The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX5335 Operating Systems**
Academic Year	: 2023/24
Date	: 02nd March 2025
Time	: 1330 - 1630hrs
Duration	: **3 hours**

General Instructions

1. Answer all the questions.
2. Read all instructions carefully before answering the questions.
3. This question paper consists of **Five (5)** questions in **Four (4)** pages.
4. This is a Closed Book Test (CBT).
5. Answers should be in clear handwriting.
6. Do not use red colour pen.

Question No 1 [20 Marks]

Efficient memory management is crucial in operating systems to optimize performance and resource utilization. Consider the following scenarios and answer the questions below:

(i). A system uses a contiguous memory allocation scheme where a process of **200 KB** needs to be loaded. However, the available memory blocks are:

- **Block 1:** 220 KB
- **Block 2:** 180 KB
- **Block 3:** 250 KB

After allocation, the system experiences fragmentation.

a) Identify and explain the type of fragmentation observed in this scenario. [04 Marks]
b) How does this fragmentation impact memory utilization? [04 Marks]
c) Propose a method to minimize fragmentation in such a system. [02 Marks]

(ii).A process requires **12 KB** of memory. The system uses a **paging technique** with a page size of **4 KB**. The pages are loaded into available frames in the following manner:

Page	Frame
P1	F5
P2	F2
P3	F7

The system also supports segmentation, where a process is divided into logical segments (e.g., Code, Data, Stack).

a) How many pages are required for the process under the paging system? Explain your answer. [03 Marks]
b) If segmentation is used instead, how would the memory be allocated differently? [03 Marks]

c) Compare and contrast paging and segmentation in terms of fragmentation and flexibility. [04 Marks]

Question No 2 [20 Marks]

Process management plays a crucial role in operating systems by ensuring efficient execution and resource utilization. Consider the following scenarios and answer the related questions.

(i). A process is executing in a multitasking operating system and undergoes the following transitions:

1. The process starts execution.
2. It requires input from the user and stops running.
3. Once input is received, it resumes execution but gets preempted by the CPU due to a higher-priority process.
4. After some time, it gets the CPU again and completes execution.

a) Identify the different process states involved in this scenario and illustrate them in a process state transition diagram. [04 Marks]
b) Explain the role of the scheduler in each transition. [04 Marks]
c) How does preemption impact process execution, and what scheduling strategy could minimize its impact? [02 Marks]

(ii).A web server is designed to handle multiple client requests simultaneously. The server follows a multithreading approach where each client request is handled by a separate thread. The system administrator notices performance issues when the number of clients increases.

a) Explain how multithreading helps in improving the performance of a web server. [02 Marks]
b) Compare user-level and kernel-level threads. Which type would be more suitable for this scenario and why? [04 Marks]
c) Discuss how thread synchronization techniques can be used to prevent performance bottlenecks in this system. [04 Marks]

Question No 3 [20 Marks]

(i). A real-time operating system is required to handle critical tasks efficiently. The system administrator is deciding between **preemptive** and **non-preemptive** scheduling policies.

a) Explain the key differences between preemptive and non-preemptive scheduling with examples. [04 Marks]

b) Which scheduling approach is more suitable for a real-time system? Justify your answer. [04 Marks]

c) Describe a scenario where non-preemptive scheduling could lead to process starvation. How can this issue be addressed? [04 Marks]

(ii). A CPU scheduling system is evaluating different scheduling strategies based on the following process details:

Process	Arrival Time (ms)	Burst Time (ms)
P1	0	6
P2	2	8
P3	4	7
P4	6	3

The system administrator wants to analyze **Shortest Remaining Time First (SRTF)** scheduling.

a) Calculate the **turnaround time** and **waiting time** for each process using SRTF scheduling. [02 Marks]

b) Explain how turnaround time and waiting time impact system performance. [02 Marks]

c) If the goal is to minimize average waiting time, which scheduling algorithm would you recommend? Why? [04 Marks]

Question No 4 [20 Marks]

(i). An enterprise system has recently been targeted by a series of cyber-attacks. The operating system of the servers incorporates various security features such as user authentication, access control lists (ACLs), encryption, and audit logging. However, vulnerabilities in the OS kernel and outdated security patches have led to unauthorized access attempts.

a) Describe the primary security mechanisms that an operating system employs to protect system resources. [04 Marks]

b) Propose a comprehensive security strategy for this enterprise system that addresses both prevention and response. [04 Marks]

(ii). An automotive manufacturer uses a real-time operating system (RTOS) to control critical functions in modern vehicles, such as braking and engine management. The RTOS is designed to meet strict timing constraints, but recent software updates have introduced latency issues, risking system stability and safety.

a) Define a real-time operating system and explain the importance of meeting timing constraints in such environments. [04 Marks]

b) Discuss the potential impacts of latency issues in an RTOS controlling critical automotive functions. [04 Marks]

c) Propose a method to test and validate the updated RTOS to ensure it meets the necessary real-time performance and safety requirements. [04 Marks]

Question No 5 [20 Marks]

(i). A system administrator notices that a computer with **4 GB RAM** is running multiple applications simultaneously. When opening a new application, the system slows down significantly, and some processes are temporarily moved to disk to free up memory.

a) Explain the concept of **swapping** and how it is used in memory management. [04 Marks]
b) Discuss the advantages and disadvantages of swapping in this scenario. [04 Marks]
c) Suggest an alternative memory management technique that could improve system performance without excessive swapping. [04 Marks]

(ii).A company's server runs multiple virtual machines (VMs) on a single physical machine. The administrator notices that the system frequently accesses the hard disk, leading to severe performance degradation. After analysis, it is found that all VMs are continuously requesting memory pages.

a) Define **thrashing** and explain why it occurs in this scenario. [04 Marks]
b) Suggest two strategies to minimize thrashing and improve overall system performance. [04 Marks]