KATHMANDU UNIVERSITY
End Semester Examination [C]
November/December, 2023

Marks Scored:

Level : B.E./B.Sc.
Year : II
Course : COMP 202
Semester : I
Exam Roll No. :
Time: 30 mins.
F. M. : 10
Registration No.:
Date : 05 DEC 2023

SECTION "A"
[20 Q. × 0.5 = 10 marks]

Choose and encircle in the most appropriate option.

1. Which of the following statement is **FALSE**?
   a. n is $\Omega(log_4 n)$
   b. $n^3 log_2 n$ is $\Omega(3n log_8 n)$
   c. O(log n) is better time complexity than O(log n log n)
   d. O(log n) is O(n)

2. Suppose the functions f and g are non-negative functions. The function f(n) = O(g(n)) if and only if there exist positive constants c and n_0 such that _____ for all $n, n \geq n_0$
   a. $f(n) \leq cg(n)$
   b. $f(n) = cg(n)$
   c. $f(n) \geq cg(n)$
   d. $f(n) \neq cg(n)$

3. Which of the following is a problem associated with recursion?
   a. Overhead of repeated function calls
   b. Collision of different function calls
   c. Searching for all duplicate elements
   d. Making only two recursive calls

4. In divide-and-conquer approach, subproblems are solved
   a. In parallel
   b. Recursively
   c. Iteratively
   d. In a random manner

5. What is the time complexity of the following algorithm if the time complexities of func1 and func2 are O(n) and O(1) respectively:

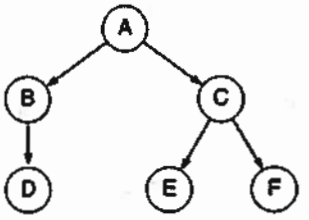
```
i = n
repeat
   func1()
   i = i - 1
until i < 0
func2()
```

   a. O(1) * O(n)
   b. n * O(n) + n * O(1) + O(1)
   c. O(n) + O(1)
   d. n + O(1)

6. How many leaf nodes are there in a heap with n nodes?
   a. $n - 1$
   b. $log_2 n$
   c. $\lceil n \rceil$
   d. $\lfloor n \rfloor$

7. Consider the following two statements about tree traversal
   I. While traversing two different binary search trees with the same keys but placed in different order, it is possible to get the same sequence of visited nodes.
   II. Depth-first traversal and breadth-first traversal on the same tree can result in the same sequence of visited nodes in special cases.
   a. Both statements are correct.
   b. I is correct but II is not.
   c. II is correct but I is not.
   d. Both statements are false.

8. If we represent the following tree using left-child-right-sibling representation, where will E point to?



a. A b. C c. D d. F

9. If the Huffman coding algorithm assigns codes as follows, what will 001100010001110 decode to?

Character	a	b	c	d	e	f
Code	11	000	010	10	011	001

a. fabdfab b. fdfbad c. fdbffad d. babdfad

10. Which of the following linked lists does not have NULL pointer in any node?
a. Singly linked list
b. Circularly linked list
c. Doubly linked list
d. Forward linked list

11. Which of the following is **TRUE**?
a. Linked lists are best suited for relatively permanent collections of data.
b. Linked lists are best suited for data collections with varying length.
c. Adding data at the head of a linked list is more complex removing data from the head.
d. Pop operation in a stack implemented using a linked list is faster than that in a stack implemented using an array.

12. What is the equivalent infix expression of the postfix expression: AB+C*DE/- ?
a. (A + B) * C - D / E
b. A + B * C - D / E
c. (A + B) * (C - D) / E
d. A + (B * (C - D)) / E

13. What does 'stack overflow 'refer to?
a. Accessing item from an undefined stack
b. Popping an item from an empty stack
c. Pushing an item into an empty stack
d. Pushing an item into a full stack

14. In which of the following applications, priority queue data structure is the most appropriate?
a. Evaluation of postfix expressions
b. Organizing file structure
c. Finding minimum spanning tree using Prim's algorithm
d. Storing students' information

15. Which of the following is **FALSE** about graphs?
a. An acyclic graph does not contain any cycles.
b. An adjacency matrix presentation of a graph cannot contain the information about parallel edges.
c. Adding a vertex in adjacency list representation is easier than adjacency matrix representation.
d. Finding whether there is an edge between any two nodes in a graph is easier in adjacency list representation.

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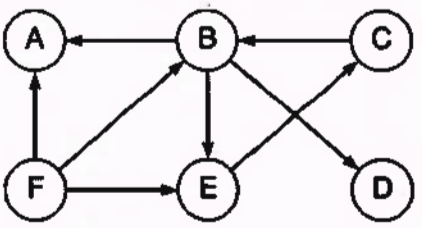
16. Which of the following is true about this graph?



a. It is an acyclic graph
b. Both DFS and BFS starting from F result in visiting the vertices in that order: F, B, E, C, A, D
c. Both DFS and BFS starting from F result in visiting the vertices in that order: F, B, E, A, D, C
d. There is at least one vertex that cannot be reached from any other vertices.

17. Which of the following is the best case scenario for quick sort?
a. After partitioning, the pivot element lies in the middle of the list.
b. After partitioning, the pivot element lies at the extreme ends of the list.
c. After partitioning, the pivot element lies in the first quarter of the list.
d. The pivot element is at the first position before partitioning but goes to the last position after partitioning.

18. What is the worst case time complexity of merge sort?
a. $O(1)$ b. $O(n)$ c. $O(log_2 n)$ d. $O(n^2)$

19. How many comparisons are required to find 75 in the following data using binary search?
34, 44, 56, 59, 75, 89
a. 1 b. 2 c. 3 d. 5

20. Consider the following sequence of keys: 221, 278, 179, 245. If we insert this sequence into a hash table of size 11 using the hash function h(k) = k % 11, how many probing do we need to insert 741 if we use quadratic probing for collision resolution?
a. 1 b. 2 c. 3 d. 4

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F. M. : 40

SECTION "B"
[6 Q. × 4 = 24 marks]

Attempt *ANY SIX* questions.

1. Which data structure would you use in the following scenario? Justify your choice.[2 + 2]
   a. You need to store product categories and subcategories in your website.
   b. You need to maintain a waiting list for a medical cabinet, where patients get to see a doctor based on their arrival time but some patients needing special treatment (e.g., old people, emergency cases) should have less waiting time.

2. Convert the following infix expression to prefix and then evaluated the resulting postfix expression using stack: [2 + 2]
   24 + (89 - 75) / (34 - 27) – 25

3. Construct a binary search tree from the following sequence of keys entered in that order:
   65, 22, 48, 98, 33, 18, 67, 35, 20, 27, 19
   Now delete 22 from the tree. [3 + 1]

4. With the help of the following data, explain how insertion sort works.
   23, 78, 22, 11, 8, 7, 2

5. Write an algorithm to find neighbors of a node in a graph represented by an adjacent matrix. Discuss its time complexity. [3 + 1]

6. Explain the idea behind greedy algorithms. Write about a problem that can be solved using greedy methods. Solve an instance of the problem showing all the intermediate steps. [1 + 3]

7. Write short notes on: [2 + 2]
   a. Heap data structure
   b. Queue abstract data type

SECTION "C"
[2 Q. × 8 = 16 marks]

Attempt *ANY TWO* questions.

8. Answer the following questions:
   a. Suppose you are given two algorithms, A1, and A2, that solve exactly the same problem. Time complexity of A1 and A2 are respectively O(n log n) and O(n), while space complexity of A1 and A2 are respectively O(1) and O(log n). How would you decide which algorithm to use to solve the problem? [3]

   b. Using any standard data structures, design an algorithm that takes two sets of numbers and returns the intersection of those two sets. Note that the input sets may not be of the same size, and the algorithm must return a set containing the common elements in the input sets. For example, if the input sets are {2, 4, 6} and {8, 4, 2, 1, 7}, the algorithm must return {2, 4}. Also compute the time complexity of your algorithm. [3 + 2]

9. Assume that a linked list node contains `data`, and two pointers, `prev`, and `next`, that point to its corresponding predecessor node and successor node respectively. Also assume that `H` and `T` are the pointers to the first node and the last node, respectively, in the list. Now consider the following algorithms and answer the following questions:

```
Algorithm(data)
1: if (data == H->data)
2:  H = H->next
3:  if (H != NULL)
4:    H->prev = NULL
5:   endif
6: else
7:   temp = H
8:   while (temp->next->data != data)
9:     temp = temp->next
10:  endwhile
11:  if (temp->next != T)
12:    temp->next->next->prev = temp
13:  endif
14:  temp->next = temp->next->next
15: endif
```

a. With proper illustrations, explain what this algorithm does. [4]
b. Compute the time complexity of this algorithm. [2]
c. Discuss some scenarios where doubly linked lists are preferred over singly linked lists. [2]

10. What is the main goal of hashed search and how is it achieved? Insert the following sequence of keys in a hash table of size 17 using the hash function h(k) = k % 17. Use quadratic probing to resolve collisions. [3 + 5]
4453, 2319, 6512, 6123, 8983, 5410, 7517