

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION)**

CLASS: IMSc.  
BRANCH: IMSc.

SEMESTER : VI/ADD  
SESSION : SP/2025

**SUBJECT: CS303 OPERATING SYSTEM**

TIME: 3 Hours

FULL MARKS: 50

**INSTRUCTIONS:**

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

- Q.1(a) Explain the role of a medium-term scheduler and illustrate its advantages with the help of a diagram. Define system calls and analyse their usage with examples. [5] CO 1 BL 1, 4
- Q.1(b) Discuss the benefits of multithreading. Distinguish between threads and processes from the viewpoint of single-threaded and multi-threaded process models. Use pictorial representations to highlight the difference in process models. [5] CO 1, 2 BL 2, 4

- Q.2(a) Discuss convoy effect with respect to CPU scheduling with the help of an appropriate example. [5] CO 2 BL 3, 4
- Consider the following set of processes using Shortest Remaining Time First (SRTF) algorithm. Calculate the total waiting time (in ms) for process P2 and the average waiting time (in ms) for all processes in the system.

Process	Execution Time (ms)	Arrival Time (ms)
P1	20	0
P2	25	15
P3	10	30
P4	15	45

- Q.2(b) Consider the following set of processes with priorities ranging from 0 (highest) to 4 (lowest). Calculate the average waiting time (in ms) of all processes using preemptive priority scheduling algorithm. [5] CO 2 BL 3, 5

Process	Arrival Time (ms)	Burst Time (ms)	Priority
P1	0	11	2
P2	5	28	0
P3	12	2	3
P4	2	10	1
P5	9	16	4

Explain a major drawback faced by priority scheduling algorithms and suggest a potential solution to the said problem.

- Q.3(a) Identify the fundamental conditions that would inevitably lead to a deadlock in a system. Examine the different methods to recover from such a deadlock situation. [5] CO 3 BL 1, 5
- The following two processes P1 and P2 execute concurrently, having a common shared variable with initial value of B = 2.
- ```

P1() {
    C = B-1;
    B = 2*C;
}
P2() {
    D = 2*B;
    B = D-1;
}
    
```
- Analyse the execution flow to identify all possible distinct values of B and justify how each value arises.

PTO

- Q.3(b) How do semaphores address the limitations of mutex locks in process synchronization? [5] 3, 3, 5  
 Consider a non-negative counting semaphore S, where P(S) decrements S and V(S) increments S. During an execution, 20 P(S) operations and 12 V(S) operations are issued. Determine the largest initial value of S for which at least one P(S) operation will be blocked. Support your answer with proper reasoning.

An operating system uses the Banker's algorithm for deadlock avoidance to manage allocation of three resource types X, Y, and Z to processes P0, P1 and P2. The table below shows the current system state:

| Process | Allocation |   |   | Max |   |   |
|---------|------------|---|---|-----|---|---|
|         | X          | Y | Z | X   | Y | Z |
| P0      | 0          | 0 | 1 | 8   | 4 | 3 |
| P1      | 3          | 2 | 0 | 6   | 2 | 0 |
| P2      | 2          | 1 | 1 | 3   | 3 | 3 |

The system is currently in safe state and there are still 3, 2 and 2 units of type X, Y and Z available respectively. Considering the following independent requests for additional resources, determine whether both the requests can be permitted.

- Req1: P0 requests 2 units of Z  
 Req2: P1 requests 2 units of X

- Q.4(a) Compare and contrast between logical and physical address space. Explain how a logical address is mapped to a physical address in a paging system with detailed pictorial representation. Why is fragmentation a critical issue in memory management? [5] 4, 2, 6  
5

- Q.4(b) Explain pure demand paging and analyse how it can lead to performance issues such as Belady's Anomaly and thrashing. [5] 4 3, 4  
 Consider a demand paging system with four-page frames (all initially empty) using LRU replacement policy. For the following page reference string, illustrate the number of page faults and compute the page fault rate.  
 7, 2, 7, 3, 2, 5, 3, 4, 6, 7, 7, 1, 5, 6, 1  
 [Note: Page fault rate is defined as the ratio of number of page faults to the number of memory accesses].

- Q.5(a) Identify the different file access methods. Discuss the most common schemes for defining the logical structure of a directory. [5] 4 1, 2

- Q.5(b) Define transfer rate and random-access time with respect to magnetic disks. [5] 4 1, 3  
 Suppose the following disk request sequence (track numbers) for a disk with 100 tracks is given: 45, 20, 90, 10, 50, 60, 80, 25, 70. Assume that the initial position of the R/W head is on track 50. Determine the additional distance that will be traversed when the Shortest Seek Time First (SSTF) algorithm is used in comparison to the SCAN algorithm (assume that the SCAN algorithm moves towards 100 when it starts executing).