DATA STRUCTURE & RDBMS
(MECH 3134)

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

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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)   Average case complexity to search an element in Binary Search Tree with 'n' nodes is
            (a) $O(n)$ (b) $O(\log(n))$ (c) $O(n^2)$ (d) $O(\log(n^2))$.

    (ii)   What is the average case time complexity of Quick sort?
            (a) $O(n)$ (b) $O(\log(n))$ (c) $O(n^2)$ (d) $O(n\log(n))$.

    (iii)   Advantages of linked list representation of binary trees over arrays?
            (a) dynamic size
            (b) ease of insertion/deletion
            (c) ease in randomly accessing a node
            (d) both dynamic size and ease in insertion/deletion.

    (iv)   When sorting the array {11,22,33,44,55} in ascending order, the sorting algorithm that takes the least amount of time is
            (a) Bubble Sort   (b) Selection Sort
            (c) Insertion Sort   (d) Quicksort.

    (v)   Any binary tree can be accurately reconstructed from its:
            (a) Preorder & Postorder sequences   (b) Inorder sequence only
            (c) Inorder & Postorder sequences   (d) None of the above are true.

    (vi)   For a weak entity set to be meaningful, it must be associated with another entity set, called the
            (a) Identifying set   (b) Closure   (c) Neighbour set   (d) Attribute set.

    (vii)   Which one is correct with respect to RDBMS?
            (a) Primary key ⊆ Super key ⊆ Candidate key
            (b) Primary key ⊆ Candidate key ⊆ Super key
            (c) Super key ⊆ Primary key ⊆ Candidate key
            (d) Candidate key ⊆ Super key ⊆ Primary key.

(viii)   In ER diagrams, a double ellipse is used to denote
(a) Multi-valued attribute   (b) Composite entity
(c) Multi-valued entity   (d) Derived attribute.

(ix)   Which of the following statements about normal forms is FALSE?
(a)   BCNF is stricter than 3 NF
(b)   Lossless, dependency -preserving decomposition into 3 NF is always possible.
(c)   Loss less, dependency – preserving decomposition into BCNF is always possible.
(d)   Any relation with two attributes is BCNF

(x)   Which of the following guarantees that - "A transaction is either performed in its entirety or not performed at all"?
(a) Isolation   (b) Durability   (c) Atomicity   (d) Consistency.

Group – B

2.   (a)   Write the pseudo code of two functions: ***push(x)*** and ***pop ()*** of a stack using linked list where 'x' is a data item to be inserted in the stack.

(b)   What are the time complexities to insert and delete a node from the tail of the Linked List - Justify your answer.

(c)   Write a pseudo code to insert and delete an element from a circular queue using array.

4 + 4 + 4 = 12

3.   (a)   Convert the following infix expression into postfix expression using Stack:
2^2^3 + (2+6) / 2
[N.B. Explain all the intermediate steps with diagrams of the stack during conversion process.]

(b)   Using a stack, explain the process of evaluation of the postfix expression obtained from the above expression of Q3(a).
[N.B. Explain all the intermediate steps with diagrams of the stack during evaluation process.]

6 + 6 = 12

Group – C

4.   (a)   Consider the given list of numbers:
94, 2, 48, 12, 56, 32, 4, 67, 23, 87, 23, 55.
(i)   Construct a Binary search tree (BST) by inserting each number according to the above mentioned sequence and show the diagram of the BST after insertion of each element.
(ii) What is the height of that tree?
Delete values 94, 56, 87, 67, 2, 12 from the above tree and show the reconstruction of the tree after each deletion separately.

(b) Construct a binary tree whose nodes in inorder and preorder are given as follows:
Inorder : D B E A F C G
Preorder: A B D E C F G
Show all intermediate steps.

(3 + 1 + 4) + 4 = 12

5. (a) Explain the best-case scenario for the Quick Sort algorithm to sort an array in the descending order; Calculate the time complexity of Quick Sort in its best case scenario.

(b) Consider the following unsorted data sequence in the array:
10, 20, 30, 100, 40, 50, 60.
Apply Insertion sort to the above data set and sort the sequence. [N.B. Clearly explain all the intermediates steps.]

(c) Compare the pros and cons of Quick Sort and Insertion sort with the help of a suitable data sequence.

(2 + 3) + 4 + 3 = 12

Group – D

6. (a) What do you understand by physical data independence and logical data independence?

(b) Briefly explain the concept of weak entity set using a suitable example. How does the primary key of a weak entity set is formed in a RDBMS?

(c) Consider the following relation:
CUSTOMER (Firstname, MiddileName, SurName, cust_id, age, uniqueMobileNo, Location)
What could be the possible super keys (any four) and candidate keys (any two) of the above-mentioned relation **CUSTOMER**?

(d) What is referential integrity? Explain with a suitable example

3 + 3 + 4 + 2 = 12

7. (a) Consider a relational database as given below:
Product (p-no, p_name, cost, s-no)
Supplier(s-no, s_name, phn)
Order(or-no, p-no, s-no, or-date)
where the underlined attributes are the primary keys.
Write down the expressions using <u>relational algebra</u> for the following queries:
(i) List the product number (p-no), product name (p_name) and supplier name (s_name) of those products whose cost is below Rs.2000.
(ii) Find the supplier number and phone number (phn) of those who supplies product number P-32 and P-75.

(iii) Find the order number (or-no) and product name (p_name) of those products that have been supplied within the period of 10th January, 2021 and 31st March, 2021.

(b) Explain the difference among primary key, candidate key and super key.

(3 × 3) + 3 = 12

Group – E

8. (a) Why normalization is required in Database design?

(b) Consider the following Relation (R) and its Functional dependencies.
$R(\theta, \mu, \gamma, \alpha, \beta)$,
$\{\theta, \mu\} \rightarrow \{\alpha\}$,
$\{\theta, \mu\} \rightarrow \{\beta\}$,
$\{\alpha\} \rightarrow \{\gamma\}$.
$\theta, \mu, \gamma, \alpha$ and β are all atomic.
(i) Determine the candidate key/ keys.
(ii) What is the level of normalization in the Relation (R)?
(iii) Split the relation R further to Achieve highest level of Normalization (i.e. BCNF).

(c) Explain using an example that how BCNF is better than 3NF.

2 + (2 + 2 + 3) + 3 = 12

9. (a) Consider the following schedule **S**:
$R_1(X) \rightarrow W_1(X) \rightarrow R_1(Y) \rightarrow W_2(X) \rightarrow R_1(Z) \rightarrow W_2(Y) \rightarrow C_2 \rightarrow A_1$
Explain whether it is recoverable or not recoverable.
[**N.B**. Here operations like $R_i(X)$, $W_i(Y)$ are notations used for read and write operations of transaction T_i on data items (such as,) X and Y respectively .
C_i and A_i are notations used for commit and abort operations of Transaction T_i respectively].

(b) Let T1 and T2 be transactions that operate on same data items A, B & C. Let r1(A) mean that T1 reads A, w1(A) mean that T1 writes A, same for T2. Given below, are two schedules S1 & S2. Determine if they are conflict serializable or not. Explain your answer.
If a schedule is serializable, write down the equivalent serial schedule(s).
S1: r1(A); w1(A); r2(A); w2(A); r1(A); w1(A)
S2 : r1(A); w1(A); r2(A); w2(A); r1(B); w1(B); r2(C); w2(C)

(c) Briefly explain one of the acid properties, i.e., 'consistency' using an example.

4 + 6 + 2 = 12

Department & Section	Submission link:
ME	https://classroom.google.com/c/MTQyMzIyMTg4NDUz/a/Mj YzNzU1OTM5OTc3/details