UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	DATA STRUCTURES AND ALGORITHMS
COURSE CODE	:	BEJ 32103
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS.
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **OPEN BOOK.**

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 Given the following fragment code in **Figure Q1**. Answer (i) to (iii).

```
int aMax(int A[],int arraySIZE){
//Input: An array A storing n ≥ 1 integer.
//Output: The maximum element in A
int currentMax, i;
currentMax = A[0];          //Line1
i=1;                        //Line2
while (i<arraySIZE) {       //Line3
    if (currentMax < A[i])  //Line4
        currentMax = A[i];  //Line5
    i++;}                   //Line6
return currentMax;          //Line7
}
```

Figure Q1

(i) Determine the minimum (best case) and maximum (worst case) of total number of operations.

(10 marks)

(ii) Briefly explain, how does the best and worst case can occur. Justify your reason.

(6 marks)

(iii) Based on your answer in **Q1(i)**, determine the running time in Big-Oh notation for the worst case. Provide steps/procedures to obtain the answer.

(4 marks)

Q2   (a)   Given the following algorithm and the contents of queue *V1* and *V2* in **Figure Q2(a)**. Answer (i) and (ii).

> *V3* = createQueue
> *count* ← *0*
> loop (not empty *V1 AND* not empty *V2*)
>   *count* ← *count* + *1*
>   *dequeue (V1, x)*
>   *dequeue (V2, y)*
>   *if (y = count)*
>   *enqueue (V3, x)*
>
> The contents of queue *V1* and *V2* are as follows.
>
>   *V1: 42 30 41 31 19 20 25 14 10 11 12 15*
>
>   *V2: 1 4 5 4 10 13*

Figure Q2(a)

(i)   Using a tracing table, illustrate the running of the algorithm. Note that the queue contents are shown front (left) to rear (right).

(8 marks)

(ii)   State the final content of queue *V3*.

(2 marks)

(b)   (i)   Define a stack in the data structure.

(2 marks)

(ii)   State two ways to implement the stack.

(2 marks)

(iii)   Imagine a stack that currently hold two characters; *D* and *C*. State the top value of the stack. Also, state the stack operation to obtain the value.

(2 marks)

(iv)   State the stack operations for the following events in sequence order.

Fill in the empty stack with four values, 10, 5, 12 and 20.
Then, remove 10 from the stack.

(4 marks)

Q3   (a)   Based on elements of array *T* in **Figure Q3(a)**, answer the following questions:

$$T \quad \boxed{80 \mid 70 \mid 56 \mid 66 \mid 14}$$
$$ \quad [0] \quad [1] \quad [2] \quad [3] \quad [4]$$

Figure Q3(a)

(i)   Draw a binary tree.

(5 marks)

(ii)   Does the tree is a complete binary tree? Give a reason.

(3 marks)

(iii)   What is the maximum number of nodes if the tree is a full binary tree? Show your calculation.

(2 marks)

(b)   (i)   Briefly explain the concept of *Bubble Sort* algorithm.

(2 marks)

(ii)   Given the partial code of *Bubble Sort* algorithm. In **Figure Q3(b)**, note that n is an array size.

```
for (i=0; i<=n-2; i++)//Line1: is array size
{
    if (A[i]<A[i+1])   //Line2
    {
      temp=A[i];        //Line3
      A[i]=A[i+1];      //Line4
      A[i+1]=temp;      //Line5
    }
}
```

Figure Q3(b)

Initially, the arrangement of element of array *Z* is as follows.

$$Z \quad \boxed{10 \mid 23 \mid 2 \mid 12 \mid 34}$$
$$ \quad [0] \quad [1] \quad [2] \quad [3] \quad [4]$$

Determine the final arrangement of data for array *Z* after all execution of *Bubble Sort* in the **Figure Q3(b)**. Also, provide a tracing table to show your step-by-step execution.

(8 marks)

Q4   Given a binary heap in **Figure Q4.** Answer (i) and (ii).
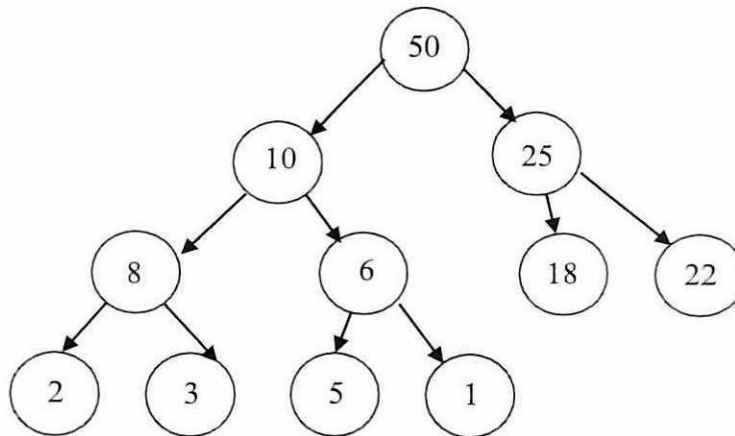

Figure Q4

(i)   Illustrate each steps of the resulting heap for inserting node 48, followed by node 20, then node 42, and lastly node 8.

(14 marks)

(ii)   Based on the binary heap in **Q4(i)**, illustrate each steps of the resulting heap diagram for deleting one maximum node.

(6 marks)

5

Q5 Using Dijkstra's algorithm, determine the shortest path from node A to all nodes in **Figure Q5**. Provide your answer in a table and a final diagram.
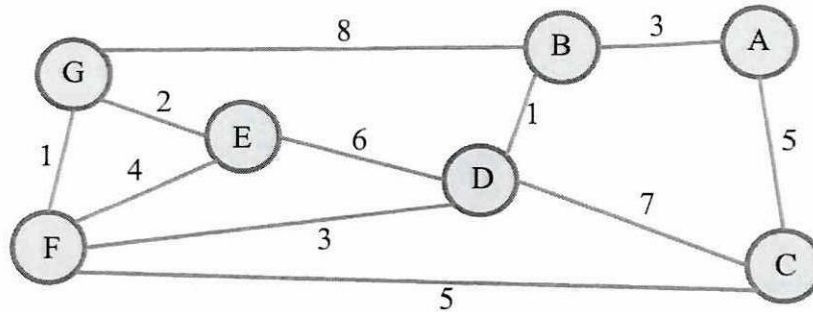

Figure Q5

(20 marks)

-END OF QUESTIONS –