NATIONAL EXAMINATIONS May 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 one of the two calculators, a Casio 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.

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1 [20 marks].

[13] **(a)** Consider a **preemptive** short term scheduling strategy in which the priority of a process may change dynamically with time. (Larger priority numbers imply higher priority). At any point in time the highest priority process is run on the system. Ties are broken in favour of the process that entered the ready to run queue first. If a running process is preempted then its time of entry into the ready to run queue is the time at which the preemption was made.

When a process is waiting in the ready to run queue its priority changes at a rate **a**. That is,

> Priority of a process in the ready to run queue = a.t
> (where t is the time elapsed (in seconds) after the process entered the ready to run queue).

When a process is selected to run on the CPU its priority is set to **Q**. As it starts running on the CPU its priority changes at a rate **b**. That is,

> Priority of the process running on the CPU = Q + b.t'
> (where t' is the time elapsed (in seconds) after the process started running on the CPU).

The parameters Q, a, and b can be set to give many different scheduling policies. Once chosen the values of these parameters become fixed and cannot change.

Determine Q, a, and b that will produce the First Come First Served policy.

[7] **(b)** Briefly describe the Shortest Remaining Time First (SRTF) scheduling policy. Explain the benefits and shortcomings of SRTF.

2 [20 marks].

[3] **(a)** Given that the base (relocation) register contains 1300, the limit register contains 1500, what is the physical memory address generated when the logical memory address is 501? [all addresses are expressed in decimal].

[3] **(b)** Given that the base (relocation) register contains 1600, the limit register contains 1500, what is the physical memory address generated when the logical memory address is 1550? [all addresses are expressed in decimal].

[10] **(c)** Consider a demand paged virtual memory system and the following page reference string:

92, 93, 94, 95, 93, 94, 91, 96, 97, 99, 97, 99, 99, 97, 99, 91

Determine the number of pages faults for the First In First Out (FIFO) page replacement policy when 3 frames are allocated to the program.

[4] **(d)** Which of the following is a hard real time and which one is a soft real time system:
(i) an air line reservation system (ii) a spaceship direction control system.

3 [20 marks].

[8] **(a)** Consider an operating system which uses a Process Table for short term scheduling (CPU scheduling). The Process Table contains a set of records each of which represents a Process Control Block (PCB). The PCB contains the current state of the process (ready, blocked or running). Another field in the PCB is P that is incremented every T units of time by the operating system. Every 50T units of time the operating system also adds K to the value of P for each PCB (K >0). The initial value of P is set to 0 when the process first enters the multiprogramming mix.

The short term scheduler used by this operating system is fairly simple: it performs a new scheduling decision only when the running process blocks for I/O or it completes. The short term scheduler scans the Process Table starting from the top and examines each PCB. The ready process that has the smallest P is selected to run on the CPU.

Identify as many defects as you can in the design of the short term scheduler.

[4] **(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 monitor? [Justify your answer].

[8] **(c)** Consider a demand paged virtual memory system in which a single program is currently running. The page map table is held in associative registers (associative memory). It takes 20 milliseconds to service a page fault if an empty frame is available or the replaced page is not modified, and 40 milliseconds if the replaced page is modified. Memory access time is 100 nanoseconds.

Assume that for 45% of the page faults a page replacement is necessary and the page to be replaced is modified. What is the maximum acceptable page fault rate such that the effective memory access time for the program is not greater than 200 nanoseconds?

4 [20 marks].

[12] **(a)** Different methods exist for storing information on the disk. Consider a file currently consisting of 120 blocks (numbered 1 - 120). Assume that the directory is available in main memory.

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

(A) The contents of block 100, 87 and 101 are read.
(B) The contents of block 101 are exchanged with the contents of block 91.
(C) A new block is inserted after block 90. The content of the new block are the same as that of block 110.
(D) Block 85 is deleted.

[contd. on next page]

Consider each case (A-D) separately. 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: (i) The length of the file is known to the system. (ii) There is no room on the disk for the file to grow at the beginning but there is room to grow at the end.

[4] **(b)** What is a multi-level directory in the context of a file system? Discuss its advantages in comparison to a single level directory.

[4] **(c)** Briefly discuss the linked list based technique for free space management. Include the advantages and shortcomings (if any) of the technique?

5 [20 marks].

[6] **(a)** What is a deadlock? With the help of examples discuss the necessary conditions for the occurrence of a deadlock .

[2] **(b)** Can a deadlock occur on a system comprising read-only files?

[12] **(c)** Consider a multiprogrammed system with 15 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, the resource is allocated to the requesting process; otherwise the requesting process is blocked. Seven processes P1.. P7 are run concurrently on the system. At any given point in time, each of P1..P5 can simultaneously hold up to two resources whereas each of P6-P7 can hold up to three resources.

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.

6 [20 marks].

[10] **(a)** Consider a moving head hard disk, which consists of a single platter (surface) with 180 tracks on it. The tracks are numbered 0 to 179. The disk is currently serving a request at track 141 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) FIFO (ii) SSTF (iii) SCAN

[4] **(b)** If you have a choice between using multiple processes or multiple threads for implementing an application which one should you use?

[6] **(c)** Explain why it is hard to implement the optimal CPU scheduling strategy on a real system.

7 [20 marks].

[5] **(a)** With the help of an example explain the problem of priority inversion that can occur on a system.

[4] **(b)** Distinguish between security and protection. Briefly outline the goals of each.

[5] **(c)** With the help of examples discuss how fragmentation can occur on a disk. Describe a technique for controlling disk fragmentation.

[3] **(d)** Briefly discuss File Allocation Table (FAT).

[3] **(e)** The binding of instructions and data to memory addresses can be done at different times. Briefly discuss the differences among compile time and load time address binding.