KATHMANDU UNIVERSITY
End Semester Examination [C]
April 2022

Marks scored:

Level : B.E.
Year : II

Course : COMP 202
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration no.:

Date :

SECTION "A"

[20Q × 0.5 = 10 marks]

Encircle the most appropriate option.

1. Which of the following is a non-linear data structure?
   a. List
   b. Queue
   c. Stack
   d. Graph

2. $O(2^n)$ means the time complexity is
   a. constant
   b. linear
   c. quadratic
   d. exponential

3. State true or false if $f(n) = \Theta(g(n))$:
   I. $f(n)$ is $O(g(n))$
   II. $f(n)$ is $\Omega(g(n))$

   a. True, True
   b. True, False
   c. False, True
   d. False, False

4. What is the time complexity of the following program?

```
for (int i = 0; i < n; i++)
{
    int k = 2*i;
    for (int j =0; j < n; j++)
    {
        if (j < 1)
        {
            k = k + 3;
        }
        else
        {
            break;
        }
    }
}
```

   a. $O(1)$
   b. $O(n)$
   c. $O(n^2)$
   d. $O(\log n)$

5. Which data structure does breadth-first search use as an auxiliary structure to hold nodes for future processing?
   a. Queue
   b. Stack
   c. Tree
   d. Graph

6. Which one of the following is true?
   a. Insertion sort always outperforms merge sort
   b. Insertion sort always outperforms selection sort unless the input array is already sorted in reverse order
   c. Heap sort requires more storage than merge sort
   d. In the worst case, quick sort outperforms heap sort

7. Which of the following is not a limitation of a binary search algorithm?
   a. The array must be sorted
   b. A mechanism for finding the mid-point is needed
   c. Searching is not efficient when there are more than 10000 elements in the array
   d. Requirement of sorted array is expensive when frequent insertions and deletions are needed.

8. If the post-order traversal in a binary search tree gives 10, 15, 5, 25, 29, 35, 23. The pre-order traversal will give
   a. 5, 10, 15, 23, 25, 29, 35
   b. 23, 5, 15, 10, 35, 29, 25
   c. 10, 5, 15, 25, 23, 29, 35
   d. 25, 5, 15, 10, 23, 29, 35

9. What would be the result of the evaluation of the following postfix expression if A = 20, B = 10, C = 2, D = 6, E = 3?
   AB+C*DE/-
   a. 28
   b. 38
   c. 48
   d. 58

10. Can we read a data item at any location of a list within a constant time (0(1)) ?
    a. Yes, only if the list is implemented using pointers
    b. Yes, only if the list is implemented using an array
    c. Yes, no matter what kind of implementation is used
    d. No, we need O(n) computation steps regardless of the implementation

11. Which of the following is a disadvantage of using a circular linked list?
    a. It is possible to get into infinite loop
    b. Last node points to first node
    c. Time consuming
    d. Requires more memory space

12. What is the minimum height of a binary tree with 20 nodes?
    a. 19
    b. 1
    c. 4
    d. 6

13. Consider a network of roads. Which of the following is false for the implementation of this network using a graph?
    a. An intersection of roads can be represented by a vertex and a road can be represented by an edge
    b. An intersection of roads can be represented by an edge and a road can be represented by a vertex
    c. Adjacency matrix will be the best for storing this network when there are a few number of intersections
    d. Minimum spanning tree of this graph can be used to make decisions (e.g. paving the roads with the minimum cost)

14. If a heap is stored in an array, what would be the index of the children of the 7th node?
    a. 8 and 9
    b. 14 and 15
    c. 15 and 16
    d. 5 and 6

15. If we apply sequential search and binary search algorithms on an array containing 1000 elements, what would be the expected result?
    a. Not much difference can be noticed because computers run very fast these days
    b. Binary search is twice as fast as sequential search
    c. Binary search is 10 times as fast as sequential search
    d. Binary search is 100 times as fast as sequential search

16. Consider the following sequence of keys: 8956, 2799, 4133, 6867, 1818. 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 6758 if we use quadratic probing for collision resolution?
    a. 0
    b. 1
    c. 3
    d. 5

17. What is the worst time complexity of Binary Search algorithm?
    a. $O(n)$
    b. $O(1)$
    c. $O(log\ n)$
    d. $O(n^2)$

18. Which of the following is not an application of stack?
    a. Infix to postfix conversion
    b. Finding factorial
    c. Depth-first search on a graph
    d. Serving requests on a shared resources like a printer

19. Which of the following is not a property of heap data structure?
    a. Each node has at most 2 children
    b. Each node's key is larger than that of its descendants
    c. All leaf nodes are at the same level
    d. The tree has the minimum height possible

20. What would be the content of an initially empty stack after the following sequence of operations: push(l), push(2), push(0), pop(), pop(), push(9), pop(), push(7), push(8), push(3), push(4), pop()?
    a. 1, 2, 0, 9, 7, 8, 3, 4
    b. 1, 2, 0, 9
    c. 1, 7, 8, 3
    d. 1, 2, 7, 3

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Time : 2 hrs. 30 mins.

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Semester : I
F.M. : 40

SECTION "B"
[6Q. × 4 = 24 marks]

Attempt *ANY SIX* questions.

1. Write an algorithm to check if the given string is a palindrome. Find the time complexity of your algorithm. [2 + 2]

2. Define linked list. Describe how a linked list can be used to implement a stack. Write pseudocode for major operations on a stack implemented using a linked list. [1 + 3]

3. What are the benefits of a circular queue over a simple queue? Describe the implementation of a circular queue using an array. [1+3]

4. What is the heap data structure? How can it be implemented using an array? [2 + 2]

5. Illustrate, with an example, Prim's algorithm for finding a minimum spanning tree of a graph. [4]

6. Explain the divide-and-conquer strategy in algorithm design. Give an example of a problem which can be solved using this strategy. [2 + 2]

7. What is a hash table? Write an algorithm to insert data into a hash table using chaining to resolve collision. Let the hash function be $h(k) = k \% 17$. [1 + 3]

SECTION "C"
[2Q. × 8 = 16 marks]

Attempt *ANY TWO* questions.

8. Define binary tree. Write down some properties (such as minimum/maximum height, nodes etc.) of a binary tree. Give some examples where a binary tree can be used. Construct a Huffman code for each of the characters whose frequencies are given below:

Character	A	B	C	D	E	F	G
Frequency	25	9	7	20	5	17	10

Encode the text BGADE using the obtained code. Then, decode the text whose encoding is 11100010100011. [1+2+1+2+1+1]

9. Consider the undirected graph G given below and answer the following questions:
G = (V,E)
Set of vertices, V = {A, B, C, D, E, F, G}, and set of edges, E = {{A, B}, {A, E}, {B, C}, {B, E}, {C, D}, {C, G}, {F, G}, {G, E}}
   i. Visualize this graph. [1]
   ii. Represent this graph using an adjacency matrix. [1]
   iii. Write the algorithm for performing a Depth-First Search (DFS) on a graph. [2]
   iv. Perform DFS and BFS on this graph. Show all the steps and all auxiliary data structures used during the process. [2 + 2]

10. Construct a heap from an array containing the following elements: 23, 8, 7, 1, 9, 22, 10. Explain how heap sort algorithm works. Apply the same algorithm starting from the obtained heap. Also, discuss on the complexity of this algorithm. [2 + 2 + 3 + 1]