DATA STRUCTURE AND DATABASE CONCEPT
(ELEC 3104)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Which algorithm technique is used for quick sort?
(a) Divide and conquer (b) Greedy
(c) Backtrack (d) Dynamic programming.

(ii) What is the worst-case complexity in Bubble sort?
(a) O(n) (b) O(n log n)
(c) O($\log n^2$) (d) O(n^2)

(iii) Evaluate the following postfix expression: 15 7 + 11/
(a) 4 (b) 2 (c) 1 (d) none of the above.

(iv) The maximum height of tree with nodes n is
(a) n (b) 2n (c) n + 1 (d) 2^n.

(v) Four DML commands are:
(a) Create, Update, Delete, Select (b) Insert, Update, Drop, Select
(c) Create, Alter, Delete, Select (d) Insert, Modify, Delete, Select.

(vi) Cardinality ratio means the
(a) number of attributes associated with an entity
(b) number of entities related with other entities via a relationship
(c) number of entities in an entity set
(d) ratio of number of columns and rows in a table.

(vii) For a relation R = { J, K, L } with functional dependencies F = { JK –>L ; L –> K } the candidate keys are
(a) J and K (both, each one separately) (b) JK (taken together)
(c) only J (d) JK and JL.

(viii) In a relational model, relations are termed as
(a) tuples (b) attributes (c) tables (d) rows.

(ix) The entity integrity constraint states that
(a) no primary key value can be null
(b) a part of the key may be null
(c) duplicate object values are allowed
(d) none of these.

(x) Which of the following operations is used if we are interested in only certain columns of a table?
(a) Projection (b) Selection (c) Union (d) Join.

Group – B

2. (a) What are the properties of an algorithm? How can we measure the efficiency of an algorithm?

(b) Assume 10 × 10 2D array M. Now consider the starting address of M is 10000. Each data item is of size 4 bytes. Calculate the address for the element M[5][4]. Starting index is (0, 0). Assume that data is arranged in row major format.

(c) Consider that matrix size is 20 × 20. What will be the minimum number of zeros in the matrix, so that we shall consider it to be a sparse matrix (using triplet format)?

(d) Suppose the (i, j)th element of a matrix is non-zero. What is the worst-case time complexity to access the element from a normal matrix? What is the worst-case time complexity to access the element from the sparse matrix (using triplet representation)?

(3 + 1) + 4 + 2 + (1 + 1) = 12

3. (a) Write the pseudo code or C type function for the following functions of stack implementation using linked list. (stack is initially empty, and stack has no upper limit or overflow condition)
(i) Stack empty (ii) Push (iii) Pop (iv) Print Stack.

(b) Write a function for reversal of linked list. Assume linked list has only a single Head Pointer.

(4 × 2) + 4 = 12

Group – C

4. (a) Why is binary search not efficient in sorted linked list?

(b) Consider the following sequence of data:
70, 60, 45, 25, 85, 90, 80, 65, 55, 75, 35,120.
(i) Construct a binary search tree.

(ii) Delete 45 and 80 and reconstruct the binary search tree.

(c) Write the pseudo code for search function of binary search tree.

2 + (4 + 3) + 3 = 12

5. (a) If the quick sort algorithm is applied to a sorted array of size 100 elements, what will be the number of comparisons in case the first element is used as pivot?

(b) Suppose the following sequence of values is in the array: 45, 20, 65, 15, 43, 60, and 70. Apply quick sort algorithm and show the contents of the array after each iteration for the first two passes. Each pass sets the pivot element to its proper place and splits the problem into two sub problems.

(c) Write the pseudo code for quick sort using recursion.

2 + 4 + 6 = 12

Group – D

6. (a) Given the following relations

Find all the necessary primary keys and foreign keys, highlight them by underlining the primary keys and drawing proper arrows for the foreign keys.

(b) Write a relational algebra expression that computes the dates of Tom's appointments with doctor Jones.

(c) Translate the following SQL query in relational algebra:
SELECT pName, dName
FROM Patient, Treatment, Doctor
WHERE Patient.pID = Treatment.pID AND Treatment.dID = Doctor.dID.

(d) Write a relational algebra expression for Patient (natural join) Treatment. Also, show the output for the same.

(e) Write an SQL statement to find out the names of doctors who have treated more than one patient.

3 + 2 + 2 + 3 + 2 = 12

7. (a) Draw an ER diagram to model a simple online book store having the following properties and functionalities.

- A book can be identified by its ISBN. The book has a title, year of publishing, and price recorded against it.
- A book is written by one or more authors. Each author can be identified uniquely by his/her name and phone number. An author may have multiple books to his/her credit. An author may be attached to one or more publishers.
- A book is published by a publisher, uniquely identified by publisher's name. A publisher has address and a phone number. A publisher may publish many books. A publisher has many authors associated with it and pays royalties to the authors for their books.
- A customer registers via his/her email id, and information about their name, address, and phone number is recorded. The customer may add several books (different books / same book, multiple copies) to their shopping cart. The customer should be shown the total price during checkout.

Construct a clean and concise ER diagram for this application clearly depicting each entity, required attributes, degree and cardinality of the relationships. Specify primary key attributes of each entity type, and structural constraints on each relationship type. You may assume any unspecified requirements that you think are essential to make the specification complete. Take care of any *weak entities, recursive relationships, and role names* if such are present. You may wish to provide explanatory notes about your diagram.

(b) Identify the relations (tables) that need to be constructed from the above ER diagram and show such entities in a schema. Clearly depict the primary keys and foreign keys in all such obtained relations. (Underline the primary keys and use arrows to depict the foreign keys).

(c) Explain with the help of examples.

- Generalization v/s Aggregation
- Weak Entity and Identifying Relationship.

6 + 4 + 2 = 12

Group – E

8. (a) Consider a relation *Marks* with schema *(StudentID, StudentName, ModuleID, ModuleName, Mark)* which records marks of students for modules which they are studying. *StudentID* determines *StudentName* and *ModuleID* determines *ModuleName*. The only candidate key in this

relation is *(StudentID, ModuleID)* taken together. Is this relation in 2NF? Justify your answer with proper reasoning.

(b) Decompose the relation above to BCNF. At each level, explain how you achieve the higher normal form.

(c) List and explain the different constraints that should be maintained in a good database design.

(d) Given a relation schema *R* and functional dependencies *F* where the primary key attribute(s) are underlined
R (A, B, C, D, E) F = {AB -> CDE, A->C, D->E}
Identify and discuss all the different types of functional dependencies that are present in *F*.

2 + 4 + 3 + 3 = 12

9. (a) Explain what atomicity and durability of a transaction are.

(b) Describe the lost update problem along with a clear example.

(c) Does using the two-phase locking protocol solve the problem you described in part (b) above? Justify your answer with proper reasons.

(d) Let T1, T2 and T3 be transactions that operate on the shared data items A, B and C.
Let
r1(A) mean that T1 reads A
w1(A) means that T1 writes A

Consider the following schedule:
S1: r2(C), r2(B), w2(B), r3(B), r3(C), r1(A), w1(A), w3(B), w3(C), r2(A), r1(B), w1(B), w2(A)

By using a precedence graph, find out if the given schedule is conflict serializable or not. If so, then write the equivalent serializable schedule.

2 + 2 + 3 + 5 = 12