Reg. No:

VIT
Vellore Institute of Technology

Final Assessment Test – November 2026

Course: **BCSE303L - Operating Systems**

Class NBR(s): **2576, 2580, 3586** Slot: **A1+TA1**

Time: **3 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

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.	An operating system architecture attempts to reduce the amount of functionality executing in privileged mode by retaining only essential mechanisms such as low-level memory management, inter-process communication, and basic scheduling within the kernel. Other services are implemented outside the kernel and communicate with it through well-defined interfaces. a) Explain the major functionalities provided by an operating system. **(5 marks)** b) Identify and explain the OS structuring model that most appropriately describes the architecture described above. **(5 marks)**	**10M**	**CO1**	**BL2**
Q2.	A university server is running several applications simultaneously. A student starts a new program from the terminal while two other processes are already waiting for CPU time. a) Describe the purpose of the Ready List and the information maintained for a process using the Process Control Block (PCB). **(5 marks)** b) Illustrate the different states of a process and describe the transitions between these states during its execution. **(5 marks)**	**10M**	**CO1**	**BL3**
Q3.	A cloud-based server manages multiple processes that arrive at different times for execution. The operating system uses CPU scheduling algorithms to allocate processor time to these processes. The arrival time and CPU burst time of each process are given below.			

Process	Arrival Time	Burst Time
P1	1	8
P2	2	4
P3	2	2
P4	3	1
P5	5	3

10M CO2 BL3

a) Draw the Gantt chart using SRTF scheduling. **(2 Marks)**

b) Draw the Gantt chart using Round Robin scheduling with a time quantum (Q) = 3 units. **(2 Marks)**

c) Using SRTF scheduling, calculate the Completion Time (CT), Turnaround Time (TAT), and Waiting Time (WT) for each process. Also, calculate the average waiting time and average turnaround time. **(6 Marks)**

Q4. A system manages five processes, P0, P1, P2, P3, and P4, that compete for three types of resources: CPU units (C), Memory blocks (M), and I/O channels (I). The system has 10 instances of C, 5 instances of M, and 7 instances of I. At time t_0, the following snapshot of the system is recorded: **10M CO2 BL3**

Process	Allocation (C M I)	Maximum (C M I)
P0	0 1 0	7 5 3
P1	2 0 0	3 2 2
P2	3 0 2	9 0 2
P3	2 1 1	4 2 2
P4	0 0 2	5 3 3

a) Calculate the Need matrix for all five processes. **(2 Marks)**

b) Using Banker's Algorithm, determine whether the system is currently in a safe state. If it is safe, provide a possible safe sequence. **(4 Marks)**

c) Subsequently, process P2 makes a resource request of (1, 0, 1) for resources C, M, and I. Determine whether this request can be immediately allocated. Justify your answer using the Banker's Algorithm resource-request procedure. **(4 Marks)**

Q5. A shared online examination database is accessed concurrently by multiple student applications. Several applications may read the database simultaneously, but when an application updates the database, the writer must have exclusive access. Consider the following sequence of reader and writer requests and completions: R1 arrives → R2 arrives → W1 arrives → R3 arrives → R4 arrives → W2 arrives → R5 arrives. Assume the following synchronization variables are initially set to: read_count = 0, mutex = 1, rw_mutex = 1 **10M CO3 BL2**

a) Using the readers-preference solution to the Readers-Writers problem, trace the execution and calculate the value/state of: read_count, mutex, rw_mutex, status **(5 marks)**

b) Repeat the trace using the writers-preference solution and calculate the value/state of: read_count, mutex, rw_mutex, status **(5 marks)**

Q6. **a)** A print server has a single shared printer queue accessed concurrently by multiple processes. Only one process should update the queue at a time. The system provides hardware synchronization primitives to implement mutual exclusion.

a) Using the Test-and-Set instruction, write pseudocode for a spinlock that allows a process to enter the critical section and update the printer queue safely. **(5 Marks)**
b) Using the Compare-and-Swap (CAS) instruction, write pseudocode to implement the same mutual exclusion mechanism. **(5 Marks)**

10M CO3 BL3

(OR)

b) Five autonomous maintenance robots R1–R5 share five tools T1–T5 arranged in a circle. Each robot requires two adjacent tools to perform maintenance. Each tool is protected by a binary semaphore initialized to 1. The required tools are:

10M CO3 BL3

Robot	Tools
R1	T1, T2
R2	T2, T3
R3	T3, T4
R4	T4, T5
R5	T5, T1

a) Write semaphore-based pseudocode for acquiring and releasing the two tools. **(3 Marks)**
b) If R1–R5 each acquire their first tool simultaneously, determine whether a deadlock occurs. Justify your answer. **(3 Marks)**
c) Modify the semaphore solution to prevent deadlock. **(4 Marks)**

Q7. a) A process P1 is allocated a contiguous memory region using the base and limit register scheme. The MMU uses the following values: Base register = 300040, Limit register = 120900. The process generates the following logical addresses: (i)12000, (ii) 120900, (iii) 125000. For each logical address, determine whether it is valid or invalid. For every valid logical address, calculate the corresponding physical address. **(5 Marks)**

10M CO4 BL3

b) A system has a logical address space of 16 KB and a page size of 4 KB. Find: Number of pages, Number of bits in the logical address, Number of bits for page number, Number of bits for offset **(5 Marks)**

Q8. a) A system uses a Translation Lookaside Buffer (TLB) to improve memory access performance. The system has the following characteristics: TLB access time = 15 ns, Main memory access time = 80 ns, TLB hit ratio = 90%. For a memory reference: Calculate the access time for a TLB hit. Calculate the access time for a TLB miss, assuming that one memory access is required to obtain the pagetable entry and another to access the required data. Calculate the Effective Access Time (EAT). **(5 Marks)**

10M CO4 BL4

b) A system designer is deciding between paging and segmentation for memory management. Compare paging and segmentation. Explain why paging may suffer from internal fragmentation, whereas segmentation may suffer from external fragmentation. A programmer wants to logically separate a program into code, data, stack, and shared libraries. Explain which memory-management technique is more suitable and justify your answer. **(5 Marks)**

Q9. A video-editing system uses a disk containing 40 blocks numbered 0–39. An 8-block video file must be stored. The currently free blocks are: 2, 5, 7, 8, 12, 14, 15, 18, 21, 22, 25, 27, 30, 31, 34, 36, 37, 39.

a) Demonstrate how the 8-block video file can be allocated using Contiguous, Linked, and Indexed Allocation methods. Show the allocated blocks, block-pointer chain, and index block, wherever applicable. **(8 marks)**
b) Compare the storage overhead of the three allocation methods. **(2 marks)**

10M **CO5** **BL3**

Q10. a) A video server receives disk I/O requests from multiple applications. The disk has 200 cylinders numbered 0–199, and the disk head is initially at 53. The pending requests are: 98, 183, 37, 122, 14, 65, 67, 190. Assume the disk head is initially moving toward higher-numbered cylinders. Using the following disk scheduling algorithms: FCFS, SSTF, SCAN. For each algorithm, determine the order in which the requests are serviced and calculate the total head movement.

10M **CO5** **BL3**

(OR)

b) An autonomous railway control system consists of several processes responsible for train monitoring, signal control, track switching, and maintenance diagnostics. Each process must access only the resources required for its operation. The system contains the following resources: Train Sensors, Signal Controller, Track Switch, Diagnostic Logs.
a) Construct an Access Matrix for the four processes and resources, assigning appropriate rights such as Read (R), Write (W), and Control (C). **(3 marks)**
b) A Track-Switching process attempts to modify the Signal Controller. Using the access matrix, determine whether the operation should be permitted and justify your answer. **(2 marks)**
c) Represent the access rights of the Maintenance Diagnostic process using a Capability List and explain how a Capability-Based System can restrict a compromised process from accessing resources for which it has no capability. **(5 marks)**

10M **CO5** **BL3**

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