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**COLLEGE**

*...Bastion of Knowledge...*

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# UNIVERSITY EXAMINATIONS

## 2021 /2022 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER SUPPLEMENTARY  
EXAMINATION

FOR THE DEGREE OF BACHELOR OF  
SCIENCE (COMPUTER SCIENCE)

MAIN EXAMINATION

COURSE CODE: COM 224

COURSE TITLE: DATA STRUCTURES

DATE: 31<sup>ST</sup> MAY, 2022 TIME: 0900 – 1200 HRS

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INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF 5 PRINTED PAGES

PLEASE TURN OVER

REGULAR EXAM

## COM 224: DATA STRUCTURES

STREAM: COM

DURATION: 3 Hours

**INSTRUCTION TO CANDIDATES**Answer **ALL** questions from section A and any **THREE** from section B.**SECTION A [24 Marks]. Answer ALL Questions.****QUESTION ONE [12 MARKS]**

- Explain the three basic design goals that one should strive when designing for a program and how the complexity of a program can be measured. [3 marks]
- Explain the how dynamic memory allocation helps in managing memory and data how variable declaration affect memory allocation? [3 marks]
- Create a binary search tree for the following numbers start from an empty binary search tree. 45,26,10,60,70,30,40. Delete keys 10,60 and 45 one after the other and show the trees at each stage [3 marks]
- Explain the process of **garbage collection** and the concept of **memory leak** as used in the study of data structures. [3 marks]

**QUESTION TWO [12 MARKS]**

- Algorithm analysis is the study of an algorithm's efficiency with respect to resource utilization. What are these resources? [2 marks]
- You are given an array elements of size  $n=10000$  of time complexity of  $f(n)$ . Suppose you are to search for a given value using binary search strategy explain the condition that will result in the following types of analysis.
  - Best case [2 marks]
  - Worst case [2 marks]
- Figure 1** shows the structure of an array named CAT in computer memory

7	6	8	9	5	10
11	9	10	8	13	14
2	6	7	9	21	6

**Figure 1:** Structure of an array in memory

Write a java code excerpt that will:

- Create and initialize the structure as in **Figure 1** above. [2 marks]
- Compute Total and mean of each row and populate as new two columns on

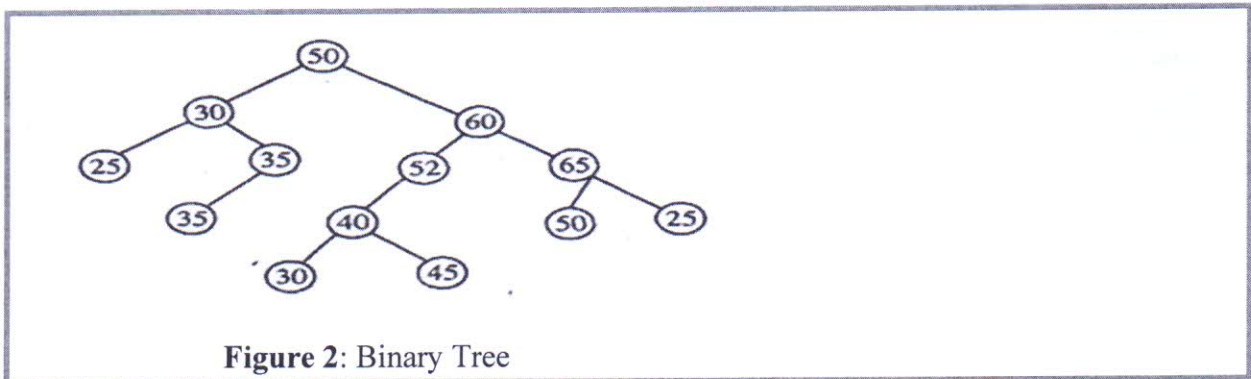
Right-hand-side of the structure.

[4 marks]

**SECTION B [36 MARKS] ANSWER ANY THREE QUESTIONS]**

**QUESTION THREE [12 MARKS]**

- a. What are the different ways of representing a Binary Tree? [2 marks]
- b. What would be appropriate measures of cost to use as a basis for comparing the two sorting algorithms? [2 marks]
- c. Consider the binary tree in **Figure 2**:



Show intermediate tree steps to add element 58 in this tree.

[3 marks]

- d. Show the result of inserting 10,12,1,14,6,5,8,15,3,9,7,4,11,13, and 2, one at a time, in to an initially empty binary heap. [3 marks]
- e. Write the steps required to evaluate the postfix expression. [2 marks]

**QUESTION FOUR [12 MARKS]**

- a. What is the difference between circular linked list and doubly link list. Mention the applications of each type of list. [4 marks]
- b. i. Write the selection sort algorithm (Ascending order), determine the running time (big O) and illustrate how it will sort the following list of elements: 89, 45, 68,90,29,34 and 17. [4 marks]
- ii. Write a java program to implement the algorithm in d (i) above. [4 marks]

## QUESTION FIVE [12 MARKS]

- a. Suppose an array Score contains 6 elements as follows: **19, 11, 23, 9, 3 and 15**. Using relevant illustration explain how you will carry out the following Sorting algorithms. Which one will you prefer?
- i. Selection sort [3 marks]
  - ii. Bubble sort [3 marks]
- b. If the first program P1 takes  $100n^2$  milliseconds and the second program P2 takes  $5n^3$  milliseconds. Determine and recommend which program P1 or P2 is better and at what condition? [3 marks]
- c. You must keep track of some data. Your options are:

A linked-list maintained in sorted order.  
 A linked-list of unsorted records.  
 A binary search tree.  
 An array-based list maintained in sorted order.  
 An array-based list of unsorted records.

For each of the listed scenarios, which choices would be best? Explain your answer.

[3 marks]

## QUESTION SIX [12 MARKS]

- a. Give the main property of a heap that is implemented as an array. [2 marks]
- b. Explain how searching algorithms work using 60, 25, 75, 15, 50, 66, 33, 44 and 33 as the search key. [4 marks]
- c. One of the two software packages, **A** or **B**, should be chosen to process data collections, containing each up to 109 records. Average processing time of the package **A** is  $T_A(n) = 0.001n$  milliseconds and the average processing time of the package **B** is  $T_B(n) = 500\sqrt{n}$  milliseconds. Which algorithm has better performance in a "Big-Oh" sense? Work out exact conditions when these packages outperform each other. [3 marks]
- d. Let processing time of an algorithm of Big-Oh complexity  $O(f(n))$  be directly proportional to  $f(n)$ . Let three such algorithms A, B, and C have time complexity  $O(n^2)$ ,  $O(n^{1.5})$ , and  $O(n \log n)$ , respectively. During a test, each algorithm spends 10 seconds to process 100 data items. Derive the time each algorithm should spend to process 10,000 items. [3 marks]

## COM 224

### QUESTION SEVEN [12 MARKS]

- a. Construct a binary tree representing an arithmetic expression. [4 marks]

$$(((3 + 1) * 3) / ((9 - 5) + 2)) - ((3 * (7 - 4)) + 6)$$

- b. Explain the implementation of circular queue using array. How is an “empty queue” distinguished from a “full queue”? Write necessary functions to perform all valid operations on circular queue. [4 marks]
- c. The elements of arrays *in Table 1* and *Table 2* represent 5 student and score of 2 students in five subjects respectively. Use it to answer questions that follow.

<b>student</b>	COM111	COM211	COM224	COM313	COM426
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**Table1:** Array of Students

<b>score</b>	11	15	19	16	17
	10	26	25	28	23

**Table 2:** Array of Score

- i. Write a signature/syntax of creating array and initializing a students and a scores arrays [2 marks]
- ii. State the output of the following code segments [2 marks]

1	student[2] ;
3	score[0][1];
4	score[2][1];

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