UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1998

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 CONCEPTS

Friday, May 15th 1998, 2.00 - 3.30

Answer THREE questions

For admin. only: paper contains 4 questions

Section A *(Use a separate answer book for this Section)*

1a i) Object code files include *relocation* information and *external symbol tables.* Explain why these are needed.

ii) Suppose a module contains an undefined symbol, used in the operands at addresses $A_1, A_2, \ldots, A_n$. Explain how this information could be represented in the object code file using a chain of pointers. How would the linker resolve these references?

b Two object code files Main.o and Sub.o contain the object file information presented as follows:

Sub.o

address	opcode	operand	reloc?
0	3	2	Yes
1	6	1	No
2	4	0	Yes
3	8	0	No

sub	code	0
A	undefined	0

Main.o

address	opcode	operand	reloc?
0	0	0	No
1	5	2	Yes
2	5	0	Yes
3	9	0	No

main	code	1
A	data	0
sub	undefined	1

The format used is as described in lectures, including chains of pointers for undefined symbols as referred to in part a ii). Note that you do *not* need to know what instructions the opcode values represent.

i) Which locations in Sub.o use the undefined symbol A?

ii) Write down, using the same format, the object file that results from linking the two files together, with Sub.o first in memory (starting at address 0) and Main.o following after. Include relocation information and an external symbol table with just one entry, for main.

c Suppose a program is to run using paged virtual memory. Is relocation needed (i) at link time, (ii) at load time, (iii) at run time? Explain your answers.

The three parts carry, respectively, 40%, 40%, 20% of the marks.

2a i) Explain the terms *critical region* and *mutual exclusion* in relation to concurrent processes.

ii) Give an example to show how, when two processes share variables, errors can arise if mutual exclusion is not enforced. Say what the critical regions are in your example.

iii) Describe how semaphore operations can be included in a program to enforce mutual exclusion. To what value must the semaphore be initialized?

b Suppose you are writing a procedure Fred to be called by numerous concurrent processes, and you wish to include code to count its calls and output a '*' character every hundred calls. Show how this can be achieved using semaphores. (You may use any standard high-level language, or pseudocode. The only way you can manipulate semaphores is by using the operations InitSema, P and V.) Remember to state how the semaphores must be initialized. Explain the role of the semaphore in your answer.

c Why in general should interrupt handlers not call the P operation? What might this do to the Simple Kernel?

The three parts carry, respectively, 50%, 30%, 20% of the marks.

Turn over ...

Section B *(Use a separate answer book for this Section)*

3a Write definitions for each of the following terms:

i) Interrupt

ii) Multi-level Priority Queue

iii) Process Control Block

iv) Context Switch

b Suppose an operating system has a simple priority system like that in the Simple Kernel.

A high priority process is unblocked every time a key is pressed on the keyboard of the computer. Given that another three high priority processes are continuously present, estimate the maximum time before a key click is processed. Assume that each high priority process blocks after 80ms on average and that the context switch time between any two processes in 5ms.

Show your calculations.

c Explain which priority (high or low) you would assign to the following processes in a computer system and why:

i) an unbuffered serial interface driver, where data is sent or received at 9600 bits per second and the operating system will need to have enough time to process each byte.

ii) a database application with student details including name, address and course options.

iii) a Keyboard interface driver. Assume that a key is being pressed on average 6 times a second when a person is typing and therefore the process needs to be invoked the same number of times.

Rank the priorities of i, ii and iii in order explaining your choice.

The three parts carry, respectively, 40%, 30%, 30% of the marks.

4 Memory Management

a When programs and their data get too large for memory they can either address this problem themselves using overlays or leave it up to the operating system using paging and/or segmentation.

i) What are overlays and what does the program have to do to manage them?

ii) Explain how hardware registers can be used to place compiled code anywhere in memory without having to relocate code.

b You have a computer with 64Mbytes of main memory. Unfortunately you do not have any sophisticated paging, segmentation or swapping facilities on it. You do, however, have some hardware registers allowing you to load and protect several programs at the same time.

i) Describe two different memory management (placement) policies for loading programs into a non-paged system.

ii) Your operating system has left 50 Mbytes of memory available to run jobs/processes in it and it has the following queue of work to be performed:

Job Number	Memory required (Mbytes)	Time to complete (Seconds)
1	15	5
2	10	30
3	20	5
4	5	35
5	10	20
6	15	20
7	10	10

Using both the Best Fit and the Worst Fit algorithms draw the contents of the memory at each change of state i.e. when jobs are removed and loaded into memory. How long does it take to finish all the jobs in the queue for each strategy?

Assume that:

- all finished jobs are removed from memory before attempting to load the next one in the queue.
- the queue is a strict queue and jobs may not be selected from the middle of the queue.
- the time given in the table means the number of seconds that the job will occupy memory.

The two parts carry, respectively, 40%, 60% of the marks.

End of paper