Question - 2: Pizzeria Gino Sorbillo

Gino's pizza is known to be the best pizza in the planet. It was featured in various movies, and people travel miles to eat the pizza. It was also featured in Eat, Pray Love. Since Gino Sorbillo is expanding, the pizzeria offers **M** pizzas. **N** chefs are employed in the pizzeria. Unfortunately, these chefs have other part-time jobs and hence cannot reach the pizzeria at the same time. The restaurant is also considering a drive-thru option. Given the rectangular layout of the restaurant, the drive-thru can only support **K** cars. Any other car waiting outside the drive-thru zone is allotted into the drive-thru zone depending on availability and a first-come-first-serve basis. All the time scales provided in the question are in seconds. If an event **E** is occurring at 1 second, it means it has been 1 second since the restaurant that the event **E** is occurring 1 second after the restaurant opened. The restaurant layout is as follows -

- **Chefs:** A chef arrives at time **T1** and exits at time **T2.** Every chef in the restaurant has been employed on competent basis, and hence, all the chefs can prepare a specific kind of pizza in a stipulated amount of time. At any given time, if no chef is present in the restaurant, the restaurant is shut down. All customers wait if there are any incoming chefs. If no chefs are incoming, the customers are rejected. A chef can only be assigned an order if they have enough time to prepare the order.

- **Pizza: M** kinds of pizzas are available. Each kind of pizza has a different preparation time **t**. If the pizza requires limited ingredients, it uses a single unit of the limited ingredient.

- **Drive-Thru Customers: K** cars can be supported through the drive-thru option. The customer present in each of the cars can order multiple pizzas of different kinds. The customer orders the instant they reach the drive-thru. If the customer is rejected by the restaurant, the customer can choose to exit the drive-thru by overtaking other cars. If the pizza can be served, the customer needs to wait till they reach the pickup spot to collect their pizzas. It takes **s** seconds to reach from the entrance to the pick up spot. If their pizza is not present at the pick up spot, but their order has not been rejected, they wait at the pick up spot.

- **Ingredients:** Some ingredients like flour, oil and yeast are available in unlimited quantity. Some of them like vegetables and meat are only available in limited quantity for the day. The restaurant then stocks these ingredients again for the next day. If all the limited ingredients available

for making all the pizzas are over, then the restaurant shuts down for the day. If the restaurant has the ingredients to make at least one pizza, the restaurant stays open, but the drive-thru orders become more selective. Drive-thru orders having at least one pizza which can be made by the pizzeria are accepted. Other drive-thru orders are rejected.

- **Ovens: L** ovens are present in the restaurant. An oven can only cook one pizza at a time. If the preparation time for a pizza is **t**, 3 seconds are taken by all the chefs to arrange the ingredients (if available), and once allotted an oven, the pizza is baked in **(t-3)** seconds and immediately sent to the pick up spot.

- **Pick up spot:** The pick up spot is massive and can high quantities of pizzas, so no restrictions here!

We want to simulate the functioning of the pizzeria. Consider the following events for each of the following entities -

1. Chef

- Chef c arrives at time **t1**.
- Chef c exits at time **t2.**
- Chef c could not complete pizza **p** for order **o** due to ingredient shortage.
- Chef c is preparing the pizza **p** for order **o**.
- Chef c is waiting for oven allocation for pizza **p** for order **o**.
- Chef c has put the pizza **p** for order **o** in the oven at time **t**.
- Chef c has picked up the pizza **p** for order **o** from the oven at time **t**.

2. Car/Customer (interchangeable)

- Customer c arrives at time **t1**.
- Customer c is waiting for the drive-thru allocation.
- Customer c enters the drive-thru zone and gives out their order **o**.
- Customer is rejected. (Note that a customer can be rejected even after being accepted. If this case happens, the customer is notified immediately. The customer exits the restaurant immediately).
- Customer c is waiting at the pickup spot.
- Customer c picks up their pizza i.
- Customer c exits the drive-thru zone.

3. Order

- Order **o** placed by customer **c** has pizzas **{p1,p2,…}**.
- Pizza **x** in order **O** has been assigned to Chef **i.**
- Order **o** placed by customer **c** awaits processing.
- Order **o** placed by customer **c** is being processed.
- Order **o** placed by customer **c** has been processed.

- Order **o** placed by customer **c** partially processed and remaining couldn’t be.
- Order **o** placed by customer **c** completely rejected.

Given appropriate inputs, simulate the pizzeria using multi-threading. **Avoid deadlocks and busy waiting**. Instead, use semaphores and mutex locks to implement the problem. **You are required to write your algorithm, followed by implementational details in your report. Answer the follow-up questions:**

- The pick-up spot now has a stipulated amount of pizzas it can hold. If the pizzas are full, chefs route the pizzas to a secondary storage. How would you handle such a situation?

- Each incomplete order affects the ratings of the restaurant. Given the past histories of orders, how would you re-design your simulation to have lesser incomplete orders? Note that the rating of the restaurant is not affected if the order is rejected instantaneously on arrival.

- Ingredients can be replenished on calling the nearest supermarket. How would your drive-thru rejection / acceptance change based on this?

The input format is as follows-

- The first line consists of the number of chefs (n), the number of pizza varieties (m), the number of limited ingredients (i), the number of customers (c), the number of ovens (o), and the time for a customer to reach the pickup spot (k).

- The second line to (2+m) consists of the pizza entity ID followed by its preparation time and the number of limited ingredients they use and its ID.

- The (2+m+1) line consists of the ingredient amount of each of the limited ingredient.

- The (2+m+2) line consists of the entry-exit times of each of the chefs ordered in the same line. (chef1_entry, chef1_exit, chef2_entry, chef2_exit, …).

- Followed by this, the rest of the lines consist of the customer's entry time, followed by the number of pizzas they want to order followed by the pizza IDs.