OPERATING SYSTEMS
(MCAP 1204)

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) Inter process communications can be done through
(a) Mails (b) Messages (c) System calls (d) Traps.

(ii) Which of the following disk scheduling techniques could lead to starvation of a process?
(a) SCAN (b) C-LOOK (c) SSTF (d) FCFS

(iii) In which of the following page replacement policies, Belady's anomaly occurs?
(a) FIFO (b) LRU (c) LFU (d) NRU.

(iv) Banker's algorithm with resource allocation deals with
(a) deadlock prevention (b) deadlock avoidance
(c) deadlock recovery (d) mutual exclusion

(v) If a process has 24 KB of logical address space and the page size is 4096 bytes, the number of pages in the process are
(a) 12 (b) 6 (c) 16 (d) 8

(vi) Dirty bit for a page in a page table
(a) helps avoid unnecessary writes on paging device
(b) helps maintain LRU information
(c) allows only read on a page
(d) none of (a), (b) or (c).

(vii) Which of the following registers is used to keep track of address of the memory location where the next instruction is located?
(a) Program counter (b) Instruction register
(c) Memory data register (d) Memory address register

(viii) Which one of the following is not an attack, but a search for vulnerabilities to attack?
(a) Denial of service (b) Port scanning
(c) Memory access violation (d) Dumpster diving

(ix) How many times the following C program prints MCA?

```
main()
  {
   fork();fork();printf("MCA\n");
  }
```

(a) Once (b) Twice (c) Four times (d) Eight times

(x) Which module gives control of the CPU to the process selected by the short-term scheduler?
(a) Dispatcher (b) Interrupt (c) Scheduler (d) None of (a), (b) or (c)

Group- B

2. (a) Differentiate between hard real-time operating system and soft real-time operating systems. Explain Symmetric multiprocessing (SMP).
[(CO1)(Remember/LOCQ)]

(b) Consider the following table:

Process no.	Arrival Time	Burst Time
P1	0	6
P2	2	1
P3	4	4
P4	5	3

Find the average waiting time and average turnaround time using HRRN algorithm? [(CO1)(Understand/HOCQ)]
(3 + 3) + 6 = 12

3. (a) Differentiate between preemptive and nonpreemptive scheduling.
[(CO3)(Understand/LOCQ)]

(b) Of these two types of programs: I/O-bound and CPU-bound, which is more likely to have voluntary context switches, and which is more likely to have nonvoluntary context switches? Explain your answer.
[(CO3)(Analyze/IOCQ)]

(c) Consider the following set of processes, with the length of the CPU burst time given in milliseconds:

Process	Burst time	Priority
P1	3	3
P2	2	1
P3	9	5
P4	5	2
P5	6	3

The processes are assumed to have arrived in the order P1, P2, P3, P4, P5, all at time 0.

(i) Draw four Gantt charts that illustrate the execution of these processes using the following scheduling algorithms: FCFS, SJF, nonpreemptive priority (a larger priority number implies a higher priority), and RR (quantum = 2).

(ii) What is the turnaround time and waiting time of each process for each of these scheduling algorithms? [(CO6)(Apply/IOCQ)]

2 + 2 + 8 = 12

Group - C

4. (a) Define Mutual-exclusion implementation with test_and_set() instruction. Explain with example. Write the difference between Semaphore and Monitor. [(CO2)(Remember/LOCQ)]

(b) Describe the classical Sleeping Barber Problem. Write down a solution of it using semaphore. [(CO2)(Analyze/IOCQ)]

(2 + 2 + 4) + 4 = 12

5. (a) What is critical section problem in process synchronization? What are the requirements that the solution to critical section problem must satisfy? [(CO4)(Understand/LOCQ)]

(b) What is a readers-writers problem? Write down a solution of it by using monitor. [(CO6)(Apply/IOCQ)]

4 + 8 = 12

Group - D

6. (a) Consider a system with five processes < P_0, P_1, P_2, P_3, P_4 > and three resource types A, B, C . Resource type A has 10 instances, B has 5 instances, and C has 7 instances. Suppose that at time T_0, the following snapshots of the system has been taken.

Process	***Allocation***	***Max***
	A B C	**A B C**
P_0	0 1 0	7 5 3
P_1	2 0 0	3 2 2
P_2	3 0 2	9 0 2
P_3	2 1 1	2 2 2
P_4	0 0 2	4 3 3

Test whether the system is currently in a safe-state. If so, find a sequence which satisfies a safety criteria. [(CO3)(Understand/HOCQ)]

(b) Given six memory partitions of 100 MB, 170 MB, 40 MB, 205 MB, 300 MB, and 185 MB (in order), how would the first-fit, best-fit, and worst-fit algorithms place processes of size 200 MB, 15 MB, 185 MB, 75 MB, 175 MB, and 80 MB (in order)? Indicate which, if any, requests cannot be satisfied. [(CO3)(Apply/IOCQ)]

6 + 6 = 12

7. (a) Why are segmentation and paging sometimes combined into one scheme? [(CO1)(Analyze/IOCQ)]

(b) Consider the following page reference string:
7, 2, 3, 1, 2, 5, 3, 4, 6, 7, 7, 1, 0, 5, 4, 6, 2, 3, 0, 1.
Assuming demand paging with three frames, how many page faults would occur for the following replacement algorithms?
(i) LRU replacement (ii) FIFO replacement (iii) Optimal replacement. [(CO3)(Evaluate/HOCQ)]

(c) Consider a system consisting of four resources of the same type that are shared by three processes, each of which needs at most two resources. Show that the system is deadlock-free. [(CO4)(Analyze/IOCQ)]

3 + 6 + 3 = 12

Group - E

8. (a) Contrast the performance of the three techniques for allocating disk blocks (contiguous, linked, and indexed) for both sequential and random file access. [(CO5)(Analyze/IOCQ)]

(b) Explain the bit vector method for management of free disk space. [(CO5)(Understand/LOCQ)]

(c) Consider a file system that uses inodes to represent files. Disk blocks are 8 KB in size, and a pointer to a disk block requires 4 bytes. This file system has 12 direct disk blocks, as well as single, double, and triple indirect disk blocks. What is the maximum size of a file that can be stored in this file system? [(CO5)(Apply/IOCQ)]

6 + 3 + 3 = 12

9. (a) What is DMA? How does it improve the performance of a computer? [(CO1)(Analyze/IOCQ)]

(b) Differentiate between blocking and non-blocking I/O. [(CO3)(Analyze/IOCQ)]

(c) Suppose a disk drive has 300 cylinders, numbered 0 to 299. The drive is currently serving a request at cylinder 84, and the previous request was at cylinder 80. The queue of pending requests, in FIFO order, is:
69; 212; 296; 280; 44; 18; 56; 152;
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?
(i) FCFS, (ii) SCAN, (iii) C-SCAN. [(CO6)(Apply/IOCQ)]

3 + 3 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23.95	57.30	18.75

Course Outcome (CO):

After the completion of the course students will be able to

1. Analyze the structure of OS and basic architectural components involved in OS design.
2. Analyze and design the applications to run in parallel either using process or thread models of different OS
3. Analyze the various device and resource management techniques for timesharing systems.
4. Understand the Mutual exclusion, Deadlock detection and agreement protocols of operating system
5. Interpret the mechanisms adopted for file sharing in distributed Applications
6. Conceptualize the components involved in designing a contemporary OS.

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