

## **CITY UNIVERSITY OF HONG KONG**

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Course code & title : CS3103 Operating Systems

Session : Semester B 2003-2004

Time allowed : Two hours

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This paper has FIVE pages including this page.

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1. This paper consists of 5 questions.
  2. Answer any FOUR questions.
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Materials, aids & instruments permitted to be used during examination:

Approved Calculator

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Answer any FOUR questions. ALL questions carry 25 marks.

Question 1

- a) "Threads not only do what processes can do, but do it better and without any disadvantage". Discuss the validity of this statement. Provide brief explanation for your arguments. (8 marks)
- b) How can a single processor system support more than one active processes? Explain by using the concepts of process creation and process state transition. (10 marks)
- c) Outline the steps in handling an interrupt. How would they be changed if a nested interrupt occurs? (7 marks)

Question 2

- a) In the context of scheduling algorithm evaluation criteria, explain what is the significance of the following :-
- (i) utilization;
  - (ii) mean response time;
  - (iii) variance of response time; (6 marks)
- b) Consider the following processes and their CPU burst time :-

<u>process number</u>	<u>burst time</u>
1	10
2	1
3	2
4	1
5	5

- (i) show in detail, with a diagram (Gantt chart or otherwise), the execution of these processes using SJF (Shortest Job First), RR (Round Robin, quantum=2) and MLFQ (Multi-Level Feedback Queue, 1<sup>st</sup> level quantum=3, 2<sup>nd</sup> and higher level quantum=4) (7 marks)
- (ii) calculate the mean waiting time for each scheduling algorithm (6 marks)
- (iii) comment on the strength and weakness of the algorithms (6 marks)

### Question 3

- a) The Pentium processor can operate with paging as the memory addressing scheme. The data structures involved are described as follows :-

A 32-bit virtual address with 10-bit used to select a Page Table Directory containing entries (PDE) pointing to Page Tables which in turn containing entries (PTE) pointing to physical frames. Address of the Page Table Directory is known to hardware. The detail formats are :-

Virtual Address :

10-bit (PDE offset)	10-bit (PTE offset)	12-bit (page offset)
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PDE :

20-bit (page table base address)	12-bit (other use)
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PTE :

20-bit (page frame base address)	12-bit (other use)
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For the Pentium processor using paging mode, assume the address of the Page Table Directory is known :

- (i) with the aid of a diagram, describe in detail how address translation is performed (6 marks)
  - (ii) what is the page size ? (2 marks)
  - (iii) what is the advantage of this scheme compared to a virtual address using 20-bit for page number and 12-bit for page offset ? (3 marks)
  - (iv) suggest 2 ways to use the 12 bits for other use in the PTE if virtual memory is implemented (2 marks)
- b) If a counter of the number of references made to a page is used, the Least Frequently Used (LFU) page-replacement algorithm can be implemented. It requires the replacement of the page with the smallest count, the older one will be replaced if the count is the same for two pages.

Consider the page reference string : 7, 0, 1, 2, 0, 3, 0, 4, 2, 3, 0, 3, 2, 1, 2, 0, 1, 7, 0, 1

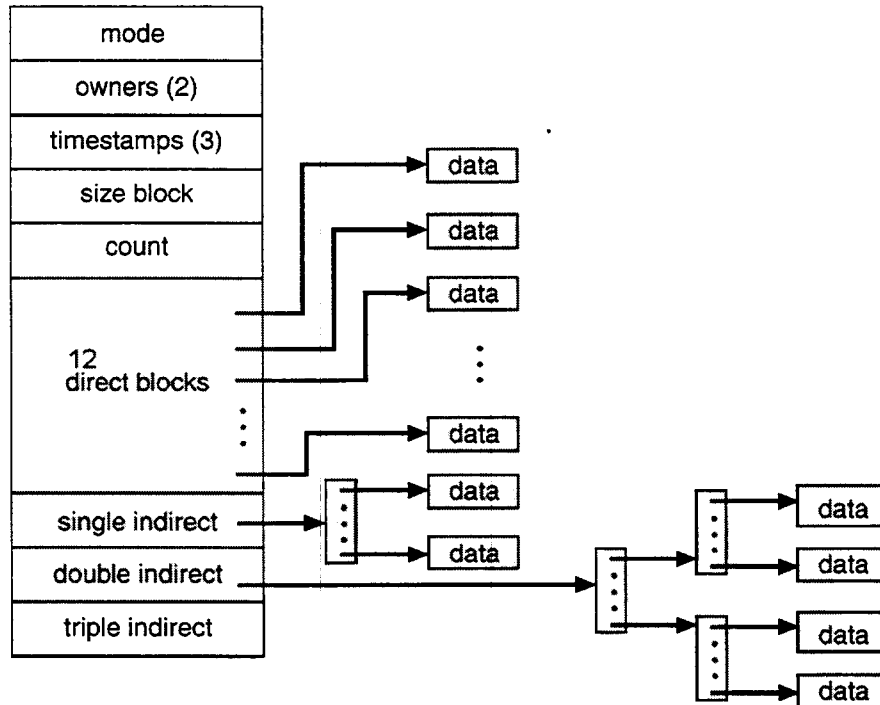
- (i) show with a diagram the number of page faults occurred if LFU is used as the page-replacement algorithm (assume pure demand paging with 3 frames) (5 marks)
- (ii) suggest a way to analyse whether LFU is a good algorithm, show your steps in detail (4 marks)
- (iii) suggest one weakness of LFU and one solution to solve it. (3 marks)

#### Question 4

- a) Name the four layers in a typical I/O system. Give a brief description for each layer by giving an example and explaining its functions.

(12 marks)

- b) With reference to the given diagram of an i-node of the Unix file system, answer the following questions :-



- (i) what is the main function of the i-node? (2 marks)
- (ii) knowing that a directory in Unix file system is also a file, explain in detail how the file /usr/mbox/in can be located? (hint: 4 i-nodes are involved and you may use your own example disk block numbers in the i-nodes) (6 marks)
- (iii) what is the maximum file size if 16-bits file pointers are used and the block size is 4K bytes? (show your calculations) (5 marks)

Question 5

- a) Given the following simple program in pseudo code :-

```
Process A
Begin
.... other stuff ....
  x = x + 1;
.... other stuff ....
End
```

Explain the following using an example built from *Process A* :- (12 marks)

- (i) mutual exclusion
- (ii) critical section
- (iii) asynchronous cooperating process
- (iv) binary and counting semaphore
- (v) how to amend *Process A* to ensure it will work in any situation with the help of Semaphore

- b) The bounded-buffer problem is defined as :-

A buffer can hold a maximum of  $N$  items and it cannot be accessed by more than one process at the same time. A *Producer* process will add items to the buffer and will block when the buffer is full. A *Consumer* process will remove items from the buffer and will block when the buffer is empty.

Write pseudo codes for the *Producer* and *Consumer* processes to solve the problem with binary and counting semaphores.

(13 marks)

\*\*\*\*\* END \*\*\*\*\*