FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGIES

SPRING 2023

FINAL EXAMINATION

COURSE TITLE:	OPERATING SYSTEMS
COURSE CODE:	BSC-ICT22310
INSTRUCTOR:	Engr. Tanwi Nkiamboh
DATE:	
DURATION:	3 Hours

INSTRUCTIONS:

- ✓ **Study Materials Prohibited**
- ✓ **Answer all the exercises.**
- ✓ **Credit is given for legibility, clarity of expressions and use of relevant illustrations.**
- ✓ **Clearly write your registration number on each answer sheet used**

Exercise 1: Sleeping Barber Problem

Imagine a hypothetical barbershop with one barber, one barber chair, and a waiting room with *n* chairs (*n* may be 0) for waiting customers. The following rules apply:

- If there are no customers, the barber falls asleep in the chair
- A customer must wake the barber if he is asleep
- If a customer arrives while the barber is working, the customer leaves if all chairs are occupied and sits in an empty chair if it's available
- When the barber finishes a haircut, he inspects the waiting room to see if there are any waiting customers and falls asleep if there is none.

There are two main complications. First, there is a risk that a race condition, where the barber sleeps while a customer waits for the barber to get him/her for a haircut arises because all of the actions—checking the waiting room, entering the shop, taking a waiting room chair—take a certain amount of time. Specifically, a customer may arrive to find the barber cutting another customer hair so he/she returns to the waiting room to take a seat but while walking back to the waiting room the barber finishes the haircut and goes to the waiting room, which he finds empty (because the customer walks slowly or went to the restroom) and thus goes to sleep in the barber chair. Second, another problem may occur when two customers arrive at the same time when there is only one empty seat in the waiting room and both try to sit in the single chair; only the first person to get to the chair will be able to sit.

Propose a solution to this problem that coordinates the actions of the customers and the barber in a way that avoids synchronization problems, such as deadlock or starvation. **(10 marks)**

Exercise 2: CPU Scheduling

Consider the set of processes with arrival time (in milliseconds), CPU burst time (in milliseconds), and priority shown below: (Higher number represents higher priority)

Process ID	Arrival Time	Burst Time	Priority
P1	0	4	2
P2	1	5	3
P3	3	1	4
P4	3	5	5
P5	4	2	5

By giving the gantt chart in each case, calculate the throughput, average response time, average waiting time, average turn around time, in the following CPU sheduling policies

i) Preemptive Shortest Job First **(5 marks)**
ii) Preemptive Priority **(5 marks)**
iii) Round Robin with quantum time 2ms **(5 marks)**

Exercise 3: Banker's Algorithm

Assume that there are 5 processes, P0 through P4, and 4 types of resources. At T0, we have the following system state:

Max Instances of Resource Type A = 3 (2 allocated + 1 Available)

Max Instances of Resource Type B = 17 (12 allocated + 5 Available)

Max Instances of Resource Type C = 16 (14 allocated + 2 Available)

Max Instances of Resource Type D = 12 (12 allocated + 0 Available)

Given Matrices												
	Allocation Matrix (N0 of the allocated resources By a process)				**Max Matrix** Max resources that may be used by a process				**Available Matrix** Not Allocated Resources			
	A	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
P_0	0	1	1	0	0	2	1	0	1	5	2	0
P_1	1	2	3	1	1	6	5	2				
P_2	1	3	6	5	2	3	6	6				
P_3	0	6	3	2	0	6	5	2				
P_4	0	0	1	4	0	6	5	6				
Total	**2**	**12**	**14**	**12**								

i) Create the need matrix (max-allocation) **(2 marks)**

ii) Use the safety algorithm to show that the system is in a safe state or not **(4 marks)**

iii) Can the following requests be granted, why or why not?

a) P1 requests (2, 1, 1, 0) **(2 marks)**

b) P3 requests (0, 2, 1, 0) **(2 marks)**

iv) What will happen if process P1 requests one additional instance of resource type B and two instances of resource type C. **(5 marks)**