Reg. No:

VIT
Vellore Institute of Technology

Final Assessment Test – November 2026

Course: **BCSE303L - Operating Systems**
Class NBR(s): **1132, 2577, 2581**
Time: **3 Hours**
Slot: **A2+TA2**
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

General Instruction

Course Outcomes:

CO1: Interpret the evolution of OS functionality, structures, layers and apply various types of system calls of various process states
CO2: Design scheduling algorithms to compute and compare various scheduling criteria
CO3: Apply and analyze communication between inter process and synchronization techniques.
CO4: Implement page replacement algorithms, memory management problems and segmentation
CO5: Differentiate the file systems for applying different allocation, access technique, representing virtualization and providing protection and security in OS

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

PART-A (10 X 10 = 100 Marks)

Answer all Question(s)

Q1. A smart city deploys millions of IoT sensors that continuously generate data. During peak traffic hours, critical emergency services experience delays due to resource contention. Explain how operating-system abstractions (processes, resources, protection domains and scheduling) influence system behavior. **10M CO1 BL2**

Q2. A cloud provider hosts a machine-learning service where each task consists of hundreds of lightweight computations. The current process-based implementation results in excessive context switching. Compare user-level, kernel-level, and hybrid threading models. **10M CO1 BL2**

Q3. A hospital's emergency response system handles life-critical requests, patient record updates, and administrative workloads. Delayed execution of life-critical tasks can lead to severe consequences. Design a CPU scheduling framework using appropriate scheduling algorithms. Evaluate performance using turnaround time, waiting time, response time, fairness and starvation prevention for the following execution scenario. **10M CO2 BL3**

Process	Type	Burst Time (ms)	Arrival time (ms)
P1	Admin	12	0
P2	Medical	8	1
P3	Critical	4	2
P4	Medical	6	3

Q4. A computer system has five processes competing for three types of resources. The operating system detects that some processes are waiting indefinitely for resources held by other processes.
Analyze the situation and answer the following:

a) Explain how a Resource Allocation Graph can be used to identify the possibility of deadlock. (2 Marks)
b) Differentiate deadlock prevention and deadlock avoidance with suitable examples. (3 Marks)
c) Recommend a suitable deadlock detection and recovery mechanism for this system, justifying your choice. (3 Marks)
d) Explain how the Banker's algorithm helps avoid unsafe resource allocation. (2 Marks)

10M CO2 BL3

Q5. A bounded buffer has 5 slots. Initially: mutex = 1, empty = 5, and full = 0. Three producer operations and two consumer operations occur in the following sequence: P1 → P2 → C1 → P3 → C2. For each operation: Show the updated values of mutex, empty and full, Draw the synchronization timeline and Determine the final semaphore values.

10M CO3 BL3

Q6. A railway reservation system receives thousands of simultaneous booking requests for the same train. Explain how semaphores, monitors or locks synchronization mechanisms can prevent data inconsistency.

10M CO3 BL2

Q7. A 64-bit computer system uses virtual memory with the following specifications:

10M CO4 BL2

• Virtual address space = 2^{36} bytes • Physical memory = 2^{32} bytes • Page size = 8 KB • TLB access time = 10 ns • Main memory access time = 100 ns·	• Cache access time = 5 ns • TLB hit ratio = 95% • Cache hit ratio = 90% • Demand paging is enabled • A page fault service takes 8 ms

During execution, a process generates **2,000,000 memory references** and **0.01%** of them cause page faults. Determine **the number of bits required** for Virtual page number, Page offset and Physical frame number, the **Effective Memory Access Time (EMAT)** considering cache and TLB, the **total number of page faults** generated and **the average memory access time** including page-fault overhead.

Q8. A multimedia application uses both segmentation and paging. The logical address space consists of the following segments:

10M CO4 BL3

Segment	Size (KB)
Code	300
Data	180
Stack	100
Video Buffer	700

The system uses:

- Page size = 4 KB and Physical memory = 256 frames
- Initially only the first page of each segment is loaded into memory using demand paging.
- While executing, the application references the following pages: **Code**: 10, 12, 18 **Data:** 5, 20 **Stack:** 8 **Video Buffe**r: 50, 80, 120. Assume all referenced pages are not currently present in memory.

Determine **the total number of pages required** for each segment and the complete application, Construct the **segment table** showing Segment number, Length and Number of pages, Identify the **page faults generated** by the given reference sequence and Calculate the **total page-fault service time,** if each page fault requires Disk seek time = 6 ms, Rotation latency = 2 ms and Transfer time = 1 ms.

Q9. a) A cloud service provider plans to consolidate 120 physical servers into a virtualized infrastructure. Each physical server currently runs one application and has CPU Utilization = 20%, Memory Usage = 8 GB, Server Cost = ₹1,20,000 and Annual Maintenance Cost = 10% of server cost.The provider decides to use a Type-1 Hypervisor and virtual machines. After virtualization Each host server can support 12 virtual machines; Virtualization overhead consumes 8% of CPU resources;Ten high-performance host servers are required, each costing ₹6,00,000: Annual maintenance remains 10% of purchase cost. Calculate the **total hardware cost**, the **annual maintenance cost before and after virtualization**, Determine the **percentage reduction in the number of physical servers** and Compute the **effective CPU utilization** available to virtual machines after accounting for virtualization overhead. **10M CO5 BL3**

(OR)

b) A multinational video-streaming company stores multimedia files in a Distributed File System (DFS) spread across three geographically separated data centers.The system uses Hierarchical directory structure. Indexed file allocation, Journaling for metadata updates and Log-Structured File System (LFS) for efficient writes. During a major power failure:Data Center A crashes unexpectedly; Several file write operations are interrupted; The journal contains committed and uncommitted transactions; Some client requests are redirected to Data Centers B and C; Users continue requesting video files during recovery. **10M CO5 BL3**

a) Explain how the Distributed File System maintains file accessibility despite the failure of Data Center A. (2.5 marks)

b) Analyze how journaling helps recover the file system after the crash. (2.5 marks)

c) Compare the role of Journaling, Soft Updates, and Log-Structured File Systems in maintaining file-system consistency. (2.5 marks)

d) Evaluate the suitability of indexed file allocation for storing large multimedia files in this scenario. (2.5 marks)

Q10. a) A smart-city transportation control center stores real-time traffic data on a magnetic disk having **5000 cylinders (0–4999)**. During peak hours, the disk receives the following request queue: **98, 183, 37, 122, 14, 124, 65, 67, 199, 250.** The initial disk head position is **53** and the head is moving towards higher-numbered cylinders. Additional disk parameters are as follows. Average seek time = **0.1 ms per cylinder;** Rotational speed = **7200 RPM;** Average rotational latency = half rotation; Transfer time per request = **0.05 ms.** The operating system must support real-time traffic updates with minimum delay. Compute **the total head movement, the total seek time and the total service time** (Seek Time + Rotational Latency + Transfer Time) using FCFS, SSTF and SCAN. Also justify the scheduling algorithm which is most suitable for this real-time transportation system considering throughput, fairness, starvation, and response time. **10M CO5 BL3**

(OR)

b) The OS security team plans to redesign the protection framework due to the security threats in a mobile banking application. Answer the following by considering the above scenario.

a) Differentiate between **authentication** and **access control** and explain their role in preventing banking fraud.for each algorithms (2.5 marks)

b) Design an Access Matrix for the following **entities**: Customer; Bank Employee; Security Auditor and **Objects**: Account Records: Transaction Logs; User Credentials.for each algorithms (2.5 marks) **10M** **CO5** **BL3**

c) Convert the Access Matrix into a Capability-Based System and explain how capabilities improve security.for each algorithms (2.5 marks)

d) Distinguish between **security policy** and **security mechanism** with suitable examples from the banking application.for each algorithms (2.5 marks)

⇔⇔⇔⇔⇔⇔