BG/K/TY

Reg. No: 24MICO115

VIT
Vellore Institute of Technology

Final Assessment Test – November 2025

Course: CSI1002 - Operating System Principles
Class NBR(s): 2450/2453/2456/2458 Slot: E1
Time: Three Hours Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Gain extensive knowledge on principles and modules of operating systems.
CO2	Interpret the evolution of OS functionality, structures, layers and different system calls to find the stages of various process states.
CO3	Design a model scheduling algorithm to compute various scheduling criteria.
CO4	Apply and analyze communication between inter process and synchronization techniques.
CO5	Implement page replacement algorithms, memory management and to apply the file system techniques.
CO6	Representing virtualization and demonstrating the various Operating system tasks and the principle algorithms for enumerating those tasks.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. Discuss the various services provided by an operating system to programs and the users, and explain how the system switches between user mode and kernel mode when a process requests access to a protected resource in detail with necessary diagrams. **CO1 BL1**

2. Consider an operating system where multiple processes execute concurrently. A parent process creates several child processes to perform different tasks, and some of these child processes terminate after completing their execution. Explain the mechanisms provided by the operating system for process creation and termination in this scenario. Discuss how the system ensures proper management of process resources during creation and deletion in detail with all the creation and termination cases. **CO2 BL2**

3. Consider a system where eight processes are scheduled using the Multilevel Feedback Queue scheduling algorithm with four queues — Q1 (Round Robin, Time Quantum = 4 ms), Q2 (Round Robin, Time Quantum = 8 ms), Q3 (Round Robin, Time Quantum = 16 ms), and Q4 (First Come First Serve). Each process enters Q1 upon its arrival, and if it utilizes its entire time quantum without completing execution, it is moved to the next lower queue. The CPU remains idle (P_{idle}) if no process allocated. Draw the Gantt chart **CO3 BL3**

representing process execution across queues. Compute the Turnaround Time and Waiting Time for each process. Find the Average Turnaround Time, Average Waiting Time, and CPU Utilization.

The details of the processes are as follows:

Process	Arrival Time (ms)	Burst Time (ms)
P1	2	7
P2	4	10
P3	6	12
P4	10	9
P5	13	5
P6	15	8
P7	18	6
P8	22	10

4. Consider a shared database that can be accessed concurrently by the multiple processes. Some processes only read the data (readers), while others can modify the data (writers). Multiple readers can access the database simultaneously, but writers require exclusive access. Suppose there are several readers and writers arriving at different times. Analyse how the operating system ensures proper synchronization in this scenario, and illustrate the process using manual iteration for all cases: when a reader arrives while no writer is active, when a reader arrives while a writer is writing, when a writer arrives while readers are reading, when multiple readers arrives and when multiple writers arrive. Discuss the need of process synchronization for this scenario and give the appropriate solution using semaphores. **CO4 BL2**

5. What is paging and give its importance. Consider a system with shared pages that supports with 54 users of which 45 users work on a word editor and the remaining users work on an image editor tool. The code (reentrant code) of the word editor occupies 140KB and that of image editor occupies 185 KB. The users of word editor need 80 KB data space each and the users of the image editor needs 90KB of data space each. How much of memory (in KB) is needed in total when the code is shared and when not shared? Give the percentage of reduction in space. **CO5 BL4**

6. Describe the structure of the page table in virtual memory systems. Discuss the different techniques used to organize the page tables, including hierarchical paging, hashed page tables, and inverted page tables. Mention the advantages and disadvantages of each method and the scenarios where they are most effective. **CO6 BL2**

7. Consider the page reference string 7, 8, 2, 1, 7, 8, 5, 7, 8, 2, 1, 5 and a system with 3 and 4 page frames. Apply the FIFO and LRU page replacement algorithms to this reference string. For each algorithm, illustrate the page replacement process, indicate which pages are replaced at each step, and calculate the total number of page faults, the hit ratio, and the miss ratio. **CO5 BL3**

8. A disk drive has 200 tracks numbered 0 to 199, and the disk head is currently positioned at track 50. The disk request queue contains the following track requests in order: 82, 170, 43, 140, 24, 16, 190. Each track-to-track movement takes 2ms. For each of the following four disk scheduling algorithms, draw the disk map showing the head movement pattern, calculate the sequence of track access, total head movement (in tracks), and the average seek time (in milliseconds): (a) FCFS (First-Come, First-Served), (b) SSTF (Shortest Seek Time First), (c) SCAN (assume head initially moving towards higher track numbers), and (d) LOOK (assume head initially moving towards higher track numbers). After solving all algorithms, identify and justify which algorithm provides the best performance in terms of minimum average seek time for this particular request sequence. **CO6 BL3**

9.a) i. What is Convoy Effect in FCFS? Calculate the average waiting time and Turnaround time of the processes given below. Change the arrival time of process P2, P3 at 0 and P1 at 1. Compare and show the impact of Convoy effect with respect to the average waiting time and turnaround time of the processes before and after modification. **[6] CO3 BL4**

Process	Arrival Time	Burst time(ms)
P1	0	28
P2	1	3
P3	1	1

ii. Given a system using shortest-job first algorithm for short-term scheduling and exponential averaging with $= 0.5$, what would be the next three expected burst time for a process with burst time of 6, 7, 4 and 5 and initial value for $\tau_0 = 11$? **[4]**

OR

9.b) Consider the following snapshot of a system: **CO3 BL4**

	Allocation			Max		
	A	B	C	A	B	C
P0	0	0	2	0	0	4
P1	1	0	0	2	0	1
P2	1	3	5	1	3	7
P3	6	3	2	8	4	2
P4	1	4	3	1	5	7

i. Using the banker's algorithm, determine whether the given state (Available = (1, 0, 2)) is safe or not. If the state is safe, illustrate the order in which the processes may complete. Otherwise, illustrate why the state is unsafe. [6]

ii. If a request from process P2 arrives for (0 0 2) can the request be granted immediately? Illustrate with iterations. [4]

10.a) Consider the structure of directories in a file system, where a directory acts as a symbol table mapping file names to their corresponding file control blocks. Discuss the different logical organizations of the directories, including single-level directories, two-level directories, and tree-structured directories. Explain how each structure handles insertion, deletion, searching for a named entry, and listing all entries, and show the advantages and disadvantages of each approach. CO6 BL2

OR

10.b) What is thrashing in an operating system? Explain how it affects system performance and describe the Working Set Model and the Page-Fault Frequency (PFF) Scheme methods used to avoid thrashing in detail. CO6 BL2

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