical processing	D, E	- Basic concepts and architecture of data warehousing along with block diagram. - ETL operations, multidimensional data and warehouse schemas - Basic introduction to OLAP	1			
	9.4 Basic concepts of NoSQL and big data	D, E, DM	- Basic introduction to Big Data and Big Data storage systems - Basic introduction to Hadoop distributed file system, key-value storage systems and MapReduce - Demonstration with a platform like MongoDB	1	1	3	
	Evaluation	QA					

**References:** (Primarily based on the syllabus, and relevant chapters may be consulted as needed)

1. Silberschatz, A., Korth, H.F., Sudarshan, S. (2019). Database system concepts. McGraw-Hill.
2. Elmasri, R., Navathe, S.B. (2021). Fundamentals of database systems. Pearson.
3. Ramakrishnan, R., Gehrke, J. (2002). Database management systems. McGraw-Hill.
4. Connolly, T.M., Begg, C.E. (2021). Database systems: A practical approach to design, implementation, and management. Pearson.

## Database Management System ENCT 301

**Year/Part: III/I**

QN	Question	Marks	Unit
1	Explain the roles of the various layers in data abstraction along with a block diagram	3	1
2	Design an ER-model for the following mini-case, along with proper cardinality constraints. “.....Mini-case description.....” Explain referential integrity constraint in the relational model along with an illustrative example.	6+3	2
3	Consider the given relational schema ..... ..... schema description a) Write a relational algebra query for ..... (query with select/join/group by, etc.) b) Write a relational algebra query for ..... (database modification query)	2+2	3
4	Consider the given relational database schema ..... ..... schema description a) Write an SQL query for ... (query with select/joins/group by, etc.) b) Write an SQL query for .... (DDL create/alter query) c) Write an SQL query for ... (insert/update/delete query) d) Write an SQL query for ... (view/trigger/procedure/grant query)	2*4	3
5	a) Formally define a functional dependency. Explain the Armstrong’s axioms for functional dependencies. b) Explain the conditions for BCNF and 3NF. Compare them and explain which normal form would you use in which condition along with proper justification.	1+2 3+3	4
6	Describe the Pipelining execution strategy for query evaluation. Explain the key differences between Denormalization and Materialized Views, focusing on the motivation for their use and their impact on data redundancy and consistency.	2+3	5
7	a) Why is the B+ tree the preferred index structure for file organization in most modern relational database systems? b) Briefly describe the mechanism that allows Extendible/Dynamic Hashing to grow without reorganizing the entire file.	3 4	6
8	a) Define the concept of Conflict Serializability. Provide a involving two transactions (T1 and T2) that is NOT serializable and explain why it is not Conflict Serializable. b) Briefly describe the four primary states in database. Illustrate these states using a simple state diagram.	1+3 3	7
9	Describe the mechanism by which Shadow Paging ensures atomicity and durability, and state its main advantage over log-based recovery and its primary disadvantage.	2+2	8
10	Describe the two primary strategies for distributing data across multiple physical locations: Data Replication and Data Fragmentation stating a key advantage of each strategy.	2+2	9

*Note: Number of questions and distribution of marks are indicative only.*