UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: March 2026

Module Number: EE5212 **Module Name: Operating Systems**

[Two Hours]

[Answer **all questions**, each question carries 10 marks]

Q1 a) Explain the concept of dynamic partitioning and critically compare it with fixed partitioning in terms of memory utilization and efficiency.

[2 Marks]

b) Explain the concept of relocation and discuss its importance in supporting efficient process execution in modern operating systems.

[2 Marks]

c) A system uses dynamic partitioning. The current free memory blocks are given in Table Q1 c) (i) and the order of the process arrival is given in Table Q1 c) (ii):

Block	Size (MB)
B1	100
B2	500
B3	200
B4	300
B5	600

Table Q1 c) (i): The current free memory blocks

Process	Size (MB)
P1	212
P2	417
P3	112
P4	426

Table Q1 c) (ii) : The order of the process arrival

i) Apply the Best-Fit allocation algorithm to assign memory blocks.
ii) Analyze and show the state of free memory after each allocation step.

[4 Marks]

d) Given a system with paging, the following parameters are provided:

- Logical address space = 16 bits
- Page size = 1 KB
- Page 5 maps to frame 9

i) Determine the number of bits required for the page number and offset
ii) Compute the physical address for logical address (page = 5, offset = 100).

[2 Marks]

Q2 a) Differentiate between deadlock prevention and deadlock avoidance, and evaluate their effectiveness in practical systems.

[2 Marks]

b) A Disk has 200 cylinders (0–199). The disk head is at position 53, moving towards 0. The request queue is: 98, 183, 37, 122, 14, 124, 65, 67

i) Apply the following disk scheduling algorithms and compute the total head movement. Illustrate the order of service of following three algorithms using appropriate charts.

- SSTF
- SCAN
- C-SCAN

ii) Evaluate one limitation of SSTF and explain how SCAN improves upon it.

[4 Marks]

c) Consider the resource allocation state of a system with processes: P1, P2, P3, P4 as shown in Table Q2(c).

Resources:

- R1 (3 instances)
- R2 (2 instances)
- R3 (2 instances)

Available resources: (R1, R2, R3) = (0, 0, 0)

Process	Allocation (R1, R2 , R3)	Requests (R1, R2 , R3)
P1	(1, 0, 1)	(1, 1, 0)
P2	(1, 1, 0)	(1, 0, 1)
P3	(0, 1, 1)	(0, 1, 0)
P4	(1, 0, 0)	(0, 0, 1)

Table Q2 c) : Resource Allocation Table

i) Construct the Resource Allocation Graph (RAG).
ii) Analyze the graph and determine whether the system is in a deadlock state, providing clear justification.

[4 Marks]

Q3 a) Explain the concept of a race condition and analyze how mutex locks ensure safe access to shared resources.

[2 Marks]

b) Develop a C program using POSIX threads where:

i) Two threads access two shared resources protected by mutex locks
ii) The program demonstrates a deadlock situation

[4 Marks]

c) Modify your program to eliminate deadlock and justify how your modification prevents it.

[2 Marks]

d) You are responsible for securing a directory named project/ that contains multiple files. Write a set of Linux commands to:

i) List all files in the project/ directory along with their current permissions
ii) Identify files that have execute permission for others
iii) Remove execute permission for others from all such files
iv) Give read and write permission only to the owner for a file named report.txt

[0.5 x 4 = 2 Marks]

Q4 a) Define a Process and identify the four essential components that constitute a Process Image. [2 Marks]

b) Compare and contrast Processes and Threads.

[2 Marks]

c) Draw a block diagram of the Seven-State Process Model. Your diagram must clearly show the following states and the transitions between them: *Running, Ready, Blocked, Ready/Suspend,* and *Blocked/Suspend.*

[2 Marks]

d) i) A single-threaded application is redesigned to be multi-threaded. If 70% of the application is inherently serial and 30% can be parallelized, calculate the theoretical Speedup (S) on a quad-core (N=4) processor using Amdahl's Law.
ii) In a system using User-Level Threads (ULTs), if one thread executes a blocking I/O system call, what happens to the other threads within the same process? Briefly explain why.

[2 Marks]

e) i) List the three main categories of information stored in a Process Control Block (PCB).
ii) Provide the step-by-step sequence (4–5 points) of the execution of a Process Switch. Ensure you mention the role of the Program Counter (PC) and the Process Image.

[2 Marks]