School of Computing and Information Technology

Student to complete:

Family name	
Other names	
Student number	
Table number	

CSCI203
Algorithms and Data Structures
South Western Sydney and Wollongong

Examination Paper
Spring 2022

Exam duration	3 hours
Weighting	55%
Items permitted by examiner	Open Book
Aids supplied	None
Directions to students	8 questions to be answered. The marks of each question is printed alongside each question. • Answer each question on a separate page clearly • Convert the answers into **one** pdf file • Submit the pdf file.

Question 1: (6 marks)

All parts of this question relate to the following array which represents a min-heap:

8	25	23	32	41	80	90	40	26	2	70	

a) Draw the binary tree corresponding to this array.

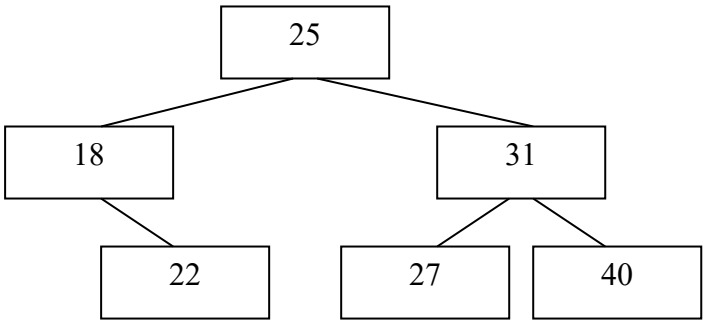
b) Show the array that results when the first element is removed and the heap is rebuilt. Show your working.

c) Show the result when an element with value 16 is added at the end of the original array and the heap is rebuilt. Show your working.

d) What is the complexity of adding an element to a heap?

Question 2: (8 marks)

All parts of this question relate to the following AVL tree:



a) Show the tree after inserting a new node with value 20 into the tree before it is rebalanced.

b) This insertion causes the tree to become unbalanced. At which node does the imbalance occur?

c) Show the tree after rebalancing to restore the AVL criterion.

d) Insert a new node with value 29 into the tree obtained after insertion of the node with value 20, show the tree before and after rebalancing if needed.

Question 3: (6 marks)

Both parts of this question relate to the following array:

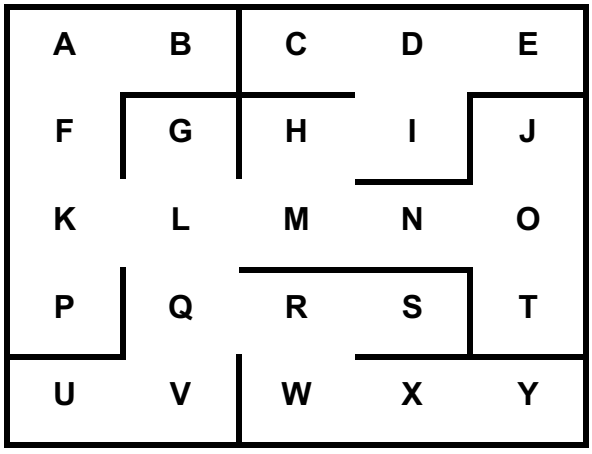
52	34	19	80	7	29	44	32	19	28

a) Show the resulting array at each stage of a merge sort.

b) After the array has been sorted, how may data comparisons are required to find the number 52 with (i) a linear search, (ii) a binary search.

Question 4: (6 marks)

Both parts of this question refer to the following maze where nodes are visited starting from node **U** and searching for node **E**. Note: If there are multiple paths out of a given node they should be tried in the order Up, Right, Down, and Left.



a) List the nodes in the order in which they are encountered if the maze is traversed using Depth-First search. Which data structure is appropriate for storing nodes that are still to be searched?

b) List the nodes in the order in which they are encountered if the maze is traversed using Breadth-First search. Which data structure is appropriate for storing nodes that are still to be searched?

Question 5: (8 marks)

Explain briefly how the following processes work:

a) Collision resolution using chaining

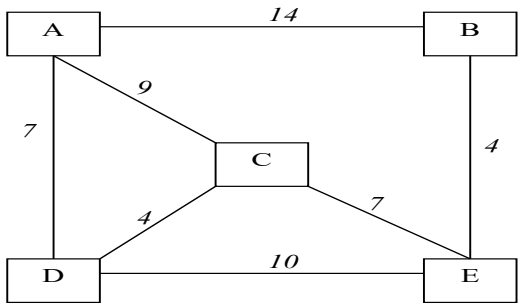
b) Collision resolution using linear probing.

c) Consider inserting the keys $11, 28, 21, 2, 75, 88, 19, 54, 34$ into a hash table of length $m = 20$. Show the result of inserting these keys using a linear probing with $p(k, i) = (h(k) + i)\ mod\ (m)$, where k is a key and i is an iteration count starting from 0

d) What are the advantages and disadvantages of using a big m in a linear probing.

Question 6: (5 marks)

Both parts of this question relate to the graph to the right.



a) Write the adjacency matrix for the graph.

b) Using Dijkstra's Algorithm, determine the minimum distance from node A to each other node. Show your working.

Question 7: (6 marks)

a) Draw an appropriate expression tree for representing the following mathematical equation:

(x*(y-z)+a) / b - c

b) Rewrite the expression in postfix notation (also known as post-order or reverse Polish notation).

c) Using diagrams, show how the following postfix expression would be evaluated by using a stack.

x y + y z w * - *

Show each stack operation in your answer.

Question 8: (10 marks)

a) Explain the process of developing an algorithm using dynamic programming technique. Use the problem of Fibonacci numbers as an example.

b) Use the bottom-up dynamic programming algorithm to find the optimal solution to the Change-making problem, where n=10 and with denominations 1, 2, 4 and 6. Show your working.

—END OF EXAM PAPER—