

98- COMP-A5 OPERATING SYSTEMS

NATIONAL EXAMINATIONS May 2014

98-COMP A-5 OPERATING SYSTEMS

3 Hours 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 one of the two pocket calculators, the Casio approved model or Sharp approved model. No other aids.
4. The candidate has to answer **any five questions** (each question has multiple parts).
5. Total Marks = 100.
6. This exam has got 6 pages (including this page).

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	0	14
Proc2	2	7
Proc3	4	21
Proc4	6	2
Proc 5	7	1

What is the minimum mean process turnaround time for (i) any non-preemptive CPU scheduling strategy (ii) any preemptive CPU scheduling strategy?

(b) Why is the optimal CPU scheduling strategy difficult to implement in practice?

(c) What is a real time system? Using examples to distinguish between a hard real time system and a time sharing system.

2 [20 marks].

(a) Consider a multiprogrammed multi-user system. Discuss why it is unlikely to have a deadlock due to the sharing of a disk on such a system.

(b) Different approaches to handling deadlocks exist on the system. With the help of examples discuss the deadlock prevention approach.

(c) Consider a multiprogrammed system consisting of eight resources of the same type. No deadlock handling technique is employed by the system. That is, if a resource is requested by a process and one is available, a resource is allocated to the requesting process; otherwise the requesting process is blocked. Seven processes are run concurrently on the system. Each process can simultaneously hold up to two resources at any given point in time.

Once a resource is acquired by a process it must be released by the process before it can be assigned to another process. Assume that each process requests and releases one resource at a time.

Can a deadlock occur on the system? Justify your answer.

3 [20 marks].

(a) Discuss the working set based memory management approach. Explain how it prevents thrashing to occur on the system.

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

71, 72, 73, 74, 75, 73, 74, 71, 76, 77, 78, 77, 78, 79, 77, 78, 79

Determine the number of page faults that would occur with the FIFO page replacement algorithm when 3 frames are allocated to the program.

(c) Discuss fragmentation in the context of (i) memory management and (ii) disk block allocation. Include methods of controlling such fragmentation in your discussion.

4 [20 marks].

(a). Different methods exist for storing information on the disk. Consider a file currently consisting of 110 blocks. Assume that the directory is available in main memory.

(i) For each of the following cases (A-C) compute the minimum number of disk operations that are required when contiguous allocation is used. Assume that there is no room for the file to grow in the beginning but there is room to grow in the end.

(A) a block is removed from the beginning of the file.

(B) a block is added after the 61 th block in the file.

(C) The last block of the file is removed.

(ii) For each of the following cases (D-F) compute the minimum number of disk operations that are required when linked allocation (based on a singly linked list) is used.

(D) a block is added at the beginning of the file.

(E) a block is added after the 61 th block in the file.

(F) The last block in the file is removed.

Consider each case (A-F) separately. For (B), (D), and (E) assume that the information to be inserted into the file is available in main memory. Note that each disk operation corresponds to the reading of a block from the disk or the writing of a block to the disk. While computing the number of disk operations, ignore the disk operations that may be required for the location and maintenance of free space. Since the directory is in main memory any operation on the directory is not counted as a disk operation.

ASSUME: The length of the file is known to the system

(b). Discuss the role of free space management on a disk. Discuss with the help of examples (i) bit vector-based free space management and (ii) linked list-based free space management

5 [20 marks].

Consider a system in which multiple processes $P_1 \dots P_n$ run concurrently. The system has got a plotter which can be directly used by the processes for plotting graphs. The plotter however can be used by a single process at a time. Access to the plotter is to be controlled with the help of a

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monitor: There are two procedures inside the monitor: `get_plotter` and `release_plotter`. There are two different colours of graphs that can be plotted: red and black. When a process wants to acquire the plotter it calls procedure `get_plotter`. The colour of the graph ('B' for black and 'R' for red) is passed as an argument. If no other process is using the plotter the process gets control of the plotter; otherwise it is blocked.

After acquiring the plotter the process comes out of the monitor and uses the plotter. When the process has completed use of the plotter it calls procedure `release_plotter`. The colour of the graph that was plotted is passed as an argument to `release_plotter`. If a single process is waiting for the plotter when the plotter is freed this process is allocated the plotter and is allowed to proceed. If multiple processes are waiting then the process that will be allocated the plotter is selected in the following way. If the number of processes waiting for plotting red graphs is 3 times or more than the number of processes waiting to plot black graphs then a process that is waiting to plot the red graph is selected; otherwise the plotter is allocated to a process waiting for plotting a black graph.

The typical operations performed by a process P_i ($i = 1 \dots n$) is given by the following algorithm.

```
Process  $P_i$ 
repeat
    1. Perform computation.
    2. Call procedure get_plotter in the monitor. [Indicate the colour of the graph through
        the argument of the procedure.]
        {If the process is not blocked inside the monitor it means that it can use the plotter.}
    3. Use the plotter.
    4. Call release_plotter in the monitor. [Indicate the colour of the graph through the
        argument of the procedure.]
until false
```

Your job is to write the algorithm (pseudo code) for the monitor that will control access to the plotter. The monitor must contain the two procedures `get_plotter` and `release_plotter` (described above) that are called by the processes. [You may incorporate other procedures and functions in the monitor if you wish.]

Provide necessary documentation to explain your solution.

Declare the variables required by your solution in the variable declaration part of the monitor. However this variable declaration CAN NOT include a variable of type semaphore.

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The generic structure of a monitor is included below for your assistance.

```
monitor monitor-name
{
    variable declarations
    procedure P1 (...) {
        ...
    }
    procedure P2 (...) {
        ...
    }
    procedure Pn (...) {
        ...
    }
    {
        initialization code
    }
}
```

6. [20 marks]

(a) Discuss how protection can be achieved in the context of two important resources in a computing system used by multiple users: (i) main memory and (ii) file system.

(b) Consider a moving head hard disk, which consists of a single platter (surface) with 200 tracks on it. The tracks are numbered 0 to 199. The disk is currently serving a request at track 161 and has just finished a request at track 140. The queue of pending requests in FIFO order is:

98, 158, 111, 187, 104, 162, 112, 188, 140.

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) FCFS

[Assume that no further requests arrive on the system during the service of the above requests.]

(c) Briefly discuss how multiple disks are used to handle disk failures on the system. Include the merits and overheads associated with the technique.

7. [20 marks]

(a) Discuss the difference between the following approaches to deadlock handling: deadlock avoidance and deadlock detection with recovery. Include the merits and short comings (if any) of each of these techniques in your discussion.

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(b) Distinguish between deadlock and starvation in the context of multiple processes trying to enter a critical section. Can starvation occur if the critical section is protected by a semaphore? [Justify your answer].

(c) Explain with the help of examples what is meant by starvation in the context of CPU scheduling. How can it be controlled?

(d) What is the role of a directory in a file system? Discuss with the help of examples (i) a single level directory and (ii) a tree structured directory. What are the advantages of a tree structured directory over a single level directory?