

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) In UNIX, the return value for the fork system call is ____ for the child process and ____ for the parent process.
Choose the appropriate words from the following alternatives to fill the gap.
(a) a negative integer, zero (b) zero, a negative integer
(c) zero, a positive integer (d) a positive integer, zero.
- (ii) Which of the following is not a state of a process?
(a) Running (b) Ready (c) Suspended (d) Finished
- (iii) Which of the following page replacement algorithms suffers from Belady's anomaly?
(a) Optimal Replacement (b) FIFO
(c) LRU (d) both (a) and (b).
- (iv) Which of the following disk scheduling algorithms is the most efficient in terms of average waiting time?
(a) FCFS (b) SSTF (c) SCAN (d) C-LOOK
- (v) Run time mapping from virtual to physical address is done by
(a) memory management unit (b) CPU
(c) PCI (d) none of (a), (b) & (c).
- (vi) The degree of multi-programming is
(a) the number of processes executed per unit time
(b) the number of processes in the ready queue
(c) the number of processes in the I/O queue
(d) the number of processes in memory.
- (vii) Threads of a process
(a) share global variables but don't share heap
(b) share both global variables and heap
(c) don't share global variables but share heap
(d) don't share both global variables and heap.

- (viii) Assuming a 1-KB page size, what is the page number and offset for the logical address 3085 (provided as decimal number)?
 (a) page = 3; offset = 85 (b) page = 3; offset = 13
 (c) page = 4; offset = 85 (d) page = 4; offset = 13.
- (ix) Virtual memory is
 (a) an extremely large main memory
 (b) an extremely large secondary memory
 (c) an illusion of an extremely large memory
 (d) a type of memory used in super computers.
- (x) Which of the following allows the CPU use a dedicated memory controller?
 (a) Direct Memory Access (b) Random Access Memory
 (c) Peripheral Bus (d) Interrupt Handler.

Group- B

2. (a) Explain the concepts of multiprogramming and multitasking.
 [(CO1) (Understand /LOCQ)]
- (b) The following processes are being scheduled using a preemptive, priority-based, round-robin scheduling algorithm.

Process	Priority	Burst	Arrival
P1	6	12	0
P2	3	20	0
P3	4	25	20
P4	4	25	25
P5	5	10	45
P6	5	15	55

Each process is assigned a numerical priority, with a higher number indicating a higher relative priority. The scheduler will execute the highest priority process. For processes with the same priority, a round-robin scheduler will be used with a time quantum of 10 units. If a process is preempted by a higher-priority process, the preempted process is placed at the end of the queue.

- (i) Show the scheduling order of the processes using Gantt chart.
 (ii) What is the turnaround time for each process?
 (iii) What is the waiting time for each process?

[(CO2)(Apply/IOCQ)]
 $3 + (3 + 3 + 3) = 12$

3. (a) State the different states of a process and explain the change of states with suitable state transition diagram.
 [(CO2)(Remember/LOCQ)]
- (b) Differentiate among short-term, medium-term, and long-term scheduling.
 [(CO6)(Analyse/IOCQ)]
- (c) What advantage is there in having different time-quantum sizes at different levels of a multilevel queuing system?
 [(CO2)(Analyse/IOCQ)]
- (d) State two differences between user-level threads and kernel-level threads.

[(CO2)(Analyse/IOCQ)]
 $4 + 3 + 3 + 2 = 12$

Group - C

4. (a) Illustrate with an example race condition between two cooperating processes. [[CO4](Apply/IOCQ)]
 (b) Implement a solution to a critical-section problem using compare_and_swap instruction. [[CO4](Apply/IOCQ)]
 (c) Compare between shared memory and message passing models of interprocess communication. [[CO2](Analyse/LOCQ)]
4 + 4 + 4 = 12
5. (a) Describe the classical Readers and Writers problem related to process synchronization. Propose a solution to it using semaphores. Does your solution result in starvation? [[CO4](Apply/IOCQ)]
 (b) How does the signal() operation associated with monitors differ from the corresponding operation defined for semaphores? [[CO4](Understand/LOCQ)]
(2 + 6 + 1) + 3 = 12

Group - D

6. (a) Consider a paging system with the page table stored in memory.
 (i) If a memory reference takes 100 nanoseconds, how long does a paged memory reference take?
 (ii) If we add TLBs, and if 80 percent of all page-table references are found in the TLBs, what is the effective memory reference time? (Assume that finding a page-table entry in the TLBs takes 3 nanoseconds, if the entry is present.) [[CO3](Analyse/IOCQ)]
 (b) Consider a system with five process(P0,P1,P2,P3,P4) and three resource type A,B and C. The resources have 10, 5, 7 instances respectively. The snapshot of the system at time T0 is as below

Process	Allocation	Max	Available
	A B C	A B C	A B C
P0	0 1 0	7 5 3	3 3 2
P1	2 0 0	3 2 2	
P2	3 0 2	9 0 2	
P3	2 1 1	2 2 2	
P4	0 0 2	4 3 3	

- (i) Check whether the current state is in safe state.
 (ii) If process P1 requests (1 0 2) check whether the system will be in safe state. [[CO4](Apply/IOCQ)]
 (c) Explain why address-space identifiers (ASIDs) are used in TLBs. [[CO6](Analyse/IOCQ)]
(1 + 2) + (3 + 2) + 4 = 12
7. (a) Under what circumstances do page faults occur? Describe the actions taken by the operating system when a page fault occurs. [[CO3](Understand/LOCQ)]

- (b) Consider the following page reference string:

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

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](Apply/IOCQ)]

- (c) Consider a computer system with a 32-bit logical address and 4-KB page size. The system supports up to 512 MB of physical memory. How many entries are there in a conventional, single-level page table? [[CO1](Apply/IOCQ)]

$$4 + 6 + 2 = 12$$

Group - E

8. (a) Explain how the choice of disk scheduling algorithm can affect the overall performance of an operating system, including factors such as response time, throughput, and resource utilization. [[CO](Analyse/IOCQ)]

- (b) Suppose that a disk drive has 5,000 cylinders, numbered 0 to 4,999. The drive is currently serving a request at cylinder 2,150, and the previous request was at cylinder 1,800. The queue of pending requests, in FIFO order, is:
2060; 1210; 2290; 2800; 540; 1610; 350; 1520; 4960; 3680

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) SSTF (iii) C-SCAN.

[[CO3](Apply/IOCQ)]

$$6 + 6 = 12$$

9. (a) Describe the steps in a DMA (Direct Memory Access) transfer. How does DMA increase system concurrency? [[CO6](Understand/LOCQ)]

- (b) Compare and contrast the advantages and disadvantages of using a sequential access file versus a random access file. [[CO2](Understand/LOCQ)]

$$(4 + 2) + 6 = 12$$

<i>Cognition Level</i>	<i>LOCQ</i>	<i>IOCQ</i>	<i>HOCQ</i>
<i>Percentage distribution</i>	31.25	68.75	0

Course Outcome (CO):

- MCAP1204.1: Analyze the structure of OS and basic architectural components involved in OS design.
 MCAP1204.2: Analyze and design the applications to run in parallel either using process or thread models of different OS
 MCAP1204.3: Analyze the various device and resource management techniques for timesharing systems.
 MCAP1204.4: Understand the Mutual exclusion, Deadlock detection and agreement protocols of operating system
 MCAP1204.5: Interpret the mechanisms adopted for file sharing in distributed Applications
 MCAP1204.6: Conceptualize the components involved in designing a contemporary OS.

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