



VIT

Vellore Institute of Technology
(Deemed to be University under Section 3 of U.C. Act, 1956)

REG.NO.:

SLOT: A1 +TA1

SCHOOL OF COMPUTER SCIENCE ENGINEERING AND INFORMATION SYSTEMS
CONTINUOUS ASSESSMENT TEST - II
FALL SEMESTER 2026-2027

Session: III [2PM to 3.30PM]

Programme Name & Branch : B.Tech CSE (Cyber Security & Artificial Intelligence and Data Engineering)
Course Code and Course Name : BCSE303L - Operating System
Faculty Name(s) : Dr.Porkodi S, Dr. Balasubramani M, Dr. Karpagam S
Class Number(s) : VL2026270103586, 2580, 2576
Date of Examination : 27 Sep 2026
Exam Duration : 90 minutes
Maximum Marks: 50

General instruction(s):

- Answer All Questions
- M - Max mark; CO - Course Outcome; BL - Blooms Taxonomy Level (1 - Remember, 2 - Understand, 3 - Apply, 4 - Analyse, 5 - Evaluate, 6 - Create)

Course Outcomes

CO 3: Apply and analyze communication between inter process and synchronization techniques.

CO 4: Implement page replacement algorithms, memory management problems and segmentation.

Q. No	Question	M	CO	BL																		
1.	A cloud service provider uses a centralized resource manager to dynamically allocate hardware resources across five running microservices (P_0, P_1, P_2, P_3, P_4). The cluster manages four distinct hardware resources: • Resource A: CPU Cores (10 instances) • Resource B: RAM Units (8 instances) • Resource C: NVMe SSD Drives (7 instances) • Resource D: Network Interface Cards (6 instances) The current Allocation and Maximum Need Matrix are given below: <table><tr><th>Process</th><th>Allocation (A B C D)</th><th>Max Claim (A B C D)</th></tr><tr><td>P_0</td><td>0 1 1 0</td><td>2 3 2 1</td></tr><tr><td>P_1</td><td>1 2 1 1</td><td>3 4 2 2</td></tr><tr><td>P_2</td><td>2 0 0 1</td><td>5 2 1 2</td></tr><tr><td>P_3</td><td>0 1 1 2</td><td>2 2 2 3</td></tr><tr><td>P_4</td><td>1 1 0 0</td><td>3 2 1 1</td></tr></table> Answer the following a) Calculate the Need Matrix for all processes and determine the currently Available resource vector. (2 Marks)	Process	Allocation (A B C D)	Max Claim (A B C D)	P_0	0 1 1 0	2 3 2 1	P_1	1 2 1 1	3 4 2 2	P_2	2 0 0 1	5 2 1 2	P_3	0 1 1 2	2 2 2 3	P_4	1 1 0 0	3 2 1 1	10	3	3
Process	Allocation (A B C D)	Max Claim (A B C D)																				
P_0	0 1 1 0	2 3 2 1																				
P_1	1 2 1 1	3 4 2 2																				
P_2	2 0 0 1	5 2 1 2																				
P_3	0 1 1 2	2 2 2 3																				
P_4	1 1 0 0	3 2 1 1																				



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2.	b) Verify if the current system is in a Safe State using Banker's Algorithm. If yes, state a valid Safe Sequence. (4 marks) c) Process P_3 submits an immediate resource request: $Request_3 = (1,0,0,1)$. Can this request be granted immediately? Justify your answer step-by-step. (4 marks)	7		
3.	In the augmented-reality dual game Neon Cyber-Paddle, two players—Player 0 (p_0) and Player 1 (p_1)—compete on a digital court with a single shared Quantum Energy Ball. Game Rules & Constraints i. Ball Control: Only one player can charge and strike the Quantum Energy Ball at any instant. Simultaneous access causes a memory buffer collision, crashing the game engine. ii. Turn-Taking Mechanics: Each player alternates striking the ball back to their opponent. Answer the following: a) Write the complete pseudocode for Player 0 (p_0) and Player 1 (p_1) using Peterson's Algorithm and Binary Semaphore to ensure synchronized control over the Quantum Energy Ball. Clearly state all shared variables and their initial values. (7 marks) b) Analyze your solution and justify how it satisfies the three conditions of the Critical Section problem. (3 marks)	10	3	3
	A smart logistics facility operates a fleet of N Autonomous Delivery Drones ($D_1, D_2, \dots, D_N$) that continuously transport packages across a warehouse. The facility has a central charging station with K identical ultra-fast charging pads, where $N > K > 1$ (for instance, 15 drones competing for 4 charging pads). The system operates under the following operational rules: i. Pad Availability: Up to K drones can charge simultaneously. If all K pads are occupied, any arriving drone must wait until a pad becomes free.	10	3	3

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	ii. Global Analytics Counter: When a drone finishes charging, it must update a shared global variable "total_drones_charged" by incrementing it by 1 before leaving the station. Multiple drones must not modify this counter at the same time to prevent race conditions. Answer the following: a) Identify whether a Binary Semaphore, a Counting Semaphore, or a combination of both should be used for this system. Clearly justify your choice for each synchronization task. (3 marks) b) Write the pseudocode for the Drone (int drone_id) process using standard semaphore operations (wait() and signal()). Declare all shared variables and semaphores along with their required initial values. (7 marks)			
4.	a) Consider a memory management system using variable partitioning. The memory currently has five free partition blocks available in the following sequential order: (6 marks) 100 KB, 500 KB, 200 KB, 300 KB, and 600 KB Four processes P_1, P_2, P_3, and P_4 request memory sequentially as follows: P_1: 212 KB P_2: 417 KB P_3: 112 KB P_4: 426 KB Which of the dynamic memory allocation strategies (First Fit, Best Fit, and Worst Fit) can successfully satisfy all four requests? For strategies that fail, identify which process cannot be allocated memory.	10	4	3



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b)

(4 marks)

Process	CPU Logical Address	Base Register (MMU)	Target Physical Address in RAM	Stored Data
Bot Alpha (P_1)	0x0400	0x08000	?	\$150.00
Bot Beta (P_2)	0x0400	0x14000	?	\$2,800.0

- Calculate and fill the target physical address in RAM using the values given in the above table.
- Scenario:** Suppose the MMU enforces a **Limit Register** of 0x7FFF (32 KB) for Bot Alpha (P_1).
Problem: If Bot Alpha attempts to execute a buggy pointer operation that accesses Logical Address 0x8500, calculate whether the MMU allows the operation. If denied, name the error event generated.

5. Consider a main memory system with 3-page frames allocated to a process. The process generates the following page reference string:

1, 2, 3, 4, 5, 3, 4, 1, 6, 7, 8, 7, 8, 9, 7, 8, 9, 5, 4, 5, 4, 2

Assume all frames are initially empty.

a) Calculate the total number of **Page Faults** using: (7.5 marks)

i. First-In, First-Out (FIFO)

ii. Least Recently Used (LRU) 9, 13

iii. Optimal (OPT)

b) Calculate the **Hit Ratio** for the Optimal algorithm. (2.5 marks) 40.9

10

4

3