University of Ruhuna - Faculty of Technology

Bachelor of Information Communication Technology Honours Degree
Level 2 (Semester II) Examination, December 2025
Academic year 2023/2024

Course Unit: ICT2213 Operating System Concepts and Applications (Theory)
Duration: 2 hours

IMPORTANT INSTRUCTIONS
- This is a Closed Book examination.
- The medium of this examination is English.
- This paper contains **four (04)** questions on **four (04)** pages.
- All **four (04)** questions are given equal marks.
- **Answer all four (04) questions.**

1)

a) State the main role of the **kernel** in an operating system. [10 marks]

b) List the key steps in the **Computer Startup** process. [16 marks]

c) Identify the main differences between **Multiprogramming** and **Multitasking operating systems.** [10 marks]

d) Briefly explain the relationship between **APIs**, **System calls**, and **the operating system**? [15 marks]

e) List the **components** of a process in **memory** and briefly describe each. [25 marks]

f) Explain the concept of **Inter-process Communication (IPC)** and describe **Message Passing** and **Shared Memory with a suitable diagram**. [20 marks]

2)

a) Briefly explain the concept of **threads** and explain how they differ from **processes**. [10 marks]

b) List **four (4)** main components that a **thread** contains. [20 marks]

c) Briefly discuss the **four (4)** benefits of multithreading in modern software applications. [20 marks]

d) Briefly explain the difference between **concurrency** and **parallelism** with **suitable diagram**. [20 marks]

e) State the **three (3)** requirements for a solution to the Critical Section Problem and briefly explain them. [15 marks]

f) Briefly explain Peterson's solution to the critical section problem for **two** processes. [15 marks]

3)

a) Briefly explain **aging** concept in CPU scheduling. [10 marks]

b) List the **five (5)** scheduling algorithm optimization criteria for effective CPU scheduling. [20 marks]

c) What is **response time** in CPU scheduling, and how is it different from waiting time and turnaround time? [10 marks]

d) How does **Round Robin (RR)** scheduling address the fairness of CPU time allocation? [10 marks]

e) Briefly explain the **deterministic evaluation** of CPU scheduling algorithms and its **limitations**. [10 marks]

f) The multilevel feedback queue is composed of three queues. [40 marks]

- Queue 0 has a round robin scheduler (RR) with a time quantum of 5 ms.
- Queue 1 has a round robin scheduler (RR) with a time quantum of 10 ms.
- Queue 2 has a first come first serve scheduler (FCFS).
- A process entering the ready queue is put into queue 0.
- If it does not finish within the allocated time at the first iteration in queue 0,then it will be moved to the end of queue 1.
- If queue 0 is empty, then the process at the head of queue 1 is given a time
- quantum of 10 ms.
- If it does not finish within the allocated time at the first iteration in queue 1,then it will be moved to the end of queue 2.
- Processes in queue 2 runs on an FCFS basis but are run only if both queue 0 and1 are empty.

Suppose that the following processes arrive for execution to the ready queue at the times indicated. Each process will run for the duration given. Length of the CPU burst and also the arrival time to the ready queue is given in milliseconds.

Process	Arrival Time	Burst Time	Turnaround time	Response time	Waiting time
P1	0	20			
P2	10	10			
P3	12	10			
P4	35	05			
P5	40	20			

Table 0 1

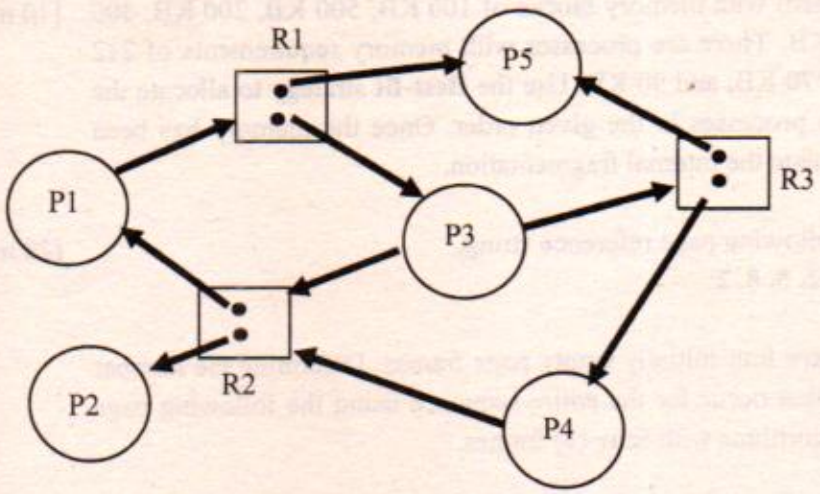
i. Draw a Gantt chart to illustrate the execution of processes given in Table 01.

ii. Calculate the waiting time, response time and turnaround time for each of the processes in a Table 01.

4)

a) Briefly discuss how can circular wait be prevented in deadlock prevention. [10 marks]

b) Consider the resource allocation graph in the figure. Draw its wait-for graph. [20 marks]



c) Given a system with four processes (P1 to P4) and four resource types A, B, C, and D. [30 marks]

- Resource type **A** has **10 instances**.
- Resource type **B** has **12 instances**.
- Resource type **C** has **8 instances**.
- Resource type **D** has **10 instances**.

The following table represents the **Maximum** resources and the **Allocation** resources for each process at time **T0.**

Maximum				
	A	B	C	D
P1	6	5	4	6
P2	3	4	3	4
P3	5	5	5	4
P4	4	3	4	5

Allocation				
	A	B	C	D
P1	3	4	2	3
P2	1	2	1	3
P3	2	2	2	1
P4	2	2	1	2

I. Calculate the available resources for each resource type (A, B, C, D) in the system at time T0.
II. Generate the Requirement matrix.
III. Identify all the safe sequences in the system.

d) Consider a system with memory blocks of 100 KB, 500 KB, 200 KB, 300 KB, and 600 KB. There are processes with memory requirements of 212 KB, 150 KB, 370 KB, and 90 KB. Use the **Best-fit** strategy to allocate the memory to the processes in the given order. Once the memory has been allocated, calculate the internal fragmentation. [10 marks]

e) Consider the following page reference string, [20 marks]
4, 7, 2, 8, 3, 1, 2, 5, 8, 2

Assume you have four initially empty page frames. Determine the number of page faults that occur for the entire sequence using the following page replacement algorithms with **four (4)** frames.

I. **Least Recently Used (LRU)**
II. **First-In-First-Out (FIFO)**

[10 marks]

f) Briefly explain why **Optimal page replacement** is considered the best and is not practical in real-world systems.

----------**End of the paper**----------