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**UNIVERSITI TEKNOLOGI MARA  
FINAL EXAMINATION**

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<b>COURSE</b>	<b>:</b>	<b>DATA STRUCTURES/ DATA STRUCTURE AND ALGORITHM ANALYSIS</b>
<b>COURSE CODE</b>	<b>:</b>	<b>CSC508/518</b>
<b>EXAMINATION</b>	<b>:</b>	<b>JULY 2023</b>
<b>TIME</b>	<b>:</b>	<b>3 HOURS</b>

**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.

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

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*This examination paper consists of 6 printed pages*

**QUESTION 1**

Given the following ADTs:

```
public class ArrayList{
    public ArrayList(); //default constructor
    public void add(Object elem);
    public int size();
    public Object get(int index);
    public Object remove(int index);
}

public class LinkedList{
    int total_student;

    public LinkedList();//default constructor;
    public void insertAtFront(Object elem);
    public void insertAtBack (Object elem);
    public Object getFirst();
    public Object getLast();
    public Object getNext();
}

public class StudentInfo{
    private String name; // student's name
    private String stuID; // student's ID
    private String gender; // i.e; "Male", "Female"
    private double cgpa; // student's cgpa
    private char major; /* student's study major,
                        i.e.: 'C' - computing,
                        'E' - engineering,
                        'M' - mathematics */

    public StudentInfo(); // default constructor
    public String getName();
    public String getID();
    public double getCGPA();
    public char getMajor();
    public StudentInfo getNext();
    public void setData(String, String, double, char);
    public void setNext();
    public void displayInfo();
}
```

a) studentArr is an object of ArrayList, and studentList, computingList, engineeringList and mathList are objects of LinkedList. Answer the following questions by providing JAVA code segment

i) Define the default constructor LinkedList() to properly initialize a LinkedList object created

(2 marks)

ii) Data for **FIFTY (50)** students have been inserted into studentArr. Find and display the details of students having CGPA over 3.75.

(3 marks)

iii) Copy all data of computing major students from studentArr to computingList.

(4 marks)

iv) All data from studentArr have been copied to computingList, engineeringList and mathList accordingly. Find the average CGPA for Mathematics major student. Then display the number of students having CGPA greater than average CGPA.

(6 marks)

v) Search and display the data for male engineering students having CGPA of less than 2.00.

(6 marks)

b) Describe **TWO (2)** situations where array is more favourable than linked list

(4 marks)

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## QUESTION 2

a) Given the following declaration of MyQueue and Book class

```
public class MyQueue<T> //A generic Queue class. T will
                        // represent any object type
{
    public MyQueue(); // constructor
    public boolean isEmpty();
    public void enqueue(T data); /*to add object into a queue*/
    public T dequeue(); //to delete object from a queue
    public T getFront(); //to retrieve front object
                        //in queue
    public T getEnd(); // to retrieve last object
                        // in queue
}
```

```
public class Book
{
    private String author;
    private int yearPublished;
    private float price;
    private String author;
    private String status; //draft/pending/published

    public Book();
    public int getYearPublish();
    public String getStatus();
    public String toString(); /* method to display all info of
                                book*/

    . . .
    // declaration of other methods
}
```

Consider the following declaration:

```
MyQueue<Book> BookQueue = new MyQueue<>();
```

Assuming there are already few Book objects in BookQueue. Write a code segment to check status of object book in BookQueue and display information of ALL books which has been published after year 2020.

(5 marks)

b) Given the following infix expression

$50 * 5 + 18 - 100 * 2 + 20 / 5$

Show the steps how a compiler would evaluate its value using a stack. Show the content of the stack in each step.

(5 marks)

c) Consider the following recursive function:

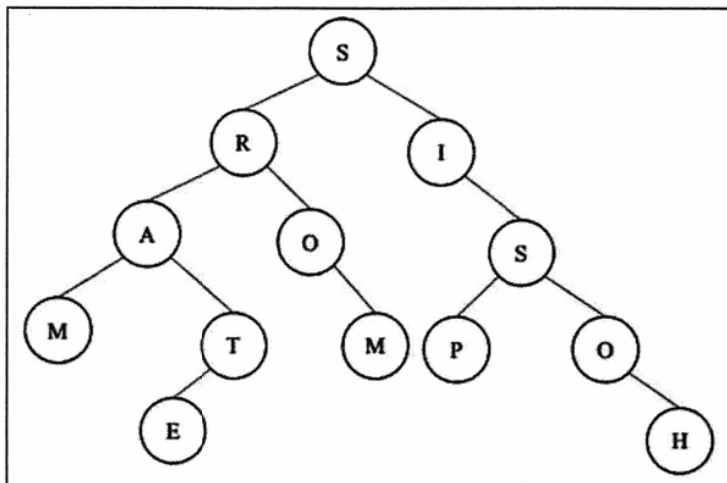
```
public static int test(int x, int y)
{
    if (x == y)
        return y;
    else if (x > y)
        return (x + y);
    else
        return (x * y) + test(x + 1, y - 1);
}
```

What is the value returned by the statement `test(3,8)`? Show all the steps taken.

(5 marks)

## QUESTION 3

a) Given the following binary tree of alphabets:



i) Write the method definition of Binary Search Tree (BST) traversal that will produce the output traversal of the word "METAMORPHOSIS".

(6 marks)

ii) Identify the order of nodes visited using **PREORDER** traversal.

(4 marks)

b) Construct an AVL Tree by inserting these primary keys of String data. Show step by step of the insertion starting with an empty tree: **MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY, SATURDAY, SUNDAY.**

(10 marks)

## QUESTION 4

a) The following data series is to be sorted in **descending** order.

40 , 60 , 10 , 20 , 50 , 30

i) Draw a diagram showing the steps of sorting the data series using merge sort.

(4 marks)

ii) Draw the diagrams showing the first three min-heap of heap sort.

(6 marks)

b) The following questions are on searching and hashing.

i) **TEN (10)** data with keys 21, 14, 35, 22, 30, 7, 19, 77, 16, and 11 are added into a hash table of size 13. Illustrate the final content of the hash table if the data are added using open addressing hashing technique with modulo (%) hash function.

(5 marks)

- ii) Identify the data structures that are suitable for linear and binary search. (2 marks)
- iii) If you need to search for an element in a large dataset that is already sorted, which search algorithm would you choose? Justify your answer. (3 marks)

**QUESTION 5**

Mandy is planning to travel to Dorf City for a long time. She had listed a few places as a must visit site during this travel. The list will cover the distance and cost of transportation between these places. These can be seen on **Table 1**:

**Table 1.** Distance and Transportation Cost for path between places

Path between places	Distance (km)	Transportation's Cost (Dollar)
Au, He	7	15
Au, Su	15	22.50
He, Wi	14	21
Wi, Au	13	12
Wi, Su	3	9.50
Su, He	2	12

- a) Draw an undirected graph using distance as its weight for the edges. (4 marks)
- b) Based on graph from question a), use Kruskal's Algorithm to answer the following questions:
- i) Draw the minimum spanning tree of the graph. Show your working steps. (7 marks)
- ii) Calculate the minimum distance between all vertices and the transportation cost for this minimum spanning tree. (3 marks)
- c) Using Dijkstra Algorithm, find the **cheapest** path to travel from **Au** to all the other places. Show your working steps. (6 marks)

**END OF QUESTION PAPER**