

UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2002

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 MC114

OPERATING SYSTEMS

Friday 26 April 2002, 10:00
Duration: 90 minutes
(Reading time 5 minutes)

Answer THREE questions

Paper contains 4 questions
Calculators required

- 1a Name one advantage and disadvantage of writing an operating system in a high-level language, such as C or C++.
- b Using the pseudocode, describe the functionality of the two main components of a *PRINTER* device driver.
- c In virtually all systems that include a DMA (direct memory access module) its access to memory runs at a *higher priority* than the processor. In one paragraph, briefly explain operation of the DMA. What does '*higher priority*' mean in this context? Why should this be the policy setting for the DMA?

The three parts carry, respectively, 15%, 55%, 30% of the marks.

- 2a Give an example which shows why testing and setting a lock must be an indivisible operation.
- b Two concurrent processes P1 and P2 have a critical region. P1 *increments* the shared integer X by one and P2 *decrements* X by 1. Write pseudocode to protect these critical regions using Semaphores.

Make sure to include data declarations and appropriate initialisations.

- c
 - i Illustrate with an example what is meant by *deadlock*?
 - ii Describe how deadlock is detected.
 - iii What would be a good policy for choosing which process to terminate once deadlock has been found? If a system did not have deadlock detection facilities how would deadlock manifest itself to the user?

The three parts carry, respectively, 20%, 45%, 35% of the marks.

- 3a) State whether each of the following statements is True or False. In each case, give a *brief* (one sentence) justification for your answer:
- i) Interrupt handlers run as high priority user processes.
 - ii) The fact that an operating system provides system calls for creating and manipulating semaphores guarantees that user processes running on that operating system will access shared data in a safe, mutually-exclusive manner.
 - iii) It does not make sense for a virtual memory system to have a swap partition that is bigger than the size of the virtual memory.
- b) What is a process? What is a thread? Explain carefully how the two concepts are related.
- c) Consider a simple operating system that only supports single-threaded processes (such as the Simple Kernel). Describe the changes that would have to be made to the data structures of such an OS so that it could support multiple threads.
- d) Suggest two performance benefits that would follow from rewriting an application that runs as a set of communicating single-threaded processes as a multithreaded application.

The four parts carry 30%, 25%, 25% and 20% of the marks respectively.

- 4 Consider a paged virtual memory system with 16K pages that runs on a machine with 32-bit virtual addresses. A 512MB hard disk with 16K sectors is used as a swap partition. Currently there are 8 processes running on the machine.
- a) Give two advantages and one disadvantage of a virtual memory system based on paging.
 - b) Compute the following quantities:
 - i) How many process page tables are required?
 - ii) How many entries are required in each?
 - iii) If a process address register (PAR) can be up to 32 bits long, what is the maximum amount of physical memory that can be supported on this machine?
 - iv) How wide (in bits) should each entry in a process page table be if 64MB physical memory is installed?
 - c) Suppose the scheme is now extended to incorporate segmentation, such that a process can have up to 8 segments, each of which is subdivided into 16KB pages. 32-bit virtual addresses are still used.
 - i) Draw a diagram to show how a virtual address should be divided into segment number, page number and page offset. Indicate the width (in bits) of each part.
 - ii) How many page tables and how many segment tables are required if 3 processes are currently running on the machine? What is the maximum segment size supported under this scheme?

The three parts carry 15%, 55% and 30% of the marks respectively.