UNIVERSITI TEKNOLOGI MARA
FINAL EXAMINATION

COURSE	:	DATA STRUCTURES AND ALGORITHMS
COURSE CODE	:	ECE532
EXAMINATION	:	DECEMBER 2018
TIME	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. This question paper consists of five (5) questions.
2. Answer ALL questions in the Answer Booklet. Start each answer on a new page.
3. Do not bring any material into the examination room unless permission is given by the invigilator.
4. Please check to make sure that this examination pack consists of:
   i) the Question Paper
   ii) an Answer Booklet – provided by the Faculty
5. Answer ALL questions in English.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

This examination paper consists of 7 printed pages

QUESTION 1

a) A variable is a named location that can store a value of a particular type. Compare four characteristics between normal variable and pointer variable.

(5 marks)

b) The basic implementation of a stack is also called a LIFO (Last In First Out) while a queue is also called a FIFO (First In First Out) to demonstrate the way it accesses data.

i) Categorise and explain the two types of operations for stack and queue.

(4 marks)

ii) Evaluate the following code statements in **Figure Q1b** and determine the output if the input are:

14, 20, 35, 68, 10, 5, -999

where the `push()` function is to add a value to the stack , `pop()` function is to remove an element from the stack, `isEmptyStack()` function is to check if the stack is not null and `top()` function is to return the top value.

(6 marks)

```
1  push(6);
2  while(x!=-999)
3  {
4       if (x%2 == 0)
5        {
6       if(!isFullStack())
7          push(x);
8        }
9       else
10      cout <<"x= "<< x <<endl;
11
12 cin>>x;
13  }
14 cout <<"Stack elements : ";
15 while (!isEmptyStack())
16 {
17     cout <<" "<<top();
18     pop();
19 }
20 cout<<endl;
```

Figure Q1b

c) i) Convert the following arithmetic expression into a binary tree.

$$4 + 3 \times 7 - 5 \div (3 + 4) + 6$$

(3 marks)

ii) List the number of edge and leaf from the binary tree created in **Question 1c (i)**.

(2 marks)

QUESTION 2

a) Based on the given structures declaration shown in **Figure Q2a:**

Struct name	Struct members
`TempScale`	`Fahrenheit` : a double `Centigrade` : a double
`Reading`	`WindSpeed` : an integer `Humidity` : a double `Temperature` : a `TempScale` structure variable

Figure Q2a

i) Show the declaration for the structures `TempScale` and `Reading`. Then, define a `Reading` structure variable.

(3 marks)

ii) In the `main()` program, write C++ statements to get inputs from user for each member of a `Reading` structure.

(2 marks)

b) **STACK** can be utilized to construct different type of expressions. Based on the following infix expression:

$$X - Y \wedge (A + B) / Z$$

i) Examine its **POSTFIX** equivalent expression. Show your answer in tabulated form.

(5 marks)

ii) Based on the **POSTFIX** expression obtained in **Question 2b(i)**, for the values of:

$$X=10,\ Y = 2,\ A = 1,\ B = 2,\ Z = 2$$

evaluate the expression. You must show the steps to get the final value in tabulated form.

(5 marks)

c) Based on the array declaration as shown in **Figure Q2c**, illustrate the Binary Search Tree and list down the nodes for the following search algorithms:

i) **Inorder traversal** algorithm
ii) **Depth-first search** (DFS) algorithm

```
int lot_num[12] = {25, 5, 12, 9, 6, 45, 37, 49, 16, 2, 11, 18};
```

Figure Q2c

(5 marks)

QUESTION 3

a) Write a function definition for `int arrsum(int *x,int y)` that sum up the total of array element pointed by `*x` with the size of `y`. The sum value is returned to the calling function.

(5 marks)

b) A recursive function is a function which either calls itself or is in a potential cycle of function calls. As the definition specifies, there are two types of recursive functions. Write a recursive function to find the sum of values from 1 to an integer value entered by user. For example: if the user enters 10, the recursive function will return the value 55.

(5 marks)

c) Insertion sort is a simple sorting algorithm that builds the final sorted array (or list) one item at a time. By using **INSERTION** sorting concept, determine the content of the array in ascending order for each iteration as shown in **Figure Q3c**.

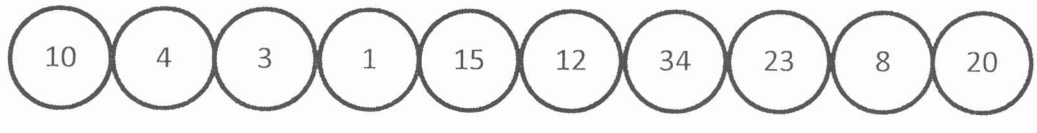

Figure Q3c

(10 marks)

QUESTION 4

a) **STACK** is applied in data structure based on the concept of Last-In-First-Out (LIFO).

i) State **TWO (2)** types of **STACK** utilized in data structure application.
(2 marks)

ii) Explain the implementation method of both types of the **STACK**.
(2 marks)

iii) Write the function definition for `isFull()` and `isEmpty()` when array is utilized in **STACK**.
(6 marks)

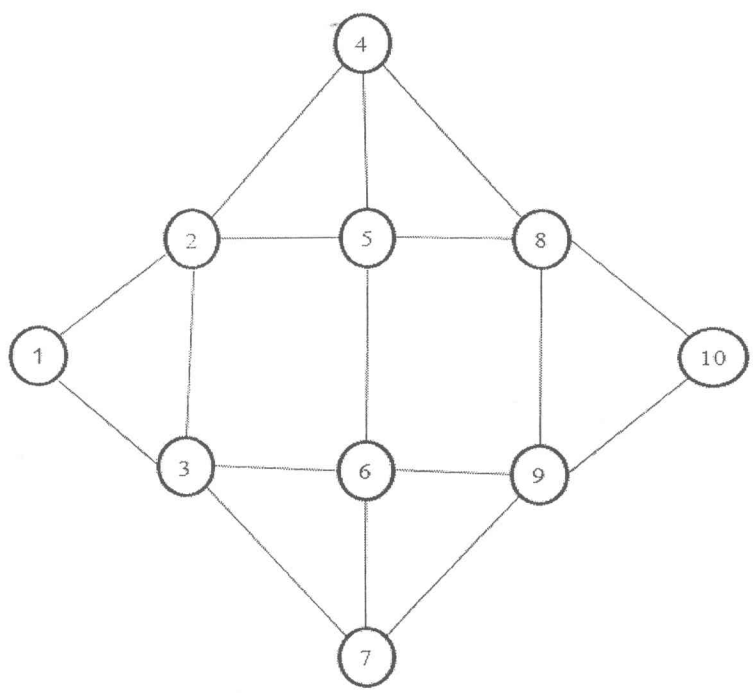

Figure Q4b

b) **Figure Q4b** shows an undirected graph which consists of ten different nodes. Each of the node is represented by an integer number. The distance between one node to another is determined by the following programming codes :

```
if(b%2==0)
      distance = 4;
if(b%2!=0)
      distance = 6;
```

The variable `b` in the programming code represents the value of the destination node. For example, from node **6** to node **9**, the value for `b` will be 9. Starting from node **1**, determine the shortest path to all other nodes using Dijktra's Algorithm.

(Hint : distance from node 1 to node 2 is not necessarily equal to distance from node 2 to node 1)

(10 marks)

QUESTION 5

a) In quicksort algorithm, the original problem/data is partitioned into simpler sub-problems and each sub problem considered independently. This can be implemented using a partition algorithm as shown in **Figure Q5a**.

1. *Determine pivot; swap it with the first element of the list.*
2. *For the remaining elements in the list:*
   - *If the current element is less than pivot,*
     (a) increment small index, and
     (b) swap current element with element pointed by small Index
3. *Swap the first element (pivot), with the array element pointed to by small index*

Figure Q5a

Assuming the pivot is the middle element of the list, determine and write the function definition for the partition algorithm using C++ programming codes based on **Figure Q5a** and the following function prototype:

```
int Partition(int data[], int first, int last);
```

where `data[]` is the set of numbers, `first` is the starting index number and `last` is the ending index number.

(5 marks)

b) A minimum spanning tree (MST) or minimum weight spanning tree is a subset of the edges of a connected, edge-weighted undirected graph that connects all the vertices together, without any cycles and with the minimum possible total edge weight.

i) Based on the graph shown in **Figure Q5b(i),** design the minimum spanning tree by using **Prim's Algorithm**, starting with node **a**.

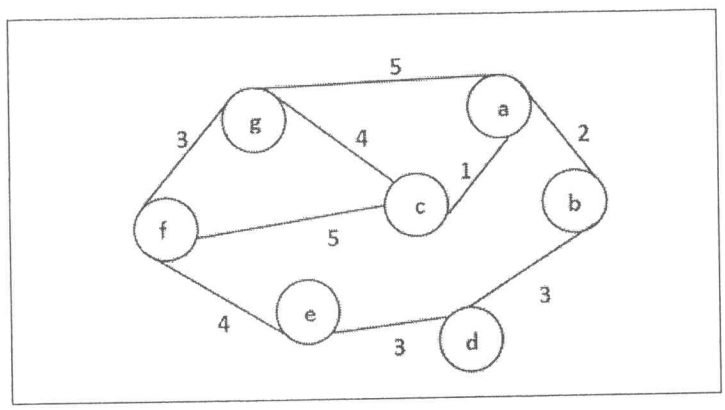

Figure Q5b(i)

(5 marks)

ii) Based on the graph shown in **Figure Q5b(ii),** design the minimum spanning tree and calculate the total minimum cost by using **Kruskal's Algorithm**.

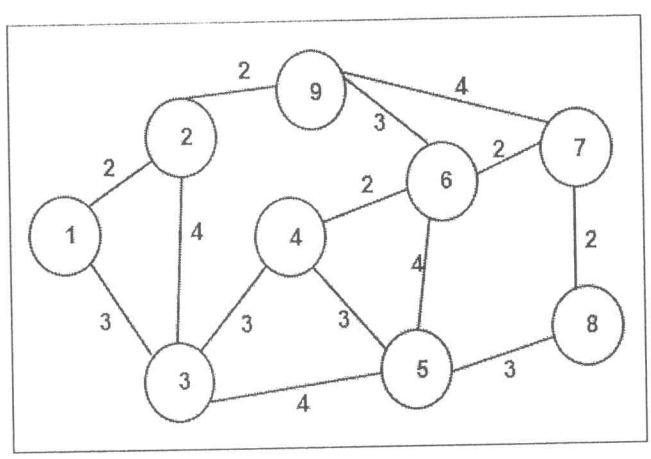

Figure Q5b(ii)

(5 marks)

c) A search algorithm is any algorithm which solves the search problem, namely, to retrieve information stored within some data structure, or calculated in the search space of a problem domain. Two widely used search algorithms are linear search and binary search. Differentiate the algorithms and the performance between linear search and binary search algorithms.

(5 marks)

END OF QUESTION PAPER