The University of Nottingham

SCHOOL OF COMPUTER SCIENCE

A LEVEL 3 MODULE, SPRING SEMESTER 2012-2013

OPERATING SYSTEMS

Time allowed TWO hours

Candidates may complete the front cover of their answer book and sign their desk card but must NOT write anything else until the start of the examination period is announced

You must answer FOUR questions out of SIX
(only the FOUR nominated solutions will be marked)

Only silent, self contained calculators with a Single-Line Display are permitted in this examination.

Dictionaries are not allowed with one exception. Those whose first language is not English may use a standard translation dictionary to translate between that language and English provided that neither language is the subject of this examination. Subject specific translation dictionaries are not permitted.

No electronic devices capable of storing and retrieving text, including electronic dictionaries, may be used.

DO NOT turn your examination paper over until instructed to do so

1. (a) Describe the three most basic process states in a multi-programming operating system and the transitions possible between them. [5 marks]

   (b) A computer system is mainly used for non-interactive work where jobs (processes) arrive randomly, persist until completed and then leave the system. There may be many processes that need scheduling concurrently. Describe two process scheduling algorithms that would be suitable for this system and explain why they are appropriate. A different system deals mainly with multiple, concurrent, interactive processes. Give two process scheduling algorithms for this situation and explain why they are appropriate. A new system is to be developed that will run a mix of the two types of processes. Are any of the previous scheduling algorithms appropriate? Describe one new algorithm that could be used. [10 marks]

   (c) (i) What are the two advantages that threads have over multiple processes? [2 marks]

   (ii) What are the differences between user-level threads and kernel-level threads and under what circumstances is one type better than the other? [4 marks]

   (d) Briefly explain the benefits of multi-threaded programming. [4 marks]

2. (a) An operating system needs to be chosen to run on a server. Many processes will execute concurrently each of which may contain programs with sparse data structures and stacks and heaps of unknown, but potentially very large size. The processes will require much more total memory than existing physical memory. Memory for each process must in general be protected from damage from other processes, but some shared memory must be possible to allow the processes to communicate. With the aid of a diagram, briefly explain a memory management technique that would be appropriate in these circumstances.
   [5 Marks]

   (b) Describe how you would implement the least recently used (LRU) page replacement algorithm in hardware. Is this algorithm the best in all cases? Why? [7 marks]

   (c) Consider the following page reference string:

   1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6

   Assume there are four (4) page frames that are initially empty. Show how many page faults would occur for the LRU page replacement algorithm. Show your working. [4 marks]

   (d) Briefly describe the concept of demand paging. What is thrashing? How does the system detect it and what can be done to eliminate it? [9 marks]

3. (a) A simple file system is to be designed that will usually access the files sequentially. Many small files will be created and deleted. Explain why a linked list file system might be appropriate. Describe two file system implementations that use linked lists and the advantages and disadvantages of each method. [12 marks]

(b) Describe the *i-node* method of implementing a file system. [8 marks]

(c) It has been suggested that the first part of each UNIX file be kept in the same disk block as its *i-node*. What, if any, would be the advantage of doing this? [5 marks]

4. Describe, compare and contrast two operating systems of your choice. Describe the advantages and disadvantages of the different aspects of their operation. [25 marks]

5. (a) Explain the mechanism and problems associated with multiprogramming operating systems that use *variable size partitions*. When linked lists are used to store and free partitions, a memory allocation algorithm is needed. Briefly describe three such algorithms. [13 marks]

(b) Consider the following segment table

Segment	Base	Limit
0	219	600
1	2300	14
2	90	100
3	1327	580
4	1952	96

What physical memory address would be generated for the following logical addresses?

(i) 0, 430

(ii) 1, 10

(iii) 2, 500

(iv) 3, 400

(v) 4, 112 [5 marks]

(c) Discuss the similarities and differences between memory management fragmentation with variable size segments and disk fragmentation. [7 marks]

6. (a) The starting position for a disk arm is at track 12. Given a disk with 80 tracks (0:79), where track requests are received in the following order:

48,21,1,24,21,39,77,6,60,

Calculate the number of tracks crossed when the following algorithms are used:

(i) First Come First Served.

(ii) Shortest Seek (Time) First.

(iii) The elevator (SCAN) algorithm starting in the direction DOWN. [15 marks]

(b) A disk takes 300 ms to rotate once, there are 100 sectors per track, and the disk arm motion is 12 ms between tracks, what rotational latency in sectors will be needed between tracks? [3 marks]

(c) What is the purpose of a RAID (redundant array of inexpensive disks) installation? Briefly describe the basic operation of RAID levels 0 to 5. [7 marks]