

Time: 3 Hours

Total Marks: 80

N.B.:

1. Question No. 1 is compulsory.
2. Solve any THREE questions out of the remaining FIVE questions.
3. Assume suitable data if required.
4. Figures to the right indicate full marks.

**Q.1 Solve any FOUR out of FIVE [20 Marks] (5 marks each) [20 Marks]**

- a) Explain the three-level DBMS architecture (Internal, Conceptual and External level) with a neat diagram.
- b) Compare File System vs Database System (at least 5 points).
- c) Define the following terms with respect to E-R Model: Strong Entity, Weak Entity, Composite Attribute, Multivalued Attribute, Cardinality Ratio, Participation Constraint.
- d) Explain the following Relational Algebra operators with example: i) Select ( $\sigma$ ) ii) Project ( $\pi$ ) iii) Natural Join ( $\bowtie$ ) iv) Division ( $\div$ )
- e) What is Normalization? Explain 1NF and 2NF with suitable example. f) Explain ACID properties of Transaction.

**Q.2**

- a) Draw an E-R diagram for "Online Shopping System" that contains the following entities and relationships: Customer, Product, Order, Payment, ShippingAddress. Include appropriate attributes, keys, cardinality and participation constraints. Convert the above E-R diagram into relational schema. **[12 Marks]**
- b) Explain Generalization, Specialization and Aggregation in Enhanced E-R Model with one example of each. **[8 Marks]**

**Q.3**

- a) Consider the following relational schema:  
Employee(emp\_id, emp\_name, dept\_id, salary, manager\_id) Department(dept\_id, dept\_name, location) Project(proj\_id, proj\_name, dept\_id, start\_date) Works\_on(emp\_id, proj\_id, hours)  
Write the following queries in SQL: i) List all employees whose salary is greater than 50,000 and who work in "Mumbai" location.  
ii) Find the department name and number of employees in each department.  
iii) Display employee name and project name for employees working more than 20 hours on any project.  
iv) Create a view "HighSalary\_Employees" that shows emp\_name, salary of employees earning more than average salary of their department.  
v) Write a trigger that prevents insertion of negative salary in Employee table. **[12 Marks]**
- b) Explain Referential Integrity and Check Constraint with example. **[8 Marks]**

Q.4

- a) Define Functional Dependency. For the relation R(A,B,C,D,E) with FD set {  $A \rightarrow BC$ ,  $CD \rightarrow E$ ,  $B \rightarrow D$ ,  $E \rightarrow A$  } i) Find all candidate keys of R. ii) Decompose the relation into BCNF showing all steps. [10 Marks]
- b) Explain Conflict Serializability and View Serializability with example. Also explain how Thomas Write Rule is used in Timestamp-based protocol. [10 Marks]

Q.5

- a) Explain Lock-Based Concurrency Control protocols: i) Two-Phase Locking (2PL) ii) Strict 2PL iii) Deadlock prevention and deadlock detection techniques. [10 Marks]
- b) What is Log-Based Recovery? Explain Deferred Database Modification and Immediate Database Modification techniques with example. [10 Marks]

**Q.6 Write short notes on any FOUR of the following: (5 marks each) [20 Marks]**

- a) Role and responsibilities of Database Administrator (DBA)
- b) Aggregate functions and GROUP BY – HAVING clause in SQL
- c) Different types of JOINS in SQL (Inner, Left, Right, Full) with example
- d) Pitfalls in Relational Database Design (Redundancy, Update, Insertion, Deletion anomalies)
- e) Timestamp Ordering Protocol vs Lock-Based Protocol f) Triggers and Stored Procedures in SQL