### **Problem Solution Description**

The task involves simulating the flow of patients through a hospital, where they go through three critical stages: preparation, operation, and recovery. Each stage has limited resources (rooms or operating theaters), and patients must wait if these resources are already occupied. The goal of the simulation is to model the arrival of patients, process them through each phase, and monitor important metrics like queue lengths and resource usage.

### **Key Components of the Solution**

#### **Simulation Environment**

The simulation is developed using SimPy, a Python library designed for discrete-event simulation. SimPy provides the tools to model time-dependent events, such as patient arrivals and their movement through different phases of the hospital system.

#### **Patient Service Times**

Each patient has a unique set of service times for the three stages (preparation, operation, and recovery). These times are not fixed but are instead drawn from **exponential distributions**. This approach introduces variability in the simulation, reflecting real-world randomness while maintaining a predictable average rate for each stage.

#### **Resources (Servers)**

1. **Preparation Rooms**:
2. There are **3 preparation rooms** available. This means that up to three patients can undergo preparation simultaneously. If all preparation rooms are occupied, newly arriving patients must wait in line.
3. **Operating Theater**:

The hospital has only **1 operating theater**, so only one patient can undergo surgery at any given time. Other patients in need of surgery must wait until the operating theater is free.

1. **Recovery Rooms**:

Similar to the preparation phase, there are **3 recovery rooms**, allowing up to three patients to recover simultaneously. Patients will have to wait if all recovery rooms are occupied.

#### **Patient Flow**

Patients arrive at the hospital at random intervals. Upon arrival, they pass through the following phases sequentially:

1. Preparation
2. Operation
3. Recovery

The time a patient spends in each phase is determined by the exponential distribution mentioned earlier. If the required resource (preparation room, operating theater, or recovery room) is occupied when a patient reaches that phase, the patient waits in a queue until the resource becomes available.

#### **Monitoring and Reporting**

The simulation continuously tracks and logs the system's state at regular intervals (e.g., every 5 minutes). It monitors key metrics, including:

* The current queue lengths for each phase (preparation, operation, recovery).
* Utilization rates of the preparation rooms, operating theater, and recovery rooms.

Additionally, the simulation records and displays detailed information for each patient:

* Arrival times and service times for all three phases.
* The time they start and finish each phase.