| Objective: |
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This assignment has been designed for students to apply appropriate concurrent program methods in the **planning** of a concurrent program from a requirement specification.

**Learning Outcomes**

ON COMPLETION OF THIS ASSIGNMENT, YOU SHOULD BE ABLE TO DEMONSTRATE THE FOLLOWING LEARNING OUTCOME(S):

| No. | Learning Outcome | Assessment |
| --- | --- | --- |
| 1 | Explain the fundamental concepts of concurrency and parallelism in the design of a concurrent system (C2, PLO1) | Exam |
| 2 | Apply the concepts of concurrency and parallelism in the construction of a system using a suitable programming language. (C3, PLO2) | Individual Assignment (System) |
| 3 | **Explain the safety aspects of multi-threaded and parallel systems (A3, PLO6)** | **Individual Assignment (Report)** |

**Programme Outcomes (PO):**

PLO6 - Digital skills

Digital skills generally refer to the ability to use information/digital technologies to support work and studies. The skills include sourcing and storing information, *processing data, using applications for problem solving and communication, as well as ethics in applying digital skills.*

**Individual Assignment - Report (20%):**

| Question No. | Topic | Question Vs Taxonomy | | | | | PLO |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | | Affective Level | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | |
| | | SQ | SQ | SQ | SQ | SQ | |
| **1** | Introduction and background | | | 20% | | | 6 |
| **2** | Explanation of the safety aspects of multi-threaded system implemented | | | 30% | | | 6 |
| **3** | Justification of coding techniques implemented. | | | 30% | | | 6 |
| **4** | Depth of discussion of concurrency concepts. | | | 20% | | | 6 |
| | Total | | | 100% | | | |

| Submission Requirements:  Part 1 |
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**Assignment Handout Date    : 11th March 2022**

**Assignment Due Date        : 22nd April 2022**

| Case Study |
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**The Problem**

The management of an airport thinks that the way in which the airport is operated means that incoming flights must spend too much time waiting for landing clearance. To evaluate the situation a simulation of the airport has been commissioned. This simulation will simply run with text output describing the events as they occur in the airport and collect a minimal amount of statistical data.

**Intention of assignment**

Even if valuable to the owner, the simulation is *not* the main purpose of this assignment - indeed, if this was the case there are much better techniques for *simulating* than writing a concurrent program.

Identify all potential sources of delays or deadlock in the problem specification and describe briefly how they are avoided in the implementation.

The requirement of this assignment is to **plan the implementation** of a program in which synchronization and communication takes place between several concurrent processes. It is intended to force you to solve (and not simply avoid) a range of interesting synchronisation problems.

**Asia Pacific Airport**

You have been tasked to automate the task of Air Traffic Controller (ATC). ATCs have three main tasks as an aircraft approaches an airport, all of which must be carried out as quickly as possible:

*******************************Basic Requirements*****************************

- There is only 1 runway for all planes to land and depart.

- Ensure that the aircraft does not collide with another aircraft on the runway or gates

- Once an aircraft obtains permission to land, it should land on the runway, coast to the assigned gate, dock to the gate, allow passengers to disembark, refill supplies and fuel, receive new passengers, undock, coast to the assigned runway and take-off.
- **Each step should take some time.**
- A congested scenario should be simulated where planes are waiting to land while the 2 gates are occupied.
- As the airport is small, there is no waiting area on the ground for the planes to wait for a gate to become available.

****************************Additional Requirements**************************
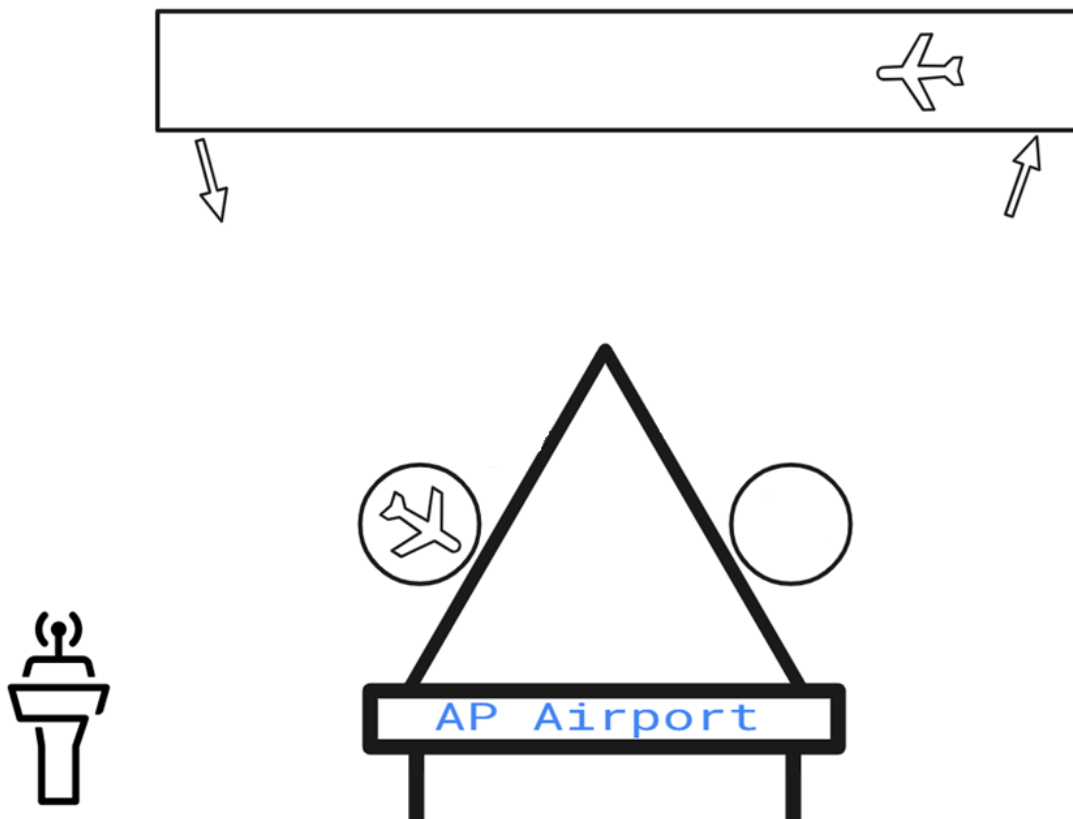
These events should happen concurrently:

- Passengers disembarking/embarking

- Refill supplies and cleaning of aircraft

As there is only 1 refuelling truck, this event should happen exclusively:

- Refuelling of aircraft

State your assumptions and how you will implement them.

*Figure 1: Layout of the Asia Pacific Airport (Not to scale)*

**Deliverables:**

For this exercise, you are to **model** the ATC scenario and **propose the Java techniques** for a program to simulate activity for the airport:

- Altogether, 6 planes should try to land at the airport.

- Use a random number generator, so a new airplane arrives every 0, 1, or 2 seconds. (This *might* be accomplished by an appropriate statement sleep (rand.nextInt(3000));

- Assume passengers are always ready to embark and disembark the terminal (i.e., no capacity issues inside the passenger terminals)

Simulate scenarios in which:

- Planes are waiting to land while the two gates are fully occupied

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**Documentation for Report (Week 8)**

***The documentation should detail the system planning and design considerations <u>prior</u> to implementation. The document should only focus on the <u>narrative</u> of <u>what should happen</u>, and <u>how it will be implemented</u>.***

1. Flow of activities (including assumptions, if any) in the planned simulation.
    - Describe basic design decisions that have been made about how to implement each component of the simulation.
    - Explanation of the safety aspects of multi-threaded system to be implemented
    - Justification of concurrency concepts (atomic statements, synchronization, semaphore, locks, etc.) to be implemented.
2. Repeat step 1 for next event.

<u>Sample document structure:</u>
    - Planes will arrive and request for landing. If runway is not available planes will enter a queue until the runway is available. To implement the queue the planes will be placed in a LinkedList for runway request queue. The LinkedList is used as we loop through it instead of accessing random items like in an ArrayList, and we only need to add and remove from the beginning, or end of the list. This will ensure fairness and First in First Out order of arrival.
    - Planes that have acquired the runway will land and this process takes 3 seconds. The runway will be acquired using …. (Locks/Semaphore/Synchronised/etc) …… This will ensure the safe usage of the runway as……

Maximum 2000 words excluding references/appendix/coding.

- General descriptions of concepts are <u>not</u> required.
- Specific contextualisation, reference and examples from the case study expected.
- <u>No</u> design diagrams are required.

**Marking Scheme (NOT for student's documentation guide)**

| Criteria | Total marks | Marks awarded |
|---|---|---|
| Assumptions [LO3-PO6] | 20 | |
| Explanation of the safety aspects of multi-threaded system implemented [LO3-PO6] | 30 | |
| Justification of coding techniques implemented [LO3-PO6] | 30 | |
| Depth of discussion of concurrency concepts [LO3-PO6] | 20 | |
| TOTAL MARKS | 100 | |