Curtin College

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End of Study Period Mock Examination

Campus: Bentley

Unit: **DSA1002 Data Structures and Algorithms**

Duration: **2 hours + 10 minutes of reading time**

Total Marks: **100**

Aids to be supplied by the College: None

Aids to be supplied by the student: None

THIS IS A CLOSED BOOK EXAM

Other information:

Calculators are NOT permitted in this exam.
Answers ALL questions in the spaces provided in the examination paper.
Answer ALL questions.
There are 6 questions in this examination.

Student Name: _____

Student ID: _____

Lecturer name: _____

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Question 1) **[32 marks]**

For each of the following questions, you are required to come up with a sequence of steps involved for each specified action on a data structure, and to then implement that sequence of steps in Java code as a method.

Note: You **do not** have to write entire Java classes, or a main method. You may take advantage of **any other methods** that may reasonably exist. Your code should consist entirely of a **single, public method**, and you may assume that any necessary libraries have been imported. Also, be sure to implement any necessary **exception handling** in your code! For the non-code questions, a descriptive sequence of steps is sufficient. You **do not** need to produce pseudocode!

a) What sequence of steps would you take when removing a value from an Array-based Hash Table using linear probing? [4 marks]

b) Implement this sequence as a Java method called `remove()` that takes a String representing the key to be removed and returns the associated Object. [4 marks]

c) What sequence of steps would you take when determining whether a Hash Table using separate chaining contains a specified key? [4 marks]

d) Implement this sequence in a method called `containsKey()` that returns a boolean, that takes in a key of type `String` representing the item to be found. [4 marks]

e) Describe the modifications you should make to a Linked List to make it iterable via the `Iterable` interface. [4 marks]

f) Implement a Java method called `hasNext()`, that returns a boolean value. Be sure to include the private class declaration, private fields, and constructor for the iterator. [4 marks]

g) Describe the sequence of steps involved in adding an item to the rear of a Doubly-linked, Doubly-ended List. [4 marks]

h) Implement this sequence as a Java method called `insertLast()`, that takes an object of class `Object`, called `inObj` as a parameter. [4 marks]

Question 2 is on the next page

Question 2) **[18 marks]**

Provide short answers – either bullet points or a **single** paragraph – to the following questions:

a) Explain the role of the pivot in the Quick Sort algorithm. [3 marks]

b) Describe the operation of the Merge Sort algorithm. [3 marks]

c) Give and explain the average time complexity of removing an item from a Binary Search Tree. [3 marks]

d) Explain the role of prime numbers in determining the index for an entry in a Hash Table. [3 marks]

e) Explain why accessing an arbitrary element in an Array has time complexity O(1). [3 marks]

f) Explain the differences between a Linked List and an Array. Be sure to include mention of memory overhead and time complexity of operations in your answer. [3 marks]

Question 3 is on the next page

Question 3) **[15 marks]**

Your task in this question is to build and traverse, and describe the function of Graphs

a) Draw the graph described by the following sets: [2 marks]

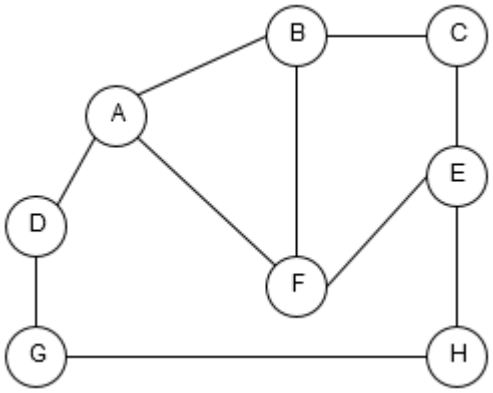
```
V = {A, B, C, D, E, F, G, H}

E = {{A, B},{A, C},{A, D},{B, D},{B, G},{C, E},{D, F},{E, F},
{E, H},{F, G},{F, H}, {G, H}}
```

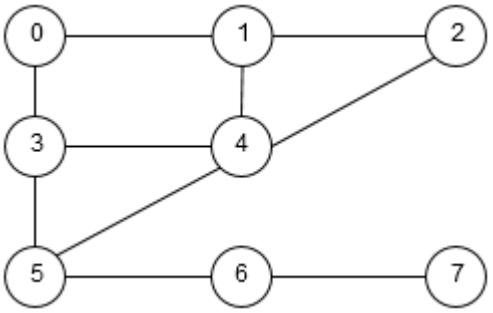
b) List all vertices in the graph with an odd degree. [2 marks]

c) Explain how directed graphs vary from undirected graphs. [2 marks]

d) Produce the adjacency list for the graph shown below: [3 marks]



e) Draw diagrams showing each step in the growth of the spanning tree produced by running a Depth First Search on the following graph, starting at Node 0. Be sure to show the final resulting sub-graph. [6 marks]



Continue your answer on the next page

Continue your answer here

Question 4 is on the next page

Question 4) **[6 marks]**

Fill in the blanks. Each answer is worth [1 mark].

a) Inserting an item into an array-based stack has time complexity _____ because the index of the top item corresponds to the number of items in the stack.

b) A Binary Search Tree contains Tree Nodes. These can be implemented in Java using a private _____ class.

c) Nodes in a Binary Search Tree contain references to two _____ Nodes.

d) It is possible to traverse a Linked List in Java using an _____.

e) A Graph is composed of Vertices and _____.

f) A 2-D Array may be loosely described as an Array of _____.

Question 5) **[18 marks]**

Your task in this question is to produce designs in UML based on a description, and to implement some parts of that design.

a) You are to design a class called “Warehouse”. This class is used to store objects of class “Artwork”. Artwork objects arrive in a Warehouse object and are placed in a buffer which is periodically emptied via the archive() method, at which point they are placed into a sorted data structure that may grow arbitrarily large. Objects may not be removed from the Warehouse, but they can be searched via the method call find() which takes a key, represented as a String and returns the corresponding Object.

   Propose a design in UML for class “Warehouse”. You may make use of any of the classes you have created as part of this unit as data structures if needed. [6 marks]

b) Implement the method archive() in the space below. [6 marks]

c) Produce a design in UML for class DSABinaryTree and also for class DSATreeNode. Show the relationship between the two classes. [6 marks]

Question 6 is on the next page

Question 6) **[11 marks]**

Your task in this question is to work with various data structures and demonstrate understanding of how their state may change.

a) Draw a series of diagrams representing each step in the removal of an item from the head of an Array-based Heap such that it remains a Heap. [4 marks]

b) Produce code for adding a new Vertex to a Graph that stores its primary list of Vertices as a Linked List via a method called `addVertex()`. It should take a `String` called label as a parameter, as well as an `Object` called `inObj`. [3 marks]

Question 6 continues on the next page

c) Draw a series of diagrams representing each step in the growth of a Binary Search Tree with keys added in the following sequence: [4 marks]

`M, N, O, L, B, C, A, K`

END OF EXAM