National Examinations December 2019

17-Comp-A5, Operating Systems

3 Hour Duration

NOTES:

1. If doubts exist as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumption made.

2. Provide justifications for your answers. Show all your work.

3. CLOSED BOOK. Candidates may use a Casio or Sharp approved calculator. No other aids.

4. The candidate has to answer **any five questions** (each question has multiple parts).

5. Total Marks = 100.

1 [20 marks].

(a) Consider the following arrivals on a system. Each process has a single CPU burst and does not perform any I/O.

Process	Arrival Time (seconds)	Execution Time(seconds)
Proc1	25	14
Proc2	27	7
Proc3	31	21
Proc4	34	2
Proc 5	42	1

[5] (i) What is the minimum mean process turnaround time for any non-preemptive CPU scheduling strategy ?
[6] (ii) What is the minimum mean process turnaround time for any CPU scheduling strategy (that may be preemptive or non-preemptive)?

[4] **(b)** Explain why CPU scheduling is more difficult to perform on a system comprising multiple processors in comparison to a single CPU-based system.

[5] **(c)** Consider a priority-based page replacement strategy for a demand paged virtual memory system on which the priority of a page has a numeric value and can be changed dynamically with time. Discuss with the help of examples how the priority of a page is to be set for achieving the following page replacement policies:

(i) First in First Out (ii) Least Recently Used (iii) Most Frequently Used

2 [20 marks].

[9] **(a)** Consider the following solution to the critical section problem involving two concurrent processes P0 and P1. Identify as many **distinct problems** as you can in the design. If similar problems occur at multiple places identify them each time but explain it only once. Your list of errors should include defects (if any) that may not necessarily give rise to incorrect results but do indicate flaws in design.

Justify your answer with the help of examples. Be as specific as you can when you describe the situations in which problems occur. **[contd. on next page]**

Algorithm

Process P0

```
do {
        Execute code in RS
        check0 = true;
        if check1 {
                check0 = false;
                while check1 {no-op};
                check0 = true;
        };

        Code for CS

        check0= false;
} while (true) ;
```

Process P1

```
do {
Execute code in RS
check1 = true;
 if check0 {
        check1=false;
        while check0  {no-op};
        check1 = true;
};

        Code for CS

        check1= false;
} while (true);
```

Note: CS: Critical Section. RS: Remainder Section. no-op: no operation.

[6] **(b)** Briefly discuss whether or not each of the three requirements associated with the solution to the critical section problem is satisfied when a monitor is used to guard the access to the critical section.

[5] **(c)** What is meant by starvation of processes? Briefly discuss (with the help of examples) how process starvation can occur on a system when a priority based CPU scheduling is used.

3. [20 marks]

(a) Consider a demand paged virtual memory system and the following page reference string:

11, 12, 13, 14, 12, 11, 15, 16, 12, 11, 12, 13, 17, 16, 13, 12, 11, 12, 13, 16.

[3] (i) What is the minimum number of page faults for this reference string that can occur on the system?

[3] (i) What is the maximum number of page faults for this reference string that can occur on the system?

[10] **(b)** Determine the number of page faults for the optimal page replacement policy when 3 frames are allocated to the program.

(c) Given that the base (relocation) register contains 1500 and the limit register contains 1600, determine the results of address translation (from logical to physical) in each of the following cases. Include the physical memory address generated.

[2] (i) when the logical memory address is 607
[2] (ii)when the logical memory address is 1702
[all addresses are expressed in decimal].

4. [20 marks]

[4] **(a)** Does a cycle in the resource allocation graph always imply the existence of a deadlock? Justify your answer.

[6] **(b)** Draw a resource allocation graph for a deadlocked system comprising at least three resources. Briefly describe how the graph captures the occurrence of a deadlock

[10] **(c)** Different approaches are available for the handling of deadlocks on the system. Using examples briefly discuss the "deadlock detection and recovery" based approach.

5. [20 marks]

[10] **(a)** Consider a moving head hard disk, which consists of a single platter (surface) with 160 tracks on it. The tracks are numbered 0 to 159. The disk is currently serving a request at track 139 and has just finished a request at track 130. The queue of pending requests in FIFO order is:

96, 157, 101, 176, 104, 160, 116, 174, 150.

What is the total head movement (in number of tracks) needed to satisfy all these requests for the following disk scheduling algorithms?

(i) LOOK (ii) SSTF (iii) C-SCAN

[5] **(b)** Briefly describe the bit vector-based free space management technique. Include the advantages and shortcomings of the technique (if any).

[5] **(c)** Discuss Belady's anomaly in the context of memory management. Can you describe an algorithm that is free from such an anomaly? Justify your answer.

6. [20 marks]

[10] **(a)** Discuss whether increasing the degree of multiprogramming can improve the CPU utilization in the following scenarios. If your answer is NO for any one of these scenarios describe what change needs to be made for the improvement of CPU utilization.

(i) when the CPU utilization is 7% and the paging disk utilization is 2%
(ii) when the CPU utilization is 15% and the paging disk utilization is 98%
(iii) when the CPU utilization is 80% and paging disk utilizations are 15%
(iv) when both the CPU and paging disk utilizations are 50%

[10] **(b)** Consider a multiprogrammed system that uses multiple partitions (of variable size) for memory management. A linked list of holes called the free list is maintained by the operating system to keep track of the available memory in the system. At a given point in time the free list consists of holes with sizes:
305K, 245K, 405K, 470K, 270K, 291K, 325K, and 350K

The free list is also ordered in the sequence given above: the first hole in the list is of size 302K words which is followed by a hole of size 243K words and so on. Jobs with different memory requirements arrive on the system in the following order:

	Arrival Time	Memory Requirement
Job 1	t1	322K
Job 2	t2	305K
Job 3	t3	403K
Job 4	t4	290K

[Given t1 < t2 < t3 < t4]

Explain how memory allocation would be performed in the given situation for (i) the best fit and (ii) the first fit policy. [For each policy determine which hole is allocated to each job after it arrives on the system].

7 **[20 marks]**.

[5] (a) With the help of examples discuss the differences between a hard and a soft real time system.

[5] (b) Briefly explain the motivation behind file protection. With the help of examples describe any one technique used by an Operating System for protecting files [Be brief].

[5] (c) Using examples briefly discuss the contiguous allocation technique used for allocating free blocks to files. Include the advantages and shortcomings (if any) of the technique in your discussion.

[5] (d) Briefly discuss how Redundant Arrays of Inexpensive Disks (RAID) can be used to improve both reliability and performance. Provide examples to support your discussion