Final Assessment Test (FAT) - November/December 2023

Programme	B.Tech.	Semester	FALL SEMESTER 2023 - 24
Course Title	OPERATING SYSTEMS	Course Code	BCSE303L
Faculty Name	Prof. Vallidevi K	Slot	F1+TF1
		Class Nbr	CH2023240100694
Time	3 Hours	Max. Marks	100

PART-A (10 X 10 Marks)
Answer all questions

01. Mr.Joe was asked to design different OS for applications which use: **[10]**
    i) Embedded systems such as Consumer Electronics like Televisions and Cameras.
    ii) Mission critical systems in aerospace and defense industries
    iii) Hypervisors
    iv) Rapid Prototyping and Development techniques
    Give 2 reasons for each scenario in choosing the OS structure. Explain each structure with a diagram. (2.5 *4 =10 Marks)

02. a) You are working on a parallel programming project and need to sum up the elements of a **[10]** large array using threads for concurrent processing. The goal is to improve the performance of the summation process by dividing the work among 4 threads. Consider you have an array of 1,000 integers, and you plan to use pthreads to divide the array into segments and have each thread compute the sum of its segment. How would you divide the work among the threads to ensure efficient parallel processing? (4 Marks)
    b) Write C code for calculating the sum of the array segment for one of the pthreads, and after the threads have computed the sum of their segments, aggregate the partial sums to get the final sum of the entire array. (6 Marks)

03. Consider three processes, all arriving at time zero, with total execution time of 10, 20 and 30 **[10]** units respectively. Each process spends the first 20% of execution time doing I/O, the next 70% of time doing computation, and the last 10% of time doing I/O again. The operating system uses the shortest job first scheduling algorithm and schedules a new process either when the running process gets blocked on I/O or when the running process finishes its compute burst. Assume that all I/O operations can be overlapped as much as possible.
    Calculate the average turn around time. For what percentage does the CPU remain idle?

04. Consider a system with five processes (P0, P1, P2, P3, and P4) that uses an appropriate **[10]** Algorithm to access a shared critical section. The choosing matrix values for each process at a given point are as follows:
    P0: Choosing[0] = 1, Choosing[1] = 2, Choosing[2] = 3, Choosing[3] = 4, Choosing[4] = 0
    P1: Choosing[0] = 3, Choosing[1] = 4, Choosing[2] = 2, Choosing[3] = 1, Choosing[4] = 0
    P2: Choosing[0] = 0, Choosing[1] = 3, Choosing[2] = 2, Choosing[3] = 4, Choosing[4] = 1
    P3: Choosing[0] = 4, Choosing[1] = 1, Choosing[2] = 3, Choosing[3] = 2, Choosing[4] = 0
    P4: Choosing[0] = 2, Choosing[1] = 0, Choosing[2] = 1, Choosing[3] = 4, Choosing[4] = 3

Assuming that all processes want to access the critical section simultaneously, answer the following:

a) Show the order in which processes request entry to the critical section and exit based on their choosing matrix values. (4 Marks)

b) Explain how the choosing matrix values determine the order in which processes can enter the critical section and how the Algorithm that you chose to solve this problem ensures mutual exclusion. (3 Marks)

c) Calculate the final values of the choosing matrix for each process after all the processes have completed their access to the critical section. (3 Marks)

Provide a detailed step-by-step breakdown of the process interactions and the changes in the choosing matrix as the processes proceed to access the critical section.

05. A system uses 3 frames for storing process pages in main memory. It uses the First in First out **[10]** (FIFO) and LRU (Least Recently Used) page replacement policy. Assume that all the page frames are initially empty.

a) What is the total number of page faults will occur while processing the page reference string given- 3, 2, 1, 0, 3, 2, 4, 3, 2, 1, 0, 4 for FIFO and LRU page replacement policy? (5 Marks)

b) Find the number of page faults if the system has 4 frames, considering the same page reference string give above in the previous subdivision. Is there any anomaly that you see while increasing the page frames for FIFO and LRU? If you identify such an anomaly, explain in detail which algorithm triggered this anomaly (5 Marks)

06. Imagine that you are the lead IT architect for a multinational corporation with diverse computing **[10]** needs. The company has data centers worldwide, and your challenge is to choose the best hypervisor type for a specific scenario. Explain your choice and rationale. Your company has recently acquired a smaller firm that specializes in high-performance computing for scientific simulations. The new subsidiary operates multiple data centers with an emphasis on parallel processing and extremely low latency. Your goal is to integrate their infrastructure with the parent company's IT environment.

a) Given the nature of the subsidiary's work, where high-performance computing and minimal latency are paramount, explain why a virtualized environment is still beneficial despite the demanding requirements. (5 Marks)

b) Provide a recommendation for the type of hypervisor that is best suited for this high-performance computing scenario.

Justify your choice based on the specific requirements and constraints of the subsidiary's work and its integration with the parent company's infrastructure. (5 Marks)

07. Consider a computer system with a file system that supports file recovery. In this system, when a **[10]** file is deleted, it's moved to a temporary storage area where it can be recovered until the system reclaims the space. Assume the following scenario:

A user accidentally deletes a file named "important.doc" from their home directory.

The file "important.doc" had a size of 2 MB.

The file system uses a journaling mechanism to track file operations.

The journal contains the following information at the time of the accidental file deletion:

Timestamp : 2023-10-15 08:00

Operation : Delete

File Name : important.doc

File Size (MB) : 2

Timestamp: 2023-10-15 08:05

Operation: Create

File Name: temp_12345.tmp

Size: 2

Assuming the accidental file deletion happened during this period and that the system supports file recovery, answer the following questions:

a) Explain how the journaling mechanism and file recovery feature work together to handle the accidental deletion of "important.doc."

If the user realizes their mistake and wants to recover "important.doc," describe the steps they should follow, including the timestamp at which they should initiate the recovery process. (3 Marks)

b) Calculate the total space occupied by the recovered file "important.doc" and the temporary file "temp_12345.tmp" in the file system after the recovery process is completed. (3 Marks)

c) Discuss the advantages and potential drawbacks of using a journaling mechanism and file recovery feature in a file system. (4 Marks)

08. Suppose a medium-sized data centre is considering virtualizing its infrastructure to reduce energy consumption and hardware costs. They have 20 physical servers that they want to virtualize. Average Annual Electricity Cost per Physical Server: $800, Average Annual Maintenance Cost per Physical Server: $1,000, Cost of a Virtualization Software License: $10,000, Expected Server Lifespan: 5 years, and Server-to-VM Consolidation Ratio: 1 physical server can host 4 virtual machines (VMs).   [10]

a) What are the total cost savings annually with virtualization, taking into account the reduced electricity and maintenance costs compared to the non-virtualized scenario? (5 Marks)

b) Calculate overall cost saving through virtualization ? (5 Marks)

09. Consider two processes P1 and P2 accessing the shared variables X and Y protected by two binary semaphores S_X and S_Y respectively. Both the values are initialized to 1. P and V denote the usual semaphore operators, where P decrements the semaphore value, and V increments the semaphore value. The pseudo-code of P1 and P2 is as follows: [10]

P_1:	P_2:
While true do {	While true do {
L_1 :	L_3 : . . . . . .
L_2 :	L_4 : . . . . . .
$X = X + 1$;	$Y = Y + 1$;
$Y = Y - 1$;	$X = Y - 1$;
$V(S_X)$;	$V(S_Y)$;
$V(S_Y)$;	$V(S_X)$;
}	}

a) Check whether there is a possibility of deadlock occurring in the situation where $L1 = P(S_X)$, $L2 = P(S_Y)$. $L3=P(S_Y)$, $L4=P(S_X)$. Justify your answer that all the properties of synchronization are met (7 Marks)

b) If the values of X and Y are 5, 6 respectively, what will be the resultant values of X and Y if the execution ordering of P1 and P2 are (P1, P2) and vice versa (3 Marks).

10. a) How long does it take to load a 1MB program from a disk whose average seek time is 25 milliseconds of time, rotation time is 20 milliseconds, track size is 128 kb and page size of the program is 16kb, assume that pages of the program are stored randomly around the disk. (5   [10]

Marks)

b) Consider the disk system with 100 cylinders. The request to access the cylinders occurs in the following sequence.

4, 37, 10,7,19,73,2,15,6,20. Assume the head is currently at cylinder 50. What is the time taken to satisfy all requests if it takes 1 ms to move from one cylinder to an adjacent one and the shortest seek time first algorithm is used? (5 Marks)

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