RAJARATA UNIVERSITY OF SRI LANKA

FACULTY OF APPLIED SCIENCES

B.Sc. in Information Technology

First Year Semester II Examination – January / February 2023

ICT 1305 – DATA STRUCTURES

Time: Three (03) hours

Instructions

Answer **All** Questions.

Paper consists with **three** (03) pages.

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1. a. Discuss advantages of using data structures as a programmers' tool.

   (03 marks)

   b. Briefly explain what an abstract data type is, using your own example.

   (03 marks)

   c. Discuss how to decide which kind of memory allocation (dynamic or static) is suitable in computer programming using examples.

   (03 marks)

   d. Find the time complexity of the following functions

   (06 marks)

       i. $T(n) = 4n^2 + 3(n + 2)$
       ii. $T(n) = \text{Log}\,(2n^3 + 5n) + 4$
       iii. $T(n) = 2e^{n/2} + 3n + 1$

   e. Derive a function to compute the time complexity of the following algorithm. Hence find the time complexity.

   (05 marks)

```
1. Begin
2.   Read a number n
3.   R ← 0
4.      For i ← 0 to n Do
5.           R ← n*i + R
6.           n ← n/2
7.      End For
8.   Print R
9. End
```

2. a. Compare and contrast array-based lists and linked lists.

(04 marks)

b. Write a few lines of C codes to define a node of a doubly linked list that allows to store index no, marks, and GPA of a student.

(04 marks)

c. Illustrate inserting an item into a sorted doubly linked list created using nodes defined in question 2 part b.

(04 marks)

d. Write required lines of C codes to delete a given node p of a doubly linked list.

(04 marks)

e. Discuss the advantages and disadvantages of doubly linked lists.

(04 marks)

3. a. An array-based queue may become full as a result of several insertion and deletion operations even there are some vacant spaces available. Explain how this happens and suggest a solution for this problem.

(04 marks)

b. Assume that you have to create a data structure to store details of any number of grocery items. For each item, the item number, name and unit price must be stored. Also, your data structure should support to access the first and the last item of the list directly.

i. Define the node structure and the list structure using C.

(05 marks)

ii. If the list is in ascending order of item number, illustrate graphically how to insert an item into the middle of the list.

(05 marks)

c. Write a pseudo function that takes the values; *item number, name* and *unit price* as parameters to insert a new item into the above proposed list.

(04 marks)

d. Find the time complexity of your pseudo function.

(02 marks)

4. a. Compare and contrast queues and stacks.

(02 marks)

b. List four applications each for queues and stacks.

(04 marks)

c. What is a priority queue?

(02 marks)

d. Represent the expression $(A/2 + B) * (C - D) + (E^2 - F^2) * (G + H)$ in prefix and postfix forms.

(04 marks)

e. Using the expression given in question 4 part d , illustrate how a stack is used to convert a given infix expression to a postfix expression.

(04 marks)

f. Insert the given list of integers [15, 12, 4, 20, 18, 2, 10 ,5] in to an array-based priority queue. Illustrates the steps clearly.

(04 marks)

5. a. Differentiate trees and Binary Search Tree (BST)s. (02 marks)

   b. Write the recursive definition of the BST structure. (02 marks)

   c. Find the time complexities of *Insert* and *lookup* operations in BST. (03 marks)

   d. Find the relationship between the number of nodes and the height of a BST.

   (02 marks)

   e. Construct a BST using the list [25,15,40,27,15,19,12,45,14,60,42,16] (04 marks)

   f. Illustrate how to delete the item 15 from BST constructed in question 5, part e.

   (03 marks)

   g. Consider the following tree traversal algorithm; (04 marks)

```
Travese(BStree)
1.  Start
2.  Initialize two queues Q1, Q2
3.  Node ← root of the BStree
4.  Insert Node into Q1
5.  WHILE Q1 is not Empty
6.        Node ← remove first of Q1
7.        Insert the value of Node into Q2
8.        If Node → left exists
9.            insert Node → left to Q1
10.       If Node → right exists
11.           insert Node → right to Q1
10. END WHILE
11. Print Q2
12. End.
```

   i. Write the output after traversing the tree constructed in question 5 part e using *Travese(BStree)* algorithm.

   (03 marks)

   ii. What does this algorithm demonstrate?

   (01 marks)

-- End --