



# UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 3, Examination in Engineering, October 2019

Module Number: EE3302    Module Name: Data Structures and Algorithms

Part-B

[2 hours]

[Answer all questions, each question carries 5 marks]

Q1. a) Fill the gaps in the following table with the costs in time for sorting a vector of integers of size  $n$  using the indicated algorithms. Assume uniform probability in the average case.

Algorithm	Best Case	Average Case	Worst Case
Quick Sort			
Merge Sort			
Insertion Sort			

[3 marks]

b) An algorithm takes 0.5 milliseconds for input size 100. How large a problem can be solved in 1 minute if the running time is the following (assume low-order terms are negligible)?

- i)  $\Theta(N)$
- ii)  $\Theta(N \cdot \log N)$
- iii)  $\Theta(N^2)$
- iv)  $\Theta(N^3)$

[2 marks]

Q2. a) Graph data structures can be used to represent connected entities.

i) Explain two ways of representing Graph data structure in a computer. [1.0 mark]

ii) Explain three main ways of traversing a Graph using recursive algorithm. [1.5 mark]

b) Queue is a data structure which behaves according to a priority order.

i) Explain the main features of a Queue. [0.5 mark]

ii) Explain the operations of inserting an element to Queue which uses an Array data structure.

[1.0 mark]

iii) Explain the operations of inserting an element to Queue which uses an LinkedList data structure.

[1.0 mark]

Q3. a) Singly Linked List is used to store data of students. The list can be represented using a Node class and LinkedList class. Assume that C++ language is used to implement the following program.

i) Write the Student class to represent First Name, Last Name, Registration Number and Date of Birth.

[1 mark]

ii) Write a Node class in the Singly Linked List which store Student object.

[1 mark]

iii) Write a method to print all student data in the list.

[1 mark]

iv) Write a method to insert data of a new student to the beginning of the Singly Linked List class.

[1 mark]

v) Write a method to insert an element to a given position of the Linked List class.

[1 marks]

Q4. a) i) Explain what is a Max-Heap data structure and draw an example of a Max-Heap in tree format.

[1 mark]

ii) Explain how you would represent a Max-Heap using an Array. Write a function to find the left child, right child and parent of a given node at position  $i$ .

[1.5 mark]

iii) Explain how you build a max heap from an Array of integer numbers.

[1.5 marks]

iv) Explain the heap sort algorithm to sort a given set of integer numbers.

[1.0 marks]

Q5. a) i) Write an algorithm to find the minimum element of a given Array.

[1 mark]

ii) Write an algorithm to find the average of a given set of integer numbers stored in an Array.

[1 mark]

b) i) Create a class which can store a Matrix with  $N$  rows and  $N$  columns of integer data.

ii) Write a method to add two Matrices and return the result in a new Matrix.

iii) Write a method to multiply Matrix of size  $N \times N$  with a vector of size  $N \times 1$ .

[3 marks]