UNIVERSITI POLY-TECH MALAYSIA
UPTM

FINAL EXAMINATION

BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN COMPUTER APPLICATION DEVELOPMENT
BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN CYBER SECURITY
BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN (DATA ANALYTICS)
BACHELOR IN COMPUTER SCIENCE (HONOURS)

COURSE	:	**ALGORITHMIC DATA STRUCTURES/ DATA STRUCTURES & ALGORITHMS**
COURSE CODE	:	**SWC3524/SWC4423**
DURATION	:	**3 HOURS**

INSTRUCTIONS TO CANDIDATES :

1. This question paper consists of **TWO (2)** parts. : PART A (30 questions)
   : PART B (3 questions)
2. Answer ALL questions in the Answer Booklet provided.
3. Please check to make sure that this examination pack consists of :
   i. The Question Paper
   ii. An Answer Booklet
4. Do not bring any material into the examination hall. The use of calculator is allowed.
5. Please write your answer using permanent ink.

MYKAD/ PASSPORT NO. : _____

ID. NO. : _____

LECTURER : _____

SECTION : _____

DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO

This question paper consists of 14 printed pages including the front page

PART A : MULTIPLE CHOICE

Choose the CORRECT answer.

1. Which Object-Oriented Programming (OOP) concept allows a subclass to inherit properties and methods from a superclass?

   A. Inheritance
   B. Abstraction
   C. Encapsulation
   D. Polymorphism

2. Which access modifier in Java provides the **HIGHEST** level of data hiding?

   A. public
   B. default
   C. private
   D. protected

3. Which OOP principle focuses on exposing only the essential features of an object?

   A. Abstraction
   B. Inheritance
   C. Overloading
   D. Polymorphism

4. What is the main advantage of using recursion over iteration?

   A. Faster execution
   B. Less memory usage
   C. Eliminates base conditions
   D. Cleaner solution for problems with repetitive structure

5. Which condition **MUST** exist in every recursive function?

   A. Static variable
   B. Base condition
   C. Loop statement
   D. Return type void

6. What is a data structures?

   A. A Java library
   B. A hardware component
   C. A programming language
   D. A way of organizing and storing data efficiently

7. Which of the following is a non-linear data structure?

   A. Tree
   B. Array
   C. Stack
   D. Queue

8. A solution is said to be efficient if it:

   A. Uses recursion
   B. Runs without errors
   C. Uses object-oriented programming
   D. Solves the problem within resource constraints

9. The Java Collections Framework (JCF) provides:

   A. Only arrays
   B. Machine learning tools
   C. Fixed-size data structures
   D. Pre-built generic collection classes

10. Which of the following is a main interface in the Collection Framework?

    A. List
    B. Queue
    C. Thread
    D. Scanner

11. Which legacy class represents a growable array of objects?

A. Stack
B. Vector
C. Hashtable
D. Dictionary

12. The Java Collections Framework was significantly introduced in:

A. Java SDK 1.0
B. Java SDK 1.1
C. Java SDK 1.2
D. Java SDK 1.8

13. The Collection interface is found in which package?

A. java.io
B. java.util
C. java.lang
D. javax.swing

14. Which of the following is considered a "container"?

A. Loop
B. Method
C. Compiler
D. Collection

15. Special-purpose implementations are designed for:

A. Sorting automatically
B. Removing duplicates only
C. General everyday use only
D. Situations with special performance or behavior requirements

16. Which of the following list implementations does **NOT ALLOW** dynamic resizing?

    i. Array
    ii. Static list
    iii. ArrayList
    iv. Primitive List

    A. i and ii only
    B. ii and iii only
    C. i, ii and iv only
    D. All of the above

17. Given the following operations on a stack:

```
Stack<String> stack = new Stack<>();
stack.push("Rose");
stack.push("Tulip");
stack.push("Lily");
stack.pop();
System.out.println(stack.search("Rose"));
```

    What will the `search("Rose")` method return?

    A. 0
    B. 1
    C. 2
    D. -1

18. Which principle does a Stack follow?

    A. Last In, First Out (LIFO)
    B. First In, Last Out (FILO)
    C. First In, First Out (FIFO)
    D. Random access

19. How do you create `LinkedList` in Java to store the names of the crew in the One Piece Anime?

    A. `LinkedList crew = LinkedList();`
    B. `LinkedList<String> crew = new LinkedList<>();`
    C. `LinkedList crew = new LinkedList<>();`
    D. `LinkedList<String> crew = new List<>();`

20. To keep track of defeated enemies, Luffy pushes each enemy's name onto a stack. What will happen when he uses the `pop()` operation?

A. All enemies will be removed
B. The enemies will be sorted alphabetically
C. The first enemy defeated will be removed
D. The most recently defeated enemy will be removed

21. What will be the output of the following code?

```
ArrayList<String> ships = new ArrayList<>();
ships.add("Luffy");
ships.add("Zoro");
ships.add("Nami");
ships.add(1, "Sanji");
ships.set(2, "Usopp");
System.out.println(crew);
```

A. `["Luffy", "Zoro", "Usopp", "Nami"]`
B. `["Luffy", "Zoro", "Nami", "Usopp"]`
C. `["Luffy", "Usopp", "Sanji", "Nami"]`
D. `["Luffy", "Sanji", "Usopp", "Nami"]`

22. During a mission, four Straw Hat crew members — A (Luffy), B (Zoro), C (Sanji), and D (Nami) — line up in a queue to board the Thousand Sunny. In what order will they board the ship?

A. ABCD
B. DCBA
C. DCAB
D. ABDC

23. What does the following function print? (Assume that `TreasureQueue` is a queue storing treasure values.)

```
void grandLine(int n) {
  TreasureQueue q = new TreasureQueue();
  q.enqueue(2);
  q.enqueue(3);

  for (int i = 0; i < n; i++) {
     int a = q.dequeue();
     int b = q.dequeue();
     q.enqueue(b);
     q.enqueue(a + b);
     print(a);
  }
}
```

A. Prints numbers from 2 to n
B. Prints the numbers in reverse order
C. Prints the first n Fibonacci numbers
D. Prints the first n terms of a Fibonacci-like sequence starting with 2 and 3

24. Which operation is used to retrieve and remove the head of the queue, or return `null` if the queue is empty?

A. `peek()`
B. `poll()`
C. `offer()`
D. `remove()`

25. Which of the following is **NOT** a real-life example of a Queue system in the One Piece world?

A. Marines processing bounty reports in the order they are received
B. Pirates boarding the Thousand Sunny in first-come, first-served order
C. Serving food to crew members one by one in the order they lined up
D. Stacking treasure chests one on top of another in the Thousand Sunny

26. What is hashing mainly used for?

A. Sorting data
B. Encrypting data
C. Compressing data
D. Searching data efficiently

27. What is a hash table?

A. A linear data structure
B. A tree-based structure
C. A stack implementation
D. A data structure that maps keys to values

28. In a hash table of size `5`, inserting keys `{20, 30, 40}` using `h(k) = k % 5` results in how many collisions?

A. 0
B. 1
C. 2
D. 3

29. Which of the following is **NOT** a type of hash functions?

A. Folding
B. Division
C. Separate Chaining
D. Radix Transformation

30. What is the index position for key `59` in a hash table of size `7` using `h(k) = k % 7`?

A. 0
B. 1
C. 2
D. 3

(TOTAL: 30 MARKS)

PART B : STRUCTURED QUESTIONS

Answer ALL questions.

QUESTION 1

a. During an elite Demon Slayer Corps operation, Tanjiro evaluates a mission's Combat Resonance Score based on:

- `t` → total number of Breathing Techniques mastered
- `s` → total number of Nichirin Blade strikes performed

Due to the unstable nature of demon battles, the combat resonance fluctuates. Some strength is calculated using the modulus (%) to simulate technique efficiency loss.

The Combat Resonance Score is calculated using the following recursive rules:

$$\text{resonance}(t,s) = \begin{cases} (t*s) \bmod 7, & \text{if } t \le 1 \text{ or } s \le 1 \\ (t+s) \bmod 5 + \text{resonance}(t-2, s-1), & \text{if } t > s \\ \text{resonance}(t-1, s-2) + (s \bmod 3), & \text{if } s \ge t \end{cases}$$

```
public class DemonSlayerResonance {

    // Recursive method to calculate combat resonance
    public static int resonance(int t, int s) {
        if (t <= 1 || s <= 1)
            return (t * s) % 7;
        else if (t > s)
            return (t + s) % 5 + resonance(t - 2, s - 1);
        else
            return resonance(t - 1, s - 2) + (s % 3);
    }

    public static void main(String[] args) {
        int techniques = 10;    // Breathing techniques
        int strikes = 6;        // Blade strikes

        System.out.println("Combat Resonance Score: " +
                resonance(techniques, strikes));
    }
}
```

If the user inputs `t=10` and `s=6`, demonstrate how each recursive call works by tracing the function.

(12 marks)

b. Consider the following Java classes:

```
class MenuItem {
    void prepare() {
        System.out.println("Preparing a menu item");
    }
}

class Pizza extends MenuItem {
    void prepare() {
        System.out.println("Baking Papazola pizza in the
oven");
    }
}

class Pasta extends MenuItem {
    void prepare() {
        System.out.println("Cooking Papazola special pasta");
    }
}

public class TestPapazola {
    public static void main(String[] args) {
        MenuItem item;

        item = new Pizza();
        item.prepare();

        item = new Pasta();
        item.prepare();
    }
}
```

i) Identify the OOP concept demonstrated above.

(1 mark)

ii) Explain how this concept works in the program when `prepare()` is called.

(2 marks)

c. State **TWO (2)** limitations of arrays in Java.

(2 marks)

d. Explain why the Java Collection Framework (JCF) is preferred over arrays in Java programming.

(2 marks)

e. Describe **THREE (3)** commonly used data structures. For each data structure, outline its basic operation and provide one real-life example of its appropriate use.

(6 marks)

(Total: 25 marks)

QUESTION 2

a. Answer the following questions based on the program below:

```
import java.util.LinkedList;

public class HealthClinicSystem {
    public static void main(String[] args) {

    LinkedList<String> patients = new LinkedList<>();
    LinkedList<String> checkups = new LinkedList<>();

    // Register patients and their checkups
    patients.offer("Ali");
    checkups.offer("Blood Test");

    patients.offer("Brenda");
    checkups.offer("X-Ray");

    patients.offer("Chen");
    checkups.offer("ECG");

    patients.offer("Dina");
    checkups.offer("Ultrasound");

    // Question 2(a)(i)
    System.out.println("Registered Patients:" + patients);

    // Question 2(a)(ii)
    System.out.println("Assigned Checkups:" + checkups);

    // Question 2(a)(iii)
    System.out.println("Who is assigned for ECG? " +
    patients.get(checkups.indexOf("ECG")));
```

```
        System.out.println("Is MRI scheduled? " +
        checkups.contains("MRI"));

        // Update appointment
        checkups.set(checkups.indexOf("Ultrasound"),"CT Scan");
        patients.add(2, "Ehsan");
        checkups.add(2, "Health Screening");

        // Priority patient arrives
        patients.addFirst("Fatin");
        checkups.addFirst("Vaccination");

        // Display updated schedule
        System.out.println("Updated Patient List: " + patients);
        System.out.println("Updated Checkup List: " + checkups);

        // Serve first patient
        System.out.println("Now serving: " + patients.poll() +
        " for " + checkups.poll());

        // Remaining appointments
        System.out.println("Remaining Appointments:" +
        patients.size());
        System.out.println("Patients waiting: " + patients);
        System.out.println("Pending checkups: " + checkups);
        }
}
```

i) Write the output of `Registered Patients:` when the program at **QUESTION 2(a)(i)** is executed.

(2 marks)

ii) Write the output of `Assigned Checkups:` when the program at **QUESTION 2(a)(ii)** is executed.

(2 marks)

iii) Write the output of each additional operations (`indexOf()`, `contains()`, `set()`, `add()`, `addFirst()`, `poll()`) from the LinkedList `patients` and `checkups`.

(8 marks)

b. During Teachers' Day preparation, a teacher researches ideas online and uses a browser to look for activities. Each website visited is pushed onto a history stack named historyStack. When the teacher clicks the Back button, the most recently visited website is popped from the stack.

The teacher visits websites in the following order:

```
historyStack.push("teachersdayideas.com");
historyStack.push("diygifttutorials.com");
historyStack.push("lessonplanhub.com");
historyStack.push("classroomdecor.com");
```

i) Write a Java statement to declare a stack named `historyStack` that stores website URLs as strings.

(1 mark)

ii) Identify the current top website on the stack.

(1 mark)

iii) Write a Java statement to check whether the stack is empty and display an appropriate message, such as:

- "No browsing history."
- "Browsing in progress."

(4 marks)

iv) Later, the teacher retraces their browsing using the Back button and visits new websites with the following operations:

```
historyStack.pop();
historyStack.push("papazolaclasses.com");
historyStack.pop();
historyStack.push("teachergifts.com");
```

Illustrate the final contents of the `historyStack` from top to bottom after all operations.

(2 marks)

(Total: 20 marks)

QUESTION 3

a. Define a hash collision.

(1 mark)

b. A parking management system uses a hash table of size 11 to assign parking slots to registered vehicles. The hash function used is:

```
hash(key) = key % 11
```

The following book IDs are to be inserted:

```
18, 29, 40, 51, 68, 77, 92
```

i. Show, step by step, how collisions are handled using Quadratic Probing.

(7 marks)

ii. Provide a final representation of the hash table for the technique after all keys have been inserted.

(7 marks)

c. A university hostel management system stores student room registration numbers in a hash table of size 7 using Double Hashing.

The hash functions are:

$$h_1(key) = key \% 7$$
$$h_2(key) = 5 - (key \% 5)$$

The codes to insert are:

```
21, 16, 51, 39
```

i. Explain step-by-step how each value is inserted into the hash table using Double Hashing.

(6 marks)

ii. Draw the final structure of the hash table after all codes have been inserted.

(4 marks)

(Total : 25 marks)

(TOTAL: 70 MARKS)
(TOTAL :100 MARKS)

END OF QUESTION PAPER