Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2018					

HIT220 – Algorithms and Complexity	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

Do all problems. If information appears to be missing from a problem, make a reasonable assumption, state it and proceed.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Part II: Linked List.

Question 1:

(Marks: 4)

Construct pseudo-code function to check whether two singly linked lists have the same contents.

Question 2:

(Marks: 9)

Suppose that the you have the below Python implemented, maintaining a reference to the first and last node in the list, along with its size.

```
class Node:
    def __init__(self, element=None, next_node=None, prev_node=None):
        self.element = element
        self.next_node = next_node
        self.prev_node = prev_node


class DoublyLinkedList:
    def __init__(self, ):
            self.head = Node(element='Head')
            self.tail = Node(element='Tail')

            self.head.next_node = self.tail
            self.tail.prev_node = self.head
```

a) What is the order of growth of the worst-case running time of each of operation below? Write down the best answer in the space provided, using one of the following possibilities.

$1 \qquad \log N \qquad N \qquad N \log N \qquad N^2$

`addFirst(data)`	*prepend the item to the beginning of the list*	
`get(i)`	*return the item at position i in the list*	
`set(I, data)`	*replace position i in the list with the item*	
`removeLast()`	*delete and return the item at the end of the list*	
`contains(data)`	*is the item in the list?*	

b) Construct pseudo-code function or Python code to append a node to the beginning of the list.

Part III: Stack and Queue.

Question 1: Queue.

(Marks: 4)

Circular Queue is a linear data structure in which the operations are performed based on FIFO (First In First Out) principle and the last position is connected back to the first position to make a circle. It is also called 'Ring Buffer'. Construct the following algorithm to implement circular queue using array.

a) enQueue(value), use this function to insert an element into the circular queue.
b) deQueue () use this function to delete an element from the circular queue.

Question 2: Stack.

(Marks: 4)

Given an expression below:

$$5 \times 4 \div 2 + 3 \times 6$$

a) Convert the infix expression to postfix expression?
b) Write the pseudo-code for converting the infix expression to postfix using a stack?

Question 3: Recursion.

(Marks: 8)

Write the pseudo-code function or the Python code to implement Fibonacci sequence, using:

a) Iterative version
b) Naive recursive version
c) Optimized recursive version
d) Which implementation of Fibonacci sequence version is best and why?

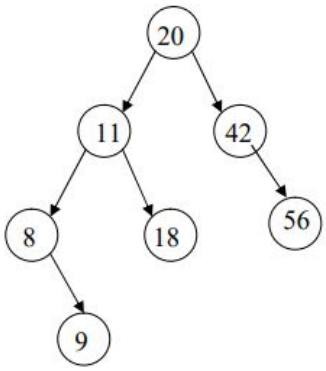
Remember: Fibonacci sequence:
0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, …

Section IV: Trees

Question 1: Binary tree.

(Marks: 8)

a) Consider the binary tree shown below. For each of the traversals listed, give the order in which the nodes are visited.



prerder							
inorder							
postorder							
breadth-first							

b) Draw the AVL tree that results from inserting the keys: 2, 3, 5, 9, 6, 4 in that order into an initially empty AVL tree. You are only required to draw intermediate trees.

Question 2: Binary Search Tree.

(Marks: 4)

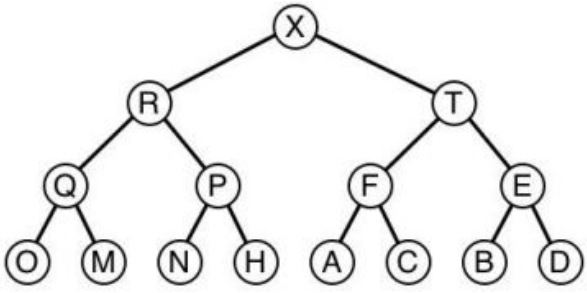
Consider the following sequence numbers, draw a binary search tree by inserting from left to right

```
11, 6, 8, 19, 4, 13, 5, 17, 43, 49, 16, 31, 32
```

Question 3: Binary heap operations.

(Marks: 4)

Consider the following max-heap:



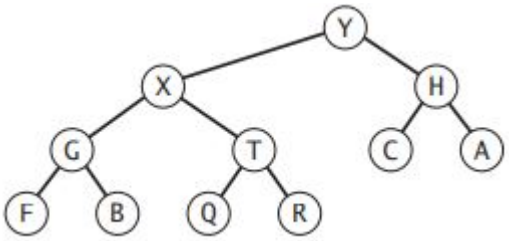
a) Draw the result of inserting S

b) Draw the result of deleting the maximum from the original max-heap shown above (before S has been inserted).

Question 4: Binary heaps.

(Marks: 4)

Consider the following binary tree representation of a max-heap. Give the array representation of the heap



0	1	2	3	4	5	6	7	8	9	10	11	12
–												–

Part V: Sorting.

Question 1: Multiple choices

(Marks: 10)

1- Suppose you have the following list of numbers to sort: [19, 1, 9, 7, 3, 10, 13, 15, 8, 12] which list represents the partially sorted list after three complete passes of bubble sort?

a) [1, 9, 19, 7, 3, 10, 13, 15, 8, 12]
b) [1, 3, 7, 9, 10, 8, 12, 13, 15, 19]
c) [1, 7, 3, 9, 10, 13, 8, 12, 15, 19]
d) [1, 9, 19, 7, 3, 10, 13, 15, 8, 12]

2- Suppose you have the following list of numbers to sort: [11, 7, 12, 14, 19, 1, 6, 18, 8, 20] which list represents the partially sorted list after three complete passes of selection sort?

a) [7, 11, 12, 1, 6, 14, 8, 18, 19, 20]
b) [7, 11, 12, 14, 19, 1, 6, 18, 8, 20]
c) [11, 7, 12, 14, 1, 6, 8, 18, 19, 20]
d) [11, 7, 12, 14, 8, 1, 6, 18, 19, 20]

3- Suppose you have the following list of numbers to sort: [15, 5, 4, 18, 12, 19, 14, 10, 8, 20] which list represents the partially sorted list after three complete passes of insertion sort?

a) [4, 5, 12, 15, 14, 10, 8, 18, 19, 20]
b) [15, 5, 4, 10, 12, 8, 14, 18, 19, 20]
c) [4, 5, 15, 18, 12, 19, 14, 10, 8, 20]
d) [15, 5, 4, 18, 12, 19, 14, 8, 10, 20]

4- Given the following list of numbers: [5, 16, 20, 12, 3, 8, 9, 17, 19, 7] Which answer illustrates the contents of the list after all swapping is complete for a gap size of 3?

a) [5, 3, 8, 7, 16, 19, 9, 17, 20, 12]
b) [3, 7, 5, 8, 9, 12, 19, 16, 20, 17]
c) [3, 5, 7, 8, 9, 12, 16, 17, 19, 20]
d) [5, 16, 20, 3, 8, 12, 9, 17, 20, 7]

5- Given the following list of numbers: [21, 1, 26, 45, 29, 28, 2, 9, 16, 49, 39, 27, 43, 34, 46, 40] which answer illustrates the list to be sorted after 3 recursive calls to merge sort?

a) [16, 49, 39, 27, 43, 34, 46, 40]
b) [21,1]
c) [21, 1, 26, 45]
d) [21]

Question 2:

(Marks: 5)

a) Illustrate the operation of straight insertion sort by completing the left table below. In successive rows of the table, show the array contents after each pass of the algorithm.

b) Illustrate the operation of bubble sort by completing the right table below. In successive rows of the table, show the array contents after each pass of the algorithm.

9	8	6	7	5	0

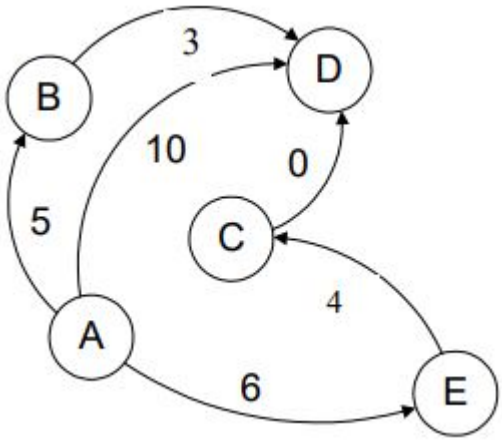
9	8	6	7	5	0

Section VI: Graph

Question 1:

(Marks: 20)

Use the following graph for this problem. Where needed and not determined by the algorithm, assume that any algorithm begins at node A.



a) Draw both the adjacency matrix and adjacency list representations of this graph. Be sure to specify which is which.

b) Give two valid topological orderings of the nodes in the graph.

c) Step through Dijkstra's Algorithm to calculate the single source shortest path from A to every other vertex. You only need to show your final table, but you should show your steps in the table below for partial credit. Show your steps by crossing through values that are replaced by a new value. Note that the next question asks you to recall what order vertices were declared known.

Vertex	Known	Distance	Path
A			
B			
C			
D			
E			

d) In what order would Dijkstra's algorithm mark each node as known?

e) What is the shortest (weighted) path from A to D?

f) What is the length (weighted cost) of the shortest path you listed in part (e)?

g) Imagine that the graph were undirected (i.e., ignore the directions of the edges). Highlight the MST(minimum Spanning Tree) on the graph above or redraw it here.