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Reg. No: 24BB[redacted]

Final Assessment Test – November 2025

VIT Vellore Institute of Technology

Course: **CBS1006 - Principles of Operating Systems**

Class NBR(s): **3273**

Slot: **C1**

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	Describe the various OS functionalities, structures and layers.
CO2	Usage of system calls related to OS management and interpreting different stages of various process states.
CO3	Design CPU scheduling algorithms to meet and validate the scheduling criteria.
CO4	Apply and explore the communication between inter process and synchronization techniques.
CO5	Implement memory placement strategies, replacement algorithms related to main and virtual memory techniques.
CO6	Differentiate the file systems for applying various file allocation and access techniques.
CO7	Representing virtualization concepts and designing of OS with protection and security enabled capabilities.

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. a) Explain the various services offered by an operating system that make it easier and more convenient for users to interact with the computer system. Also, discuss the situations in which it would be impossible for user-level programs to provide these services. **[6] CO1 BL2**

   b) Classify the various types of system calls used in operating systems and explain how the transition occurs between user mode and kernel mode. **[4]**

2. Consider the given following table for 5 processes: **CO3 BL3**

Process	Arrival Time(ms)	Burst time(ms)
P1	0	6
P2	2	4
P3	4	2
P4	5	8
P5	6	3

   a) Draw three Gantt charts that illustrate the execution of these processes using the following scheduling algorithms: FCFS, SJF Preemptive and Round Robin (Quantum =3). **[4]**

   b) What is the average waiting time and average turnaround time of each process for each of the scheduling algorithms in part a? **[4]**

   c) Based on your results, determine which algorithm yields the lowest average waiting time across all processes. Justify your answer with reference to your computed values and discuss why this algorithm performs best in this scenario. **[2]**

3. A system uses variable partition contiguous memory allocation. Free memory blocks are: 100 KB, 500 KB, 200 KB, 300 KB, 600 KB. **CO5 BL3**

Processes arrive in the order: P1 = 212 KB, P2 = 417 KB, P3 = 112 KB, P4 = 426 KB.

a) Allocate memory using First-Fit, Best-Fit and Worst-Fit algorithms. **[6]**
b) Calculate external fragmentation after allocation and justify which allocation policy minimizes fragmentation in this scenario. **[4]**

4. Consider the page reference string: **CO5 BL3**

3,5,2,1,0,8,6,7,3,6,8,4,6,0,1

Calculate the number of page faults that occur using FIFO, LRU and Optimal page replacement policies.

a) If the frame size is 3 **[4]**
b) If the frame size is 4 **[4]**
c) Identify the maximum and minimum number of page faults and corresponding hit/miss ratios among the three policies and justify a scenario illustrating Belady's Anomaly. **[2]**

5. A computer system has a CPU with a clock cycle of 10 ns and memory with a cycle time of 100 ns. A peripheral device can transfer 1 KB of data per I/O operation using Direct Memory Access (DMA) and the DMA controller transfers data at a rate of 10 MB/s. The CPU can perform other operations concurrently while DMA is active but must pause during memory access contention. **CO7 BL3**

a) Explain the working of DMA, including how it transfers data between the I/O device and memory without CPU intervention. **[6]**
b) Calculate the following: **[4]**
   i) The time taken to transfer 1 KB of data using DMA, and
   ii) the number of CPU cycles lost if the CPU must pause for memory access during the transfer and also compare the efficiency of DMA versus programmed I/O.

6. Suppose that a disk drive has 2000 cylinders, numbered 0 to 1999. The head is at cylinder 540, and the previous request was at 400. **CO7 BL4**

The queue of requests in order is:

150, 850, 40, 1300, 700, 950, 1025, 90, 200, 1600.

Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests for each of the following disk scheduling algorithms?

a) FCFS **[2]**
b) SSTF **[2]**
c) SCAN (head moving towards higher cylinders) **[2]**
d) LOOK **[2]**
e) C-LOOK **[2]**

Also, identify which algorithm gives the minimum average seek time.

7. Explain the structure of the UNIX file system with a neat diagram. Describe the role of each component such as boot block, super block, inode table and data blocks. How does the file system manage file access and storage efficiency? Illustrate with an example of how a file is located using its inode number. **CO2 BL2**

8. Consider a system with 5 processes (P1, P2, P3, P4 and P5) and 4 resource types (A, B, C and D). Given Allocation and Maximum matrices, test multiple requests from processes and decide if they can be safely granted. **CO4 BL4**

	Allocation				Max				Available			
	A	B	C	D	A	B	C	D	A	B	C	D
P1	3	0	1	4	5	1	1	7	0	3	0	1
P2	2	2	1	0	3	2	1	1				
P3	3	1	2	1	3	3	2	1				
P4	0	5	1	0	4	6	1	2				
P5	4	2	1	2	6	3	2	5				

Apply the Banker's Algorithm and determine the following:

a) Check whether the system is in a safe state now. Display the sequence of processes and work vectors utilized to confirm this. **[6]**

b) Suppose process P2 requests the resources [3, 1, 0, 2]. Check whether this request can be granted by verifying two conditions: **[4]**

- The request is less than or equal to the process's remaining needs.
- The request is less than or equal to the currently available resources.

9.a) A barber shop has 2 barbers and 6 waiting chairs. Customers arrive simultaneously in groups. **CO4 BL3**

i) Explain how the problem can be extended for multiple barbers and Illustrate with a process synchronization diagram using semaphores or monitors. **[6]**

ii) Discuss how race conditions are avoided when multiple barbers serve customers concurrently and write a pseudo-code for the Barber's Shop Problem. **[4]**

OR

9.b) Assume in an online shopping system, two processes, User1 and User2, simultaneously attempt to add ₹1000 and ₹2000 worth of funds to a shared wallet_balance. Both processes try to update the wallet balance at the same time. **CO4 BL3**

i) Define a critical section and explain why it is required in this scenario and provide an example illustrating how a race condition could occur when both users update the balance concurrently. **[6]**

ii) Suggest a hardware-based solution (such as Test and Set or Swap instruction) to prevent the race condition. **[4]**

10.a) A disk has 50 blocks, with free blocks at: **CO6 BL3**

5, 7, 10, 12, 15, 18, 20, 25, 30, 35.

i) Represent the free space using bit vector and linked list and if a new file requires 6 blocks, allocate the blocks and update both structures. **[5]**

ii) Assume if the directory contains files F1, F2, F3 show linear list and hash table representation after adding the new file. Comment on the efficiency of searching and allocation using these methods. **[5]**

OR

10.b) A file of size 6 disk blocks needs to be stored on a system. The available free disk blocks are numbered as follows: **CO6 BL3**

2, 4, 6, 8, 10, 12, 14, 16.

i) Show how the file is stored in consecutive blocks and identify the starting block and range of blocks allocated. Also, discuss any possible limitations or fragmentation issues in this approach. **[5]**

ii) Illustrate how the file blocks are linked together using pointers and show the logical order of access. Assume that one additional block is reserved as the index block. Show the structure of the index block and list all the data block numbers that it points. **[5]**

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