



**Strathmore**  
UNIVERSITY

**SCHOOL OF COMPUTING AND ENGINEERING SCIENCES  
BSC INFORMATICS AND COMPUTER SCIENCE  
BSC COMPUTER NETWORKS AND SECURITY  
END OF SEMESTER EXAMINATION  
ICS 1201: DATA STRUCTURES AND ALGORITHMS  
CNS 2101: DATA STRUCTURES AND ALGORITHMS**

DATE: 27<sup>th</sup> July 2022

Time: 2 Hours

---

**Instructions**

1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

**Question 1**

- a) Explain the difference between a data structure and an abstract data type. (3 marks)
- b) Explain the meaning of asymptotic analysis of an algorithm. (3 marks)
- c) Explain the design considerations for recursive algorithms. (3 marks)
- d) Write an algorithm/pseudocode for selection sort. Illustrate the working of the algorithm using the following array of five numbers:  
  
6, 3, 9, 1, 7 (5 marks)
- e) Construct a binary tree for the arithmetic expression  $((a + b) * c) - d$  and then perform a post-order traversal. (4 marks)
- f) State two applications of the following:
  - i. Stack
  - ii. Trees
  - iii. Graph(6 marks)

g) Analyse the Big-Oh running time of the following:

i. Code snippet 2A

```
/** Returns the sum of the integers with even index in given array. */  
public static int example2(int[] arr) {  
    int n = arr.length, total = 0;  
    for (int j=0; j < n; j += 2) // note the increment of 2  
        total += arr[j];  
    return total;  
}
```

(3 marks)

ii. Algorithm 2B

// Sum of an array of sequential numbers

const array = [1,2,3,4,5,6,7,8];

```
function determineSumOfSequentialArray(array) {  
    return array.length * (array.length + 1)/2;  
}
```

(3 marks)

## Question 2

a) Explain two applications of queues.

(3 marks)

b) Convert the following infix notation to both prefix and postfix notation:

$((A+B) * C - (D-E) ^ (F+G))$

(4 marks)

c) Assuming an array implementation of a stack, write algorithms for the following stack operations:

i. Pop

ii. If stack is full

(4 marks)

d) Assuming circular array implementation of a queue, write algorithms for the following queue operations:

i. Insert / Enqueue

ii. Remove / Dequeue

(4 marks)

## Question 3

a) Explain two differences between an array and a linked list.

(3 marks)

b) Explain two applications of a linked list.

- c) Write a pseudocode for the following linked list operations: (3 marks)
- Adding a node to the head of a linked list.
  - Finding specific key value in a linked list.
  - Deleting a node.

(9 marks)

#### Question 4

- a) Write an algorithm that uses recursion to find the power of a number e.g  $2^4$ . Illustrate the working of the algorithm by showing the series method calls and their return values for  $2^4$

(3 marks)

- b) Distinguish between recursion and iteration.

(3 marks)

- c) Suppose the following list of numbers is inserted in the order into an empty binary search tree: 45, 33, 90, 33, 68, 72, 15, 24, 30, 66, 11, 50, 10.

- Derive the binary search tree.
- Perform pre-order traversal on the derived binary search tree.

(4 marks)

- d) Write Java method for inserting a node in a binary search tree.

(3 marks)

- e) Write an algorithm or Java method for searching a key value in a binary search tree.

(2 marks)

#### Question 5

- a) Perform the following traversals on the graph in Fig. Q5a
- Depth first traversal. Show stack contents for each step
  - Breadth first traversal. Show queue contents for each step.

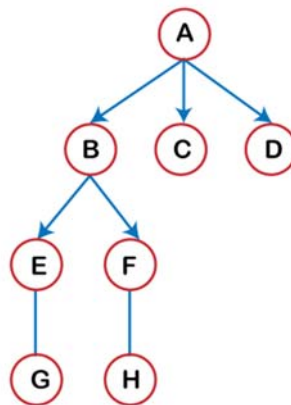


Figure Q5a: Graph

(5 marks)

b) Write an algorithm for merge sort. Illustrate the working of the algorithm using the following array of five numbers: 6, 3, 9, 1, 7

(3 marks)

c) Using illustrations, explain the meaning of the following graph terms:

- a. Degree of vertex
- b. Cyclic graph

(3 marks)

d) Write an algorithm for binary search and illustrate the working of the algorithm using the following numbers: 3,4,5,6,7,8,9.

(4 marks)