COMP25111

Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Operating Systems

Date: Thursday 27th January 2011

Time: 09:45 - 11:45

Please answer Question ONE and any TWO Questions from the other THREE questions provided

For full marks your answers should be concise as well as accurate. Marks will be awarded for reasoning and method as well as being correct

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This is a CLOSED book examination

The use of electronic calculators is NOT permitted

[PTO]

1. **<u>COMPULSORY.</u> Answer all parts.**

a) In the context of converting an address generated by a program [a compiler] to the actual address; state:

i) The names of the two memories involved (1 mark)
ii) The unit that performs [undertakes] this translation process (1 mark)

b) Differentiate between multiprogramming and fixed partitions. (2 marks)

c) Differentiate between software interrupts and hardware interrupts; in your answer give a brief description of each type of interrupt. (2 marks)

d) In the context of shared memory, state three reasons why it is necessary for processes to share memory. (2 marks)

e) In the context of permission information, e.g.: read (R), write (W), & execute (X). What can the RWX permission information control access to; with respect to security and protection? (2 marks)

f) In a segmented virtual memory system each segment has attributes associated with it; name and briefly describe the attributes. (2 marks)

g) What is the key difference between a System Call and a call to a library routine? Briefly explain why this is important. (2 marks)

h) Explain clearly what is achieved by making a Java instance method synchronized. (2 marks)

i) What does it mean to say that a deadlock has occurred between processes? (2 marks)

j) In Unix, how does a shell implement a pipe between commands? (2 marks)

2. a) Explain the difference between a process and a thread. (2 marks)

b) What does it mean to say that a system supports kernel threads? What are the advantages and disadvantages of kernel threads over user-level threads? (4 marks)

c) Define a semaphore, and the operations which can be performed on it. (3 marks)

d) In a particular application, there are three threads which change the value of a shared variable, x, and they use three semaphores, S1, S2, and S3, to control this, as shown below. Semaphores S1 and S2 are initialised to 0, and S3 is initialised to 1. These semaphores are not used in any other part of the code.

Thread-1	Thread-2	Thread-3
…	…	…
P(S1)	P(S2)	P(S3)
P(S2)	P(S2)	V(S2)
x = x*3	x = x+5	x = x-1
V(S3)	V(S1)	V(S2)
…	…	V(S2)

i) If the shared variable, x, is initially 0, and it is not changed anywhere else, what is its value after completion of the above threads? Justify your answer. (4 marks)

ii) What are the values of the three semaphores at the end of the above code? (3 marks)

iii) Would it matter if the two P operations in Thread-1 were exchanged? How might the behaviour change? (4 marks)

[PTO]

3. a) Explain clearly the algorithm used to locate a file referred to by a full pathname in a hierarchical file system. (4 marks)

b) In a system using File Allocation Tables (FATs) the value obtained by the above algorithm is the number of the first block. Describe carefully how such a system thereby provides access to the whole file? (4 marks)

c) What are the advantages and disadvantages of using inodes compared to a File Allocation Table (FAT)? (4 marks)

d) Suppose a new file system were invented with the following properties. Pointers to blocks on disk occupy 4 bytes. The contents of a file are given by a cnode (invented just for this system) which consists of 6 pointers (in order) for the first 6 blocks of the file, followed by 2 pointers to indirect blocks, i.e. blocks which contain pointers to the remaining blocks (in order). Derive an equation for the maximum size of a file (in bytes) as a function of the blocksize. (4 marks)

e) For the system described in part (d), give an algorithm which will return the pointer to the i'th block of a file. The result should be zero if the file has less than i blocks, and you should assume that unused pointers in the cnode and any indirect blocks are also zero. (4 marks)

4. a) Direct memory access (DMA) is interrupt driven. Given that a processor writes to a disk, utilizing DMA, describe the four-step DMA process for writing data. (4 marks)

b) A CPU instructs a hard disk that utilises DMA to write data to disk.

i) Name and briefly describe the two registers that are normally used during the DMA process. (1 mark)

ii) Transfer of data to a disk can actually be undertaken by programmed input/output (I/O) or interrupt I/O. Draw two flow charts [diagrams] that depict the sequence of events needed to perform disk writing using polling [programmed] I/O and interrupt I/O. (4 marks)

iii) Give a description of DMA. In your explanation address the following issues:

a) State if DMA can transfer data in two directions. (1 mark)

b) State the extent to which the processor intervenes. (1 mark)

iv) Briefly compare and contrast interrupt-driven I/O and programmed I/O. In your critique address the following issues:

a) Which is more efficient? (1 mark)

b) What they both rely on to transfer data? (1 mark)

c) What limits the processor with respect to the transfer of data? (1 mark)

d) What technique should be used for large volumes of data transfer? (1 mark)

c) Given an 8G address space and associated 256K page size; calculate the number of pages that result in the virtual address space. (1 mark)

d) Given a physical address size of 2G and associated 128K block size below. Calculate the number of page frames in the physical address space. (1 mark)

e) Given the simple page table diagram below, and the virtual address 0x00050006.

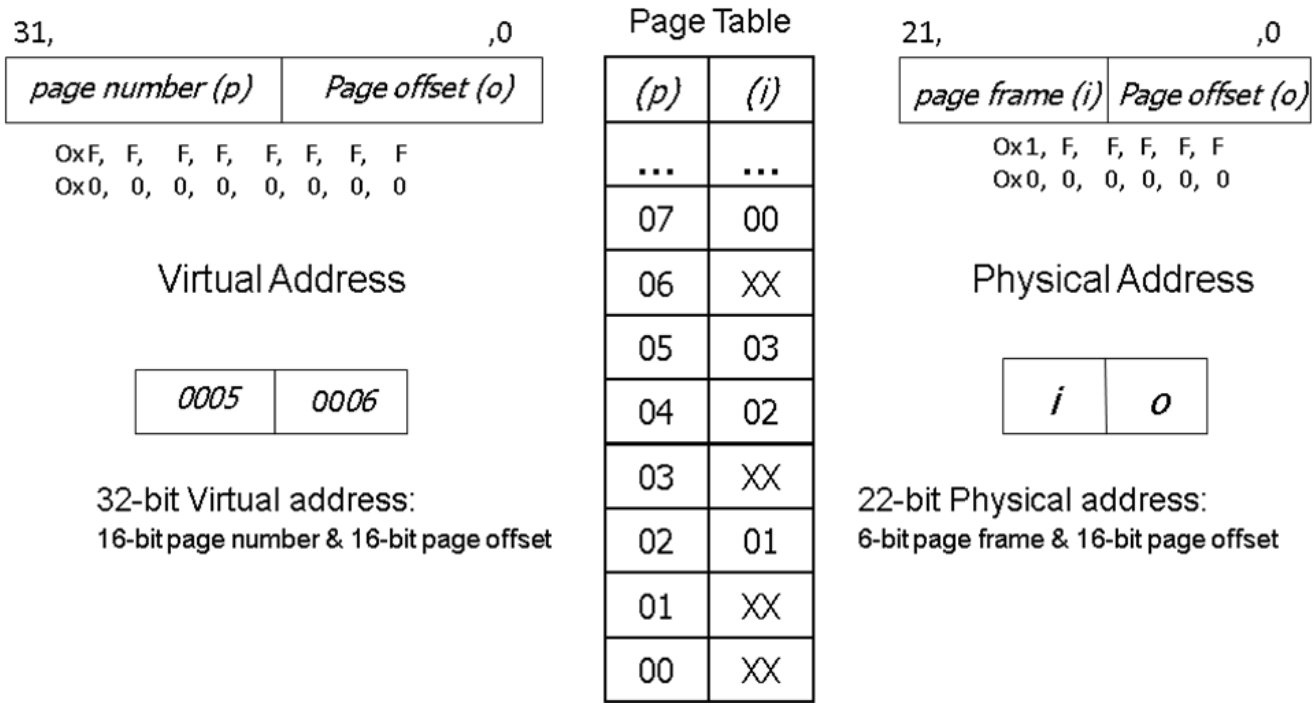
i) State the physical address given the data in the page table;

(1 mark)

(Question 4 continues on the following page)

(Question 4 continues from the previous page)

ii) Then give a brief description of the procedure the paged virtual memory utilises to generate a physical memory address from a virtual memory address. (2 marks)



END OF EXAMINATION