UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2004

BEng Honours Degree in Computing Part II
MEng Honours Degrees in Computing 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 City and Guilds of London Institute

PAPER C211

OPERATING SYSTEMS II

Wednesday 28 April 2004, 10:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators not required

1 a Explain why, when avoiding busy-wait cycles, interrupts are essential.

b Describe the classic instruction cycle, and what happens when an interrupt takes place.

c Explain the *vectored interrupt* scheme.

d Discuss the difference between a *precise* and an *imprecise* interrupt; give possible complications.

e Give a brief description of the super-scalar architecture and the pipelined CPU approach. Explain why imprecise interrupts are an issue on the former, but not on the latter.

The five parts carry, respectively, 10%, 20%, 10%, 20%, and 40% of the marks.

2 a Give the design (pseudo code) for both the *synchronous send* and the *receive* procedure as used in a message passing mechanism.

b Discuss the differences between *synchronous* and *asynchronous* send, and their implications for the kernel. The answer should not be longer than a few sentences (about a 100 words).

c Explain the principle of a *mailbox*, and the discuss its behaviour in the context of both *synchronous* and *asynchronous* sends.

d Give the *process state diagram.* Give an extension that deals with the notion of a process being *swapped out*, i.e., whos process descriptor exists, but no longer has its code in memory.

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

3 Disk organisation and file systems

a The file system of an operating system uses a disk block size of 4K bytes (i.e. 4096 bytes). Each disk block address is 8 bytes long. Using the block chaining method and the file allocation table method, determine how many disk block reads are required to access byte 8180 and byte 408820 in a particular file. You can assume that the entire file allocation table is stored on the hard disk.

b A Minix-like file system uses a disk block size of 1K bytes (i.e. 1024 bytes). Assume that each disk block can hold 4 inodes. The file `/a/b/c` has a total length of 24K bytes. A process then performs the following three system calls on this file:

```
fd = open("/a/b/c", "r"); /* Open file for reading */
seek(fd, 1500);           /* Seek to location 1500 */
read(fd, buffer, 1024);   /* Read 1024 bytes of data */
```

Calculate, for the worst case, how many disk operations the file system will perform to implement these three system calls. For each disk operation specify which of the three system calls performs the operation and what the purpose of the disk operation is (i.e. what data it stores or retrieves).

c Suppose that the current version of a Minix-like file system does not support any links. What changes do you need to make to the internal structures of the file system (inodes, directories, etc.) to support hard links? What changes do you need to make to the internal structures of the file system to support soft links?

d Consider the introduction of a new RAID level, called RAID level 6. Compared to RAID level 5, RAID-6 works as follows: Instead of only one parity strip, RAID-6 has two parity strips. Assume that if the data in a strip changes, both parity strips will have to be updated too. Also, assume that the RAID-6 allows the loss of any two disks without perceived loss of data.

i) Explain the main performance bottleneck with RAID-5 for "small" writes.

ii) Explain the performance impact of RAID-6, as compared to RAID-5. When should the system administrator use RAID-6 instead of RAID-5?

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

4 Security

a Briefly describe the following terms in the context of operating system security.

i) Trojan horse

ii) Logic bomb

iii) Virus

b The following access matrix is used to control resources in an operating system:

	File1	File2	File3	CD-RW	D1	D2	D3	D4
D1	read	write	owner					
D2	read, write+							
D3	read	read, execute	execute	owner, write				enter
D4	read			write		enter		

The membership of domain looks as follows:

D1: Paul, Fred
D2: Greg
D3: Sophie, Susan, Charlotte
D4: Charles, Jo

Answer the follow questions and explain how you have derived these answers:

i) Who can access File2?

ii) How can Greg burn a CD using the CD-RW?

ii) Identify all resources and operations accessible to Fred.

iv) Under what circumstances can Jo lose write access to the CD-RW?

c Describe two different techniques for implementing an access matrix. What are their advantages and disadvantages?

d Capabilities have been widely explored in distributed systems as a way of transferring rights to remote users. Discuss what specific features are important if capabilities are to be used in this way, without creating security holes?

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