

**OPERATING SYSTEMS
(INFO 3102)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which of the following statements about synchronous and asynchronous I/O is NOT true?
- (a) An ISR is invoked on completion of I/O in synchronous I/O but not in asynchronous I/O
 - (b) In both synchronous and asynchronous I/O, an ISR (Interrupt Service Routine) is invoked after completion of the I/O
 - (c) A process making a synchronous I/O call waits until I/O is complete, but a process making an asynchronous I/O call does not wait for completion of the I/O
 - (d) In the case of synchronous I/O, the process waiting for the completion of I/O is woken up by the ISR that is invoked after the completion of I/O.
- (ii) A single processor system has three resource types X, Y and Z, which are shared by three processes. There are 5 units of each resource type. Consider the following scenario, where the column alloc denotes the number of units of each resource type allocated to each process, and the column request denotes the number of units of each resource type requested by a process in order to complete execution. Which of these processes will finish LAST?
- | | alloc | request |
|----|-------|---------|
| | X Y Z | X Y Z |
| P0 | 1 2 1 | 1 0 3 |
| P1 | 2 0 1 | 0 1 2 |
| P2 | 2 2 1 | 1 2 0 |
- (a) P0
 - (b) P1
 - (c) P2
 - (d) None of the above, since the system is in a deadlock.
- (iii) Which of the following is NOT a valid deadlock prevention scheme?
- (a) Release all resources before requesting a new resource
 - (b) Number the resources uniquely and never request a lower numbered resource than the last one requested.
 - (c) Never request a resource after releasing any resource
 - (d) Request and all required resources be allocated before execution.

- (iv) A counting semaphore was initialized to 10. Then 6 P (wait) operations and 4 V (signal) operations were completed on this semaphore. The resulting value of the semaphore is
(a) 0 (b) 8 (c) 10 (d) 12.
- (v) How many processes will run in parallel if the following code snippet executes?
for(int i=0;i<4;i++)
 fork();
(a) 4 (b) 2 (c) 16 (d) 15.
- (vi) A virtual memory system uses First In First Out (FIFO) page replacement policy and allocates a fixed number of frames to a process. Consider the following statements:
P: Increasing the number of page frames allocated to a process sometimes increases the page fault rate.
Q: Some programs do not exhibit locality of reference.
Which one of the following is TRUE?
(a) Both P and Q are true, and Q is the reason for P
(b) Both P and Q are true, but Q is not the reason for P
(c) P is false, but Q is true
(d) Both P and Q are false.
- (vii) Let $m[0] \dots m[4]$ be mutexes (binary semaphores) and $P[0] \dots P[4]$ be processes. Suppose each process $P[i]$ executes the following:
wait ($m[i]$); wait($m[(i+1) \text{ mode } 4]$);

release ($m[i]$); release ($m[(i+1) \text{ mod } 4]$);
(a) Thrashing (b) Deadlock
(c) Starvation, but not deadlock (d) None of the above.
- (viii) An operating system uses Shortest Remaining Time First (SRTF) process scheduling algorithm. Consider the arrival times and execution times for the following processes:
- | Process | Execution time | Arrival time |
|---------|----------------|--------------|
| P1 | 20 | 0 |
| P2 | 25 | 15 |
| P3 | 10 | 30 |
| P4 | 15 | 45 |
- What is the total waiting time for process P2?
(a) 5 (b) 15 (c) 40 (d) 55.
- (ix) Consider a virtual memory system with FIFO page replacement policy. For an arbitrary page access pattern, increasing the number of page frames in main memory will
(a) Always decrease the number of page faults
(b) Always increase the number of page faults
(c) Sometimes increase the number of page faults
(d) Never affect the number of page faults.

- (x) Consider the following statements about user level threads and kernel level threads. Which one of the following statement is FALSE?
- (a) Context switch time is longer for kernel level threads than for user level threads
 - (b) User level threads do not need any hardware support
 - (c) Related kernel level threads can be scheduled on different processors in a multi-processor system
 - (d) Blocking one kernel level thread blocks all related threads.

Group- B

2. (a) Compare between the concepts of time sharing system, multiprogramming system, multitasking system and multiprocessing system. [(CO1)(Remember/LOCQ)]
- (b) Compare between the concepts of monolithic kernel and microkernel. [(CO2)(Understand/LOCQ)]
- 8 + 4 = 12**
3. (a) “vfork() and wait() system calls are used for nearly same purpose but in different situations” – Justify this statement. [(CO3)(Evaluate/HOCQ)]
- (b) Draw and explain the process lifecycle including all active and suspended states. [(CO3)(Understand/LOCQ)]
- (c) State the differences between Kernel Level and User Level Threads with proper example. [(CO3)(Understand/LOCQ)]
- 3 + 6 + 3 = 12**

Group - C

4. (a) Given 3 processes A, B and C, three resources x, y and z and following events,
(i) A requests x (ii) A requests y (iii) B requests y (iv) B requests z (v) C requests z
(vi) C requests x (vii) C requests y
Assume that requested resources should always be allocated to the request process if it is available. Draw the resource allocation graph for the sequences. And also mention whether it is a deadlock? If it is a deadlock, how to recover from the deadlock. [(CO3)(Analyze/IOCQ)]
- (b) State and explain Lamport Bakery algorithm with all considerations that are to be assumed. [(CO3)(Remember/LOCQ)]
- (4 + 1 + 2) + 5 = 12**
5. (a) “FCFS scheduling cannot be pre-emptive” – Justify. [(CO3)(Evaluate/HOCQ)]
- (b) Which scheduling gets affected with “starvation”. How it can be solved? [(CO3)(Understand/LOCQ)]
- (c) Consider three processes, all arriving at time zero, with total execution time of 10, 20 and 30 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 a shortest remaining compute time 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. For what percentages of do the CPU and I/O remain idle? [(CO3)(Analyze/IOCQ)]
- 2 + (1 + 2) + 7 = 12**

Group - D

6. (a) A system uses FIFO policy for page replacement. It has 4 pages frames with no pages loaded to begin with. The system first accesses 100 distinct pages in some order and then access the same 100 pages but now in the reverse order. How many page faults will occur? [[CO4](Apply/IOCQ)]
 (b) What is Belady's anomaly? Which algorithm gets affected with this anomaly? [[CO4](Remember/LOCQ)]
 (c) With a suitable example demonstrate how Belady's anomaly affects the performance of that specific page replacement algorithm. [[CO4](Analyze/IOCQ)]
4 + (3 + 1) + 4 = 12
7. (a) A computer system implements a 40-bit virtual address, page size of 8 kilobytes, and a 128-entry translation look-aside buffer organized into 32 sets each having four ways. Assume that the TLB tag does not store any process id. Find the minimum length of the TLB tag in bits. [[CO4](Apply/IOCQ)]
 (b) State the difference between Paging and Segmentation. [[CO4](Understand/LOCQ)]
 (c) With suitable diagram explain how the concepts of paging and segmentation can be combined? [[CO4](Understand/LOCQ)]
5 + 3 + 4 = 12

Group - E

8. (a) Explain the difference between polling and interrupt driven I/O operations with suitable block diagram. [[CO5](Understand/LOCQ)]
 (b) Explain the difference between file Sequential Access and Direct Access. Which is used in which type of memory? [[CO4](Understand/LOCQ)]
8 + (3 + 1) = 12
9. (a) What is the difference between protection and security? [[CO6](Remember/LOCQ)]
 (b) "OTP is safer than conventional password" – Justify. [[CO6](Evaluate/HOCQ)]
 (c) Describe the different methodologies followed for free space management in a disk. [[CO4](Remember/LOCQ)]
3 + 3 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	50	25

Course Outcome (CO):

After the completion of the course students will be able to -

1. Analyze and differentiate between different types of operating systems (namely, batch, multi programmed, time-sharing, real-time, distributed, parallel processing system) based on their application domains and evolution.
2. Demonstrate and describe system operations, internal structure of computer system and operating system.
3. Design multiprocessing and multithreading environments based on inter-process/thread communication and synchronization.
4. Compare the different level of memory (Primary memory, cache, virtual memory, secondary storage) and how they are correlated to improve the performance of the system.
5. Demonstrate the operations of IO devices and how they are governed by the operating system.
6. Discuss the activity and impact of threat, virus, worm and how the system could be protected from them.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.