UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4, Examination in Engineering, December 2018

Module Number: EE4303 Module Name: Data Structures and Algorithms

Part-B

[2 hours]

[Answer **all questions**, each question carries 5 marks]

Q1. a) An algorithm takes 0.5 ms for input size 100. How long will it take for input size 500, if the running time is given by the following (assume low-order terms are negligible)?

i) $\Theta(N)$

ii) $\Theta(N \cdot logN)$

iii) $\Theta(N^2)$

iv) $\Theta(N^3)$

[2 marks]

b) Explain Bubble sort algorithm by using a diagram.

[2 marks]

c) Find the asymptotic complexity of the Bubble sort algorithm.

[1 mark]

Q2. a) Doubly Linked List can be represented using a Node class and LinkedList class. Assume that C++ language is used to implement the program.

i) Write the Node class.

[1 mark]

ii) Write a method to print node data in the list.

[1 mark]

iii) Write a method to insert an element to the end of the Doubly Linked List class.

[1 mark]

iv) Write a method to insert an element to the given position of the LinkedList class.

[2 marks]

Q3. a) Tree data structures can be used for searching.

i) Show the result of inserting 3, 1, 4, 6, 9, 2, 5, 7 into an initially empty binary search tree.

[1 mark]

ii) Show the result of deleting the root.

[1 mark]

iii) Write an algorithm to insert a node with a given key value to the binary search tree using C++ syntax.

[1.5 marks]

iv) Explain by using diagrams how a node with a given key value is deleted from the binary search tree. Explain all three cases of deletion.

[1.5 marks]

Q4. a) AVL tree is a special binary search tree.

i) Explain the AVL property of a node.

[1 mark]

ii) Explain the single rotation and double rotation techniques which are used to balance an AVL tree.

[2 marks]

iii) While inserting a node to the AVL tree, a violation of AVL property can occur in one node. The rotation should be done to correct that violation. Show that the height of the subtrees are same before and after this procedure.

[1 mark]

iv) Show the result of inserting 2, 1, 4, 5, 9, 3, 6, 7 into an initially empty AVL tree.

[1 mark]

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

ii) What is the asymptotic time complexity of the algorithm?

[1 mark]

b) Matrix operations are very common in scientific applications.

i) Calculate the asymptotic time complexity of adding two $N \times 1$ Vectors.

ii) Calculate the asymptotic time complexity of adding two $N \times N$ matrices

iii) Calculate the asymptotic time complexity of multiplying two $N \times N$ matrices

[1.5 marks]

c) Merge sort algorithm is one of the basic sorting algorithms.

i) Explain the merge sort algorithm for a given array of elements.

[1.5 marks]

ii) Calculate the asymptotic time complexity of the algorithm

[1 mark]

Q6. a) Explain how you would represent graph shown in Figure Q6.a using adjacency list and adjacency matrix.

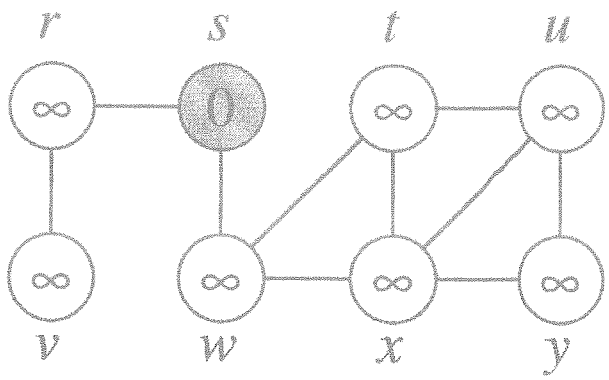

Figure Q6.a: Figure of an undirected graph.

[1 mark]

b) Explain the breadth first search operation on the graph shown in Figure Q6.a, taking *s* as the starting node.

[1 mark]

c) Explain Prims algorithm for finding the minimum spanning tree shown in Figure Q6.c taking *a* as the starting node.

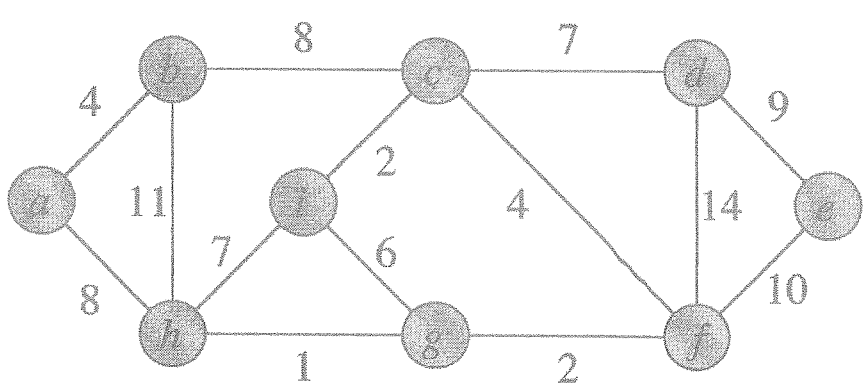

Figure Q6.c: A figure of a weighted undirected graph.

[1.5 mark]

d) Explain the Dijkstra's algorithm for finding shortest paths from vertex *s* in the weighted graph shown in Figure Q6.d.

[1.5 mark]

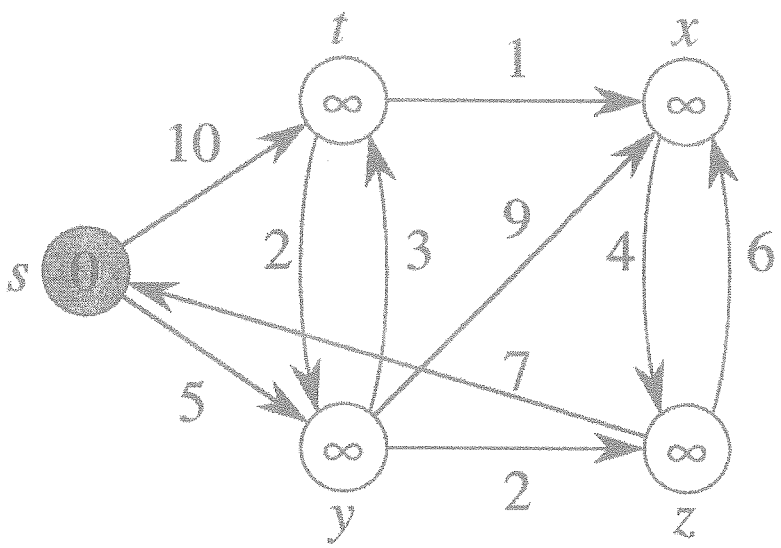

Figure Q6.d: Figure of a weighted directed graph.