

UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1996

BSc Honours Degree in Mathematics and Computer Science Part II
MSci Honours Degree in Mathematics and Computer Science Part II
for Internal Students of the Imperial College of Science, Technology and Medicine

*This paper is also taken for the relevant examinations for the
Associateship of the Royal College of Science*

PAPER MC2.5

OPERATING SYSTEMS

Friday, May 3rd 1996, 10.00 - 11.30

Answer TWO questions

For admin. only: paper contains
3 questions
3 pages (excluding cover page)

- 1a What used to be meant by a *batch system* for executing computer programs? Why did it require memory protection? Describe the hardware support needed for this.
- b An *off-line batch system* would have used extra “satellite” computers to transfer I/O between slow devices, such as card readers and printers, and faster devices, such as tape drives.
- i) Suppose a particular off-line batch system used two satellite computers, one each for input and output, and suppose the fast I/O was 10 times as fast as the slow I/O. Consider the following batch of 4 programs (all times are in seconds):

| Program | Time spent on slow I/O | Computation time |
|---------|------------------------|------------------|
| 1 | 15 | 1 |
| 2 | 5 | 8 |
| 3 | 5 | 15 |
| 4 | 8 | 2 |

Calculate the total CPU time (including satellites) used for the batch under two systems: a simple batch system, and the off-line batch system described in the question.

- ii) What were the benefits of using two extra computers in this way?
- c What are the benefits of parallelism *to the operating system*? What hardware features are required to support it? How does the use of parallelism make satellite computers unnecessary?

The three parts carry, respectively, 25%, 50%, 25% of the marks.

2 This question concerns the simple kernel that was presented in lectures.

- a
- i) Describe briefly the functions of the Time and Delay system calls.
 - ii) Suppose the system clock runs at 50 ticks (clock interrupts) per second. The following procedure is intended to be the code for a process that displays the elapsed real time in seconds, updating it every second.

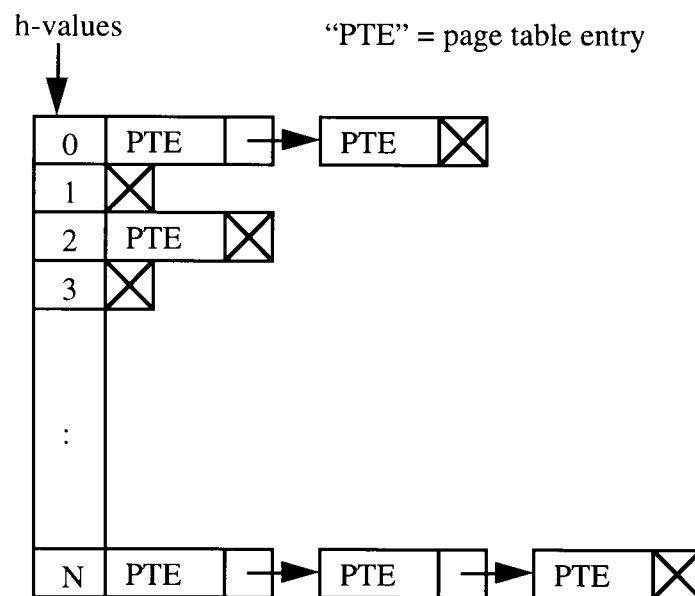
```
procedure p1;  
var n:integer;  
begin  
    n := 0;  
    while true do begin  
        display(n);      {a procedure call to display  
                           n on the screen}  
        n := n+1;  
        Delay(50)  
    end  
end p1;
```

Explain why this will fail to behave as intended.

- iii) Rewrite the procedure so that it displays as nearly as possible at one second intervals, with no cumulative error.
- b
- i) Explain carefully why the idle process is always either running or ready, and how this knowledge is used in the scheduling procedure (Dispatch).
 - ii) Part i) can break down if interrupt handlers make certain system calls. Explain how, and which system calls can cause this problem.

Turn over ...

- 3a i) Explain the difference between *absolute* addressing and addressing *relative* to a base register.
- ii) Give the main reasons why absolute memory addresses in a program cannot be known at compile time.
- iii) Explain how relative addressing and paged virtual memory both allow programs to run at a range of different positions in memory.
- b An “inverted page table” has entries only for the pages currently in main memory. It works using a function h , which to each page number p assigns an integer $h(p)$ between 0 and some maximum value N . For each possible h -value there is maintained a linked list of page table entries for the resident pages with that value. To look up a particular page number p , you just search the list corresponding to $h(p)$. For instance, in the example illustrated, for any p with $h(p) = 0$ we must check two page table entries.



Suppose that a system has 2^{20} pages of virtual memory address space, but at most 2^{10} page frames in memory.

- i) What would be the advantages and disadvantages of using an inverted page table?
- ii) How many h -values are needed if the performance is to be comparable with a conventional page table?
- iii) What kind of function h is needed to make best use of this scheme?

End of paper