



**UNIVERSITI TEKNOLOGI MARA
FINAL EXAMINATION**

COURSE	:	DATA STRUCTURES / DATA STRUCTURE AND ALGORITHM ANALYSIS
COURSE CODE	:	CSC508/518
EXAMINATION	:	FEBRUARY 2023
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 9 printed pages

QUESTION 1

Given the following ADT's:

```
public class ArrayList
{
    public ArrayList()
        // method definition

    public void addFirst(Object elem)
        // method definition

    public Object get(int index)
        // method definition

    public Object set(int index, Object elem)
        // method definition

    public Object remove(int index)
        // method definition

    public int indexOf(Object elem)
        // method definition

    public int size()
        // method definition
}

public class LinkedList
{
    // declaration of other methods and data

    public void insertAtFront(Object elem)
        // method definition

    public void insertAtBack(Object elem)
        // method definition

    public Object getFirst()
        // method definition

    public Object getLast()
        // method definition

    public Object removeFirst()
        // method definition

    public Object removeLast()
        // method definition
}
```

```
public Object getNext()  
    // method definition  
}  
  
public class Election  
{  
    private String candName; // candidate's name  
    private String party; // candidate's political party, ie: BN, PH, PN  
    private String area; // the area where the candidate stands  
    private int numVotes; // the number of votes  
  
    public Election (); // default constructor  
    public Election (String,String,String,int); // normal constructor  
    public String getName(); // accesors  
    public String getParty();  
    public String getArea();  
    public int getVotes();  
    public void setData (String,String,String,int); // mutator  
    public void displayInfo(); // display candidate's info  
}
```

a) Write a Java program segment to:

i) Declare an ArrayList object named candList and a LinkedList object named elecList.

(2 marks)

ii) Insert and store **ONE HUNDRED (100)** candidates' data to candList list.

(3 marks)

iii) Copy all the candidates' data who represented "PH" party from candList to elecList.

(4 marks)

iv) Find and display the details of the candidate who won the highest votes from the array list candList.

(6 marks)

v) Search and display the name of the candidates from "PH" party and contested at "Shah Alam" area in the LinkedList named elecList.

(6 marks)

b) Describe **TWO (2)** advantages of linked list over array list.

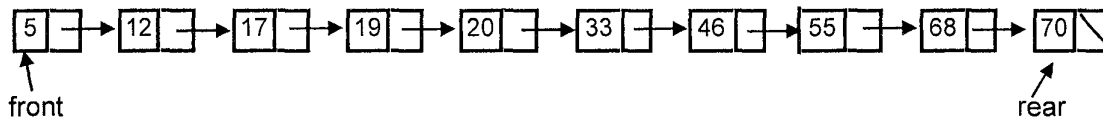
(4 marks)

QUESTION 2

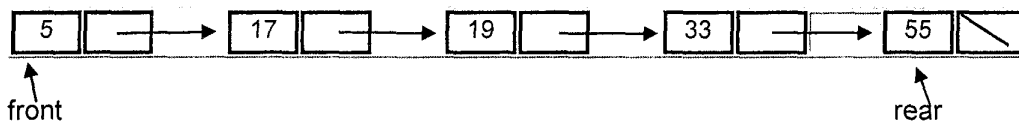
Answer the following questions:

- a) The following diagrams are the logical diagrams of Queue `queueNum`, `queueOdd` and `queueEven`. Data structure queue is implemented using linked list.

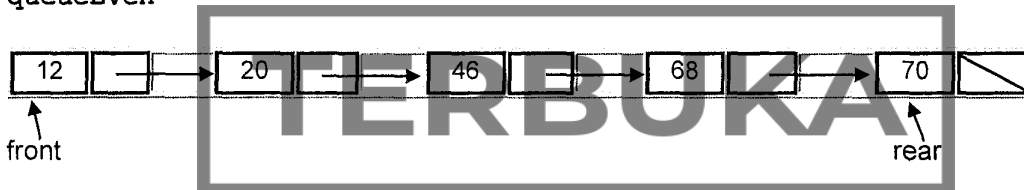
`queueNum`



`queueOdd`



`queueEven`



Assuming that queue `queueNum` already has some elements in it, write an application program to read from `queueNum` and check whether the element is odd or even. If it is odd number, then the element should be inserted into queue `queueOdd`, and if it is even number, then the element should be inserted into `queueEven`, in the order of the given example above.

The following are the ADTs of Queue.

```
public class Queue {

    public Queue();

    public void enqueue(Object); // To add item in a queue

    public Object dequeue(); // To remove an item from a queue

    public void isEmpty(); // To check whether the queue is empty or not

}
```

(5 marks)

- b) Evaluate the following expression F by showing the content of the stack, if the following values are given:

A = 20, B = 15, C = 10, D = 5, E = 8

$$F = 10 * \frac{A * 2 + B}{C - D} - E * E$$

(5 marks)

- c) Given the following recursive definition for $f(n)$ where n is a non-negative integer.

$$f(n) = \begin{cases} 1 & , \text{ if } n = 0 \\ 2 & , \text{ if } n = 1 \\ (n * n) + f(n - 1) + f(n - 2) & , \text{ if } n > 1 \end{cases}$$

Write the definition of the recursive function $f(n)$ in Java.

(5 marks)

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QUESTION 3

- a) i) Based on the following program segments of inserting `String` into a BST tree, write the output of the program.

(Note: Assume that `inOrderTraversal()` function to traverse the item using inorder traversal has been defined in the `BSTree` class.)

```
class TreeApp{
    public static void main(String[] args) {
        BSTree theTree = new BSTree();
        theTree.insertNode("XYZ");
        theTree.insertNode("YZZ");
        theTree.insertNode("XXZ");
        theTree.insertNode("XXY");
        theTree.insertNode("XYX");
        theTree.insertNode("XZZ");
        System.out.println("InOrder Traversal :");
        theTree.inOrderTraversal();
    }
}
```

(3 marks)

- ii) Given the following Student, TreeNode, BSTree ADTs have been declared as follows:

```
public class Student
{
    private String name;
    private double studentGPA;
    private String status;
    public Student(String, double, String);
    public void setStatus(String s);
    public String getName();
    public double getGPA();
    public String getStatus();
}

public class TreeNode
{
    public Student data;
    public TreeNode left;
    public TreeNode right;
    // definition of other methods
}

public class BSTree
{
    private TreeNode root;
    // definition of other methods
    public BSTree();
    public void insertNode(Student);
    public void inOrderTraversal();
    public void changeTS();
    public void displayTS();
}
```

Consider the information in the following table for student's academic status.

Name	GPA	Status
Abu	3.64	LU
Alya	3.75	LU
Amalina	2.64	LU
Balqis	3.50	LU
Danish	2.57	LU
Maria	3.44	LU
Mark	3.01	LU
Minah	3.34	LU
Nurul	3.84	LU
Ryan	3.51	LU

Based on the table above, graduating students with GPA above and equivalent to 3.50 will have an academic status of TS (Tamat dengan Sijil), while others will have the TM (Tamat) status.

Write the definition of method `changeTS()` and its recursive method to change the students' academic status from "LU" to "TS" or "TM" based on their GPA in the final semester.

Sample output:

Student name printed in Ascending Order

```
Name Abu with GPA 3.64 status is TS
Name Alya with GPA 3.75 status is TS
Name Amalina with GPA 2.64 status is TM
Name Balqis with GPA 3.5 status is TS
Name Danish with GPA 2.57 status is TM
Name Maria with GPA 3.44 status is TM
Name Mark with GPA 3.01 status is TM
Name Minah with GPA 3.34 status is TM
Name Nurul with GPA 3.84 status is TS
Name Ryan with GPA 3.51 status is TS
```

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(5 marks)

iii) Based on question ii), the students' status have been changed according to their GPA.

Write the definition of method `displayTS()` and its recursive method to display the graduating student with the status TS.

The report should have the student's name and their GPA.

Sample output:

Student with TS status

```
Student name: Ryan GPA: 3.51
Student name: Abu GPA: 3.64
Student name: Alya GPA: 3.75
Student name: Balqis GPA: 3.5
Student name: Nurul GPA: 3.84
```

(5 marks)

- b) Construct the following sequence of numbers into an AVL tree, one by one, starting with an empty tree: **77, 66, 55, 44, 33, 22, 11**.

Write the balance factor for each node during the insertion.

(7 marks)

QUESTION 4

- a) Answer the following questions on data sorting techniques.

- i) Draw the steps of insertion and selection sorts based on the following data series and highlight the difference between the two techniques.

45 78 90 21 32

(5 marks)

- ii) Describe the properties of Binary Heap and briefly describe the difference between Min-Heap and Max-Heap. Provide the Binary Tree diagrams to illustrate Min-Heap and Max-Heap.

(5 marks)

- b) Answer the following questions on searching and hashing.

- i) Given the following values to be inserted into a hash table of size 10:

23 45 66 77 24 90 80 20 12 100

Draw the diagram of the hash table if the hash function uses the modulus (%) operation and use chaining technique for hashing collision.

(5 marks)

- ii) Suggest the suitable data structure for linear search and binary search and briefly justify your answer. Briefly explain **ONE (1)** advantage and **ONE (1)** disadvantage of hashing.

(5 marks)

QUESTION 5

Given a set of edges and weight in Table 1.

Table 1

A, D	A, B	A, E	B, C	D, E	C, B	E, D	D, B	E, B	E, C
2	16	3	5	7	3	5	12	10	4

- a) Draw a directed graph with the given weighted for the edges.
(6 marks)
- b) Find and calculate the cost of a minimum spanning tree using Kruskal's algorithm. Show all your work and draw the minimum spanning tree.
(6 marks)
- c) Using Dijkstra Algorithm, find the shortest path from A to all other vertices for the graph. Show all the working steps.
(8 marks)

END OF QUESTION PAPER