KATHMANDU UNIVERSITY
End Semester Examination
March, 2025

Marks Scored:

Level : B.Sc.
Year : II

Course : COMP 202
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 11 MAR 2025

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and mark [X] encircle the most appropriate option from each set of choices

1. What is the primary characteristic of an algorithm?
   [ ] Infinite execution
   [ ] Definite sequence of steps
   [ ] Undefined steps
   [ ] Randomized execution

2. Which asymptotic notation represents the worst-case time complexity?
   [ ] Theta (Θ) [ ] Omega (Ω) [ ] Big O (O) [ ] Small o (o)

3. Following is an incorrect pseudo code for the algorithm which is supposed to determine whether a sequence of parentheses is balanced:

```
declare a character stack
while ( more input is available)
{
  read a character
  if ( the character is a '(' )
    push it on the stack
  else if ( the character is a ')' and the stack is not empty )
    pop a character off the stack
  else
    print "unbalanced" and exit
}
print "balanced"
```

   Which of these unbalanced sequences does the above code think is balanced?
   [ ] (((() [ ] ())(() [ ] ((())) [ ] (()))()

4. While evaluating a postfix expression, when an operator is encountered, what is the correct operation to be performed?
   [ ] push it directly on to the stack
   [ ] pop 2 operands, evaluate them and push the result on to the stack
   [ ] pop the entire stack
   [ ] ignore the operator

5. Suppose a stack implementation supports an instruction REVERSE, which reverses the order of elements on the stack, in addition to the PUSH and POP instructions. Which one of the following statements is TRUE with respect to this modified stack?
   [ ] A queue cannot be implemented using this stack.
   [ ] A queue can be implemented where ENQUEUE takes a single instruction and DEQUEUE takes a sequence of two instructions.
   [ ] A queue can be implemented where ENQUEUE takes a sequence of three instructions and DEQUEUE takes a single instruction.
   [ ] A queue can be implemented where both ENQUEUE and DEQUEUE take a single instruction each.

6. Suppose you are given an implementation of a queue of integers Consider the following function:

```
void f (queue Q)
{
  int i;
        if (!isEmpty(Q))
        {
                i = delete (Q);
                f(Q);
                insert(Q, i);
        }
}
```

7. What operation is performed by the above function f ?

[ ] Leaves the queue Q unchanged
[ ] Reverses the order of the elements in the queue Q
[ ] Deletes the element at the front of the queue Q and inserts it at the rear keeping the other elements in the same order
[ ] Empties the queue Q

8. What does the following function do for a given Linked List with first node as head?

```
void fun1(struct node* head) {
 if(head == NULL)
        return;
 fun1(head->next);
 printf("%d  ", head->data);
}
```

[ ] Prints all nodes of linked lists
[ ] Prints all nodes of the linked list in reverse order
[ ] Prints alternate nodes of Linked List
[ ] Prints alternate nodes in reverse order

9. A circularly linked list is used to represent a Queue. A single variable p is used to access the Queue. To which node should p point such that both the operations enQueue and deQueue can be performed in constant time?

[ ] rear node
[ ] front node
[ ] not possible with a single pointer
[ ] node next to front

10. In a doubly circular linked list, how many pointers does each node contain?

[ ] One
[ ] Two
[ ] Three
[ ] None

11. Consider the binary tree shown in Figure 1. If the post order traversal yields the expression **'a c * b d * + '**, then the labels of nodes 1 to 7 will be

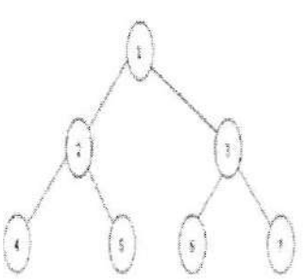

Figure 1 : A Binary Tree

[ ] + * * a c b d
[ ] * + * a c b d
[ ] + * * c a b d
[ ] + * a * c b d

12. Which of the following algorithms is the best approach for solving Huffman codes?
[ ] exhaustive search [ ] greedy algorithm
[ ] brute force algorithm [ ] divide and conquer algorithm

13. In delete operation of BST, we need inorder successor (or predecessor) of a node when the node to be deleted has both left and right child as non-empty. Which of the following is true about inorder successor needed in delete operation?
[ ] Inorder Successor is always a leaf node
[ ] Inorder successor is always either a leaf node or a node with empty left child
[ ] Inorder successor may be an ancestor of the node
[ ] Inorder successor is always either a leaf node or a node with empty right child

14. The following numbers are inserted into an empty binary search tree in the given order: 10, 1, 3, 5, 15, 12, 16. What is the height of the binary search tree (the height is the maximum distance of a leaf node from the root)?
[ ] 2 [ ] 3 [ ] 4 [ ] 6

15. In a graph representation where edge lookups take constant time but may require additional space for sparsely connected graphs, which data structure is most likely being used?
[ ] that uses a fixed-size two-dimensional array
[ ] that dynamically allocates memory for each vertex's neighbors
[ ] that stores edges in a sequential manner without direct indexing
[ ] that allows fast lookups but does not guarantee efficient iteration over neighbors

16. Which algorithm operates greedily, growing a structure iteratively by selecting the least costly edge that expands connectivity without forming a cycle?"
[ ] An algorithm that finds the shortest path between two nodes
[ ] An algorithm that determines the longest possible path in a weighted graph
[ ] An algorithm that constructs a sub graph connecting all vertices with minimal total weight
[ ] An algorithm that detects the presence of cycles in an undirected graph

17. Which data structure is typically used to represent a binary heap in heap sort?"
[ ] A structure that follows Last-In-First-Out (LIFO) order
[ ] A structure that follows First-In-First-Out (FIFO) order
[ ] A structure that allows direct indexing and maintains parent-child relationships implicitly
[ ] A structure that uses pointers to link elements dynamically

18. What is the worst case time complexity of selection sort?
[ ] O(n) [ ] O(n log n) [ ] O(n^2) [ ] O(1)

19. Which collision resolution technique places a new element in the next sequentially available slot within the hash table?
[ ] Chaining [ ] Linear probing [ ] Quadratic probing [ ] Double hashing

20. A hash table uses separate chaining with linked lists for collision resolution. If the number of stored elements exceeds the number of buckets, what is the worst-case time complexity of searching for an element?
[ ] O(1) [ ] O(log n) [ ] O(n) [ ] $O(n^2)$

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SECTION "B"
[6 Q. × 4 = 24 marks]

Attempt *ANY SIX* questions.

1. Define the terms "Data Structure" and "Algorithm." List the characteristics of an algorithm with examples. What is time complexity analysis, and how does it affect the performance of an algorithm? Illustrate with an example.

2. What is an array-based circular queue? Write an algorithm or pseudocode to insert an element at the rear (end) of the circular queue.

3. A company maintains a doubly linked list to store employee IDs and related information in no particular order. Each node in the list contains an employee ID along with pointers to both the previous and next nodes. The HR department wants to insert a new employee ID and its associated details at a specific middle position in the list, as specified by the user. Write an algorithm to insert the new employee ID at the designated middle position in the doubly linked list. Illustrate the working mechanism with figures if necessary.

4. Illustrate the process of inserting data into a Binary Search Tree (BST) using the given set of values: 25, 29, 13, 21, 24, 89, 75, -10 , -5. Construct the final BST after all insertions, then determine and write the preorder and post order traversal sequences.

5. Imagine you are using a social networking platform like Facebook, where users are connected based on friendships. You want to explore how different traversal methods can be applied to find connections between users.
   a. Suppose you want to find the shortest way to connect with a distant friend. Which traversal method would be more efficient for this task and why?
   b. If you want to explore all the friends of a user deeply before moving to the next level, which traversal technique would be more appropriate? Explain.

6. A company needs to sort a list of employee salaries in ascending order for payroll processing. The given salaries (in NPR) are:
   [4500, 2300, 7800, 1200, 5600, 3900, 8900, 6700, 3100, 2500]
   Sort the given list using the Merge Sort algorithm step by step. Show the recursive breakdown of the list into smaller sublists. Merge the sublists back while maintaining the sorted order. Write the final sorted list after applying the Merge Sort algorithm.

7. Let K be an integer array defined as: K={75,18,67,89,7,78,99,12,80,1}
   What are the necessary prerequisites for applying the Binary Search algorithm to this array? Using the given array K, illustrate the step-by-step process of searching for the key = 99 using the Binary Search technique. Provide necessary figures to support the explanation.

P.T.O.

SECTION "C"

[2 Q. × 8 = 16 marks]

Attempt *ANY TWO* questions.

8.

a. Demonstrate how an infix expression is converted into a postfix expression for the given infix expression: "A + **B** * **C** – **D** / **E**". Illustrate the conversion process using a stack and find the final expression using a table.

b. A company is implementing a hash table of size 9 using open addressing and needs to insert 7 keys: [18, 41, 22, 44, 59, 32, 31]. The hash function used is h(Key) =Key mod 9. To handle collisions, both Linear Probing and Quadratic Probing to find an open slot will be applied. Construct and compare the final hash tables for both probing methods after inserting all keys.

9.

a. Compare the implementation of Stack and Queue using a linked list, highlighting their differences in insertion and removal operations. Provide appropriate pseudo code for both data structures, demonstrating how elements are inserted and removed.

b. The following dataset consists of 10 numerical values:

45, 12, 89, 33, 76, 21, 67, 90, 11, 55

Sort the given dataset in ascending order using the sorting process with the Heap Sort algorithm describing the step-by-step procedure.

10.

a. Determine the shortest path cost from Node 0 to Node 4 using Dijkstra's algorithm. Additionally, illustrate the process using a standard table to show the updates in distance values and visited nodes at each iteration.

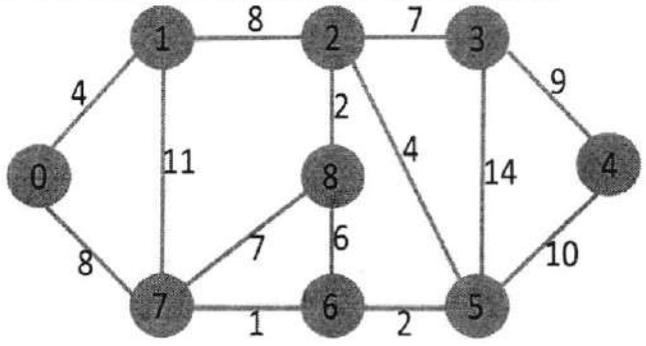

Figure 2 : An undirected Graph

b. Given the Preorder traversal sequence 1, 2, 4, 5, 3, 6, 7 and the Post order traversal sequence 4, 5, 2, 6, 7, 3, 1, construct a Binary Tree that satisfies these traversal conditions. Provide a visual representation of the tree structure.