



(Knowledge for Development)

KIBABII UNIVERSITY (KIBU)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

SPECIAL/SUPPLEMENTARY EXAMINATION

2021/2022 ACADEMIC YEAR

SPECIAL/SUPPLEMENTARY EXAMINATION

FIRST YEAR FIRST SEMESTER EXAMINATION

FOR THE DEGREE OF BACHELORS OF SCIENCE IN

(INFORMATION TECHNOLOGY)

COURSE CODE: BIT 121

COURSE TITLE: DATA STRUCTURES AND ALGORITHMS

DATE: 28/07/2022

TIME: 2.00 P.M. – 4.00 P.M

2HRS

INSTRUCTIONS TO CANDIDATES:

ANSWER QUESTIONS ONE AND ANY OTHER TWO.

QUESTION ONE (COMPULSORY)

[30 MARKS]

- a. 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]**
- b. Explain the ways how dynamic memory allocation helps in managing and data how variable declaration affect memory allocation? **[3 marks]**
- c. 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 **[5 marks]**
- d. Explain the process of **garbage collection** and the concept of **memory leak** as used in the study of data structures. **[4 marks]**
- e. Algorithm analysis is the study of an algorithm's efficiency with respect to resource utilization. What are these resources? **[2 marks]**
- f. 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.
 - i. Best case **[2 marks]**
 - ii. Worst case **[2 marks]**
- g. Construct a binary tree representing an arithmetic expression. **[4 marks]**

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

- h. **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:

- i. Create and initialize the structure as in **figure 1** above. **[2 marks]**
- ii. Compute Total and mean of each row and populate as new two columns on Right-hand-side of the structure. **[3 marks]**
- iii. Sort the marks in ascending order. (Hint use the sort () method or function sparingly) **[3 marks]**

QUESTION TWO

[20 MARKS]

a. What are the different ways of representing a Binary Tree? [2 marks]

b. Consider the binary tree in Figure 2:

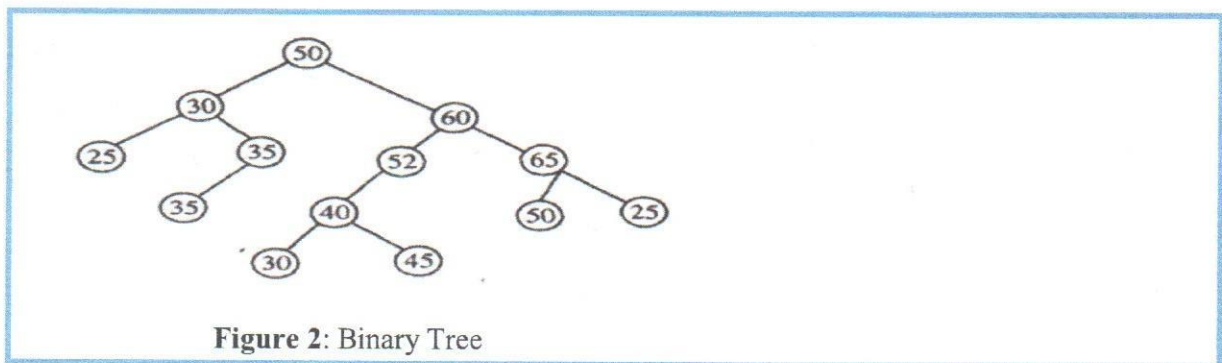


Figure 2: Binary Tree

Show intermediate tree steps to add element 58 in this tree. [3 marks]

c. 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]

d. Write the steps required to evaluate the postfix expression. [3 marks]

e. The keys 12,18,13,2,3,23,5,and 15 are inserted into an initially empty hash table of length 10 using linear probing with hash function $h(k)= k \text{ mod } 10$. What is the resultant hash table?

- f. If you have to solve the searching problem for a list of n numbers, how can you take advantage of the fact that the list is known to be sorted? Give separate answers for
- i. lists represented as arrays. [2 marks]
 - ii. lists represented as linked lists. [2 marks]

QUESTION THREE [20 MARKS]

a. What is the difference between circular linked list doubly link list. Mention the applications of each type of list. [4 marks]

b. What would be appropriate measures of cost to use as a basis for comparing the two sorting algorithms? [2 marks]

c. Explain the implementation of circular queue using array. How an “empty queue” is distinguished from a “full queue”? Write necessary functions to perform all valid operations on circular queue. [6 marks]

d. 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 FOUR

[20 MARKS]

- a. What is meant by a non-linear data structures? [2 marks]
- b. Explain the Prim's algorithm to find minimal spanning tree for a graph and show how it is different from Kruskal's algorithm. [3 marks]
- c. 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]
- d. 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]

e. 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.

student	CSC1	CSC2	CSC3	CSC4	CSC5
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Table1: Array of Students

score	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 [3 marks]
- ii. State the output of the following code segments [3 marks]

```
1 student[2]
```

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

QUESTION FIVE

[20 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. 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]
- d. 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]
- e. 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]