THE STATE UNIVERSITY OF ZANZIBAR (SUZA)
School of Computing Communication and Media Studies (SCCMS)
Department of Computer Science and IT

SAMPLE EXAMINATION

IT6003 — Advanced Programming Using Java

Programme:	MSc. Information Technology	**Duration:**	3 Hours
Semester:	I	**Total Marks:**	100

Instructions:

1. This paper has **THREE** sections: A, B, and C.
2. Section A is **COMPULSORY** (40 marks).
3. Answer **ANY THREE** questions from Section B (20 marks each = 60 marks).
4. Write clean, compilable Java code. Pseudocode is NOT accepted.
5. Marks will be deducted for syntax errors.

SECTION A: Short Answer Questions [40 Marks] — COMPULSORY

Question 1 [40 Marks]

a) Explain the difference between `ArrayList` and `LinkedList`. When would you prefer one over the other? Give one example scenario for each. [4 marks]

b) What is the output of the following code? Explain why.

```
Set<String> set = new HashSet<>();
set.add("Java");
set.add("Python");
set.add("Java");
set.add("C++");
System.out.println(set.size());
System.out.println(set);
```

[3 marks]

c) What is type erasure in Java generics? Why can't you create a generic array like `new T[10]`? [4 marks]

d) Write a lambda expression for each of the following: [4 marks]

i) A `Comparator<String>` that sorts strings by length (shortest first)
ii) A `Predicate<Integer>` that tests if a number is even and greater than 10
iii) A `Function<String, Integer>` that converts a string to its length
iv) A `Consumer<String>` that prints a string in uppercase

e) What is the output of the following stream code? Show the step-by-step evaluation.

```
List<Integer> nums = Arrays.asList(1, 2, 3, 4, 5, 6, 7, 8, 9, 10);
int result = nums.stream()
    .filter(n -> n % 2 == 0)
    .map(n -> n * n)
    .reduce(0, Integer::sum);
System.out.println(result);
```

[4 marks]

f) Explain the difference between: [3 marks]

i) `extends Thread` vs `implements Runnable`
ii) `synchronized` method vs `synchronized` block
iii) `wait()` vs `sleep()`

g) What is a race condition? Write a 5-line code snippet that demonstrates a race condition with a shared counter. [4 marks]

h) Explain why `PreparedStatement` is preferred over `Statement` in JDBC. Provide a code example showing SQL injection vulnerability with `Statement` and how `PreparedStatement` prevents it. [4 marks]

i) What is the purpose of `try-with-resources`? Write a code snippet that reads a file using `BufferedReader` with `try-with-resources`. [4 marks]

j) Explain ONE design pattern from each category with a one-line definition and one real-world example: [3 marks]

i) Creational pattern
ii) Structural pattern
iii) Behavioral pattern

k) Explain the difference between `Serializable` and `transient` keyword. What happens to a `transient` field during serialization? [3 marks]

SECTION B: Programming Questions [60 Marks]

Answer ANY THREE questions (20 marks each)

Question 2: Collections and Generics [20 Marks]

a) Create a generic class `SortedList<T extends Comparable<T>>` that maintains elements in sorted order. Implement:

- `void add(T element)` — inserts in correct sorted position
- `T get(int index)` — returns element at index
- `T removeFirst()` — removes and returns smallest
- `T removeLast()` — removes and returns largest
- `int size()`, `boolean contains(T element)`

Use an `ArrayList<T>` internally. [10 marks]

b) Given a list of `Student` objects (with name, department, gpa), write code using `HashMap`, `TreeMap`, and `Collections` to:

i) Create a map of department → list of students
ii) Find the department with the highest average GPA
iii) Create a TreeMap sorted by GPA (descending) with student names
iv) Find all students whose name appears in more than one department

[10 marks]

Question 3: Lambda Expressions and Stream API [20 Marks]

Given the following `Product` class:

```
class Product {
    String name, category;
    double price;
    int quantity;
    // constructor, getters, toString
}
```

And a `List<Product>` with 15+ products across categories: "Electronics", "Books", "Clothing", "Food".

a) Using lambda expressions, create: [4 marks]

i) `Predicate<Product>` for products priced above 100
ii) `Function<Product, String>` that formats: "name ($price)"
iii) `Comparator<Product>` that sorts by category then price

b) Using Stream API, write ONE stream pipeline for each: [10 marks]

i) Total inventory value: $\sum$(price × quantity)
ii) Most expensive product per category (Map¡String, Optional¡Product¿¿)
iii) Products with quantity ¡ 5 sorted by price ascending
iv) Average price per category (Map¡String, Double¿)
v) A formatted report string with one product per line, sorted by price descending

c) Write a generic method: [6 marks]

```
static <T> Map<Boolean, List<T>> partition(List<T> list, Predicate<T>
    pred)
```

Implement using streams. Test by partitioning products into expensive (>50) and cheap (≤50).

Question 4: Multithreading and Concurrency [20 Marks]

a) Implement the Producer-Consumer problem: [10 marks]

- `SharedBuffer` class with fixed capacity of 5, using `wait()` and `notifyAll()`
- `Producer` thread that produces integers 1–20
- `Consumer` thread that consumes and prints each value
- Main class that starts 2 producers and 1 consumer, waits for completion

b) Write a multi-threaded word counter: [10 marks]

- Read a large text file and split into 4 equal chunks
- Create 4 threads (use `ExecutorService`), each counting word frequencies in its chunk
- Use `ConcurrentHashMap<String, AtomicInteger>` for thread-safe counting
- After all threads complete (use `Future`), print the top 10 most frequent words
- Measure and print execution time

Question 5: JDBC and File I/O [20 Marks]

a) Write a JDBC program that: [12 marks]

i) Creates a `courses` table (code TEXT PK, name TEXT, credits INT, department TEXT)
ii) Inserts 10 courses using `PreparedStatement` with batch processing
iii) Queries all courses in "CS" department and displays in a formatted table
iv) Implements a transaction: transfer a course from one department to another (update department, log the change in an `audit_log` table). Rollback if the course doesn't exist.
v) Uses `ResultSetMetaData` to dynamically print column names for any query

b) Write a program that: [8 marks]

i) Creates a `Student` class implementing `Serializable` (with transient password field)
ii) Serializes a list of 10 students to "students.dat"
iii) Deserializes and prints all students (verify password is null)
iv) Also saves the same data to "students.csv" using `BufferedWriter`
v) Reads "students.csv" back using `Files.lines()` and streams, creating Student objects

Question 6: Design Patterns and Networking [20 Marks]

a) Implement a mini e-commerce checkout system using design patterns: [12 marks]

i) **Singleton**: `ShoppingCart` — only one instance, methods: addItem, removeItem, getTotal
ii) **Factory**: `DiscountFactory` creates discount strategies: "student" (20%), "member" (10%), "none" (0%) based on customer type string
iii) **Observer**: When an item is added/removed from cart, notify: `InventoryManager`, `PriceDisplay`, `Logger`

Write a `Main` class demonstrating all three patterns in a checkout workflow.

b) Write a TCP client-server application: [8 marks]

i) Server listens on port 6000, accepts multiple clients (threaded)
ii) Client sends a math expression (e.g., "ADD 5 3")
iii) Server parses, computes, and returns the result
iv) Support operations: ADD, SUB, MUL, DIV, POW
v) Handle errors: division by zero, invalid format

End of Sample Examination