Birkbeck
(University of London)

MSc Examination for Internal Students

School of Computer Science and Information Systems

Computer Systems (COIY060H7)
Credit Value: 15

Date of Examination: Friday, 29 May 2009
Duration of Paper: 14:30 - 16:30

There are five questions in this paper, all of them are compulsory.
The paper is not prior-disclosed;
The use of electronic calculators is permitted.

Questions

1. (a) Briefly describe the use of binary semaphores in the context of interprocess communication. (5 marks)

   (b) Consider the following proposed solution to the Dining Philosophers problem for five philosophers:

```
semaphore fork[5] = 1;
semaphore s = 1;
int i
void philosopher(int i)
{
   while(true) {
   think();
   wait(s);
   wait(fork[i]);
   wait(fork[i+1 mod 5]);
   signal(s);
   eat();
   signal(fork[i]);
   signal(fork[i+1 mod 5]);
   }
}
```

   Determine whether this program avoids deadlock and starvation. (15 marks)

2. (a) Describe the motivation for and main characteristics of RISC architectures. (10 marks)

   (b) Explain what register windows are and how they are used to improve performance. (10 marks)

3. (a) Explain what instruction-level parallelism is and how it is limited by dependencies. (10 marks)

   (b) List which dependencies occur in the following example and how register renaming helps remove some of these dependencies.

```
I1: Move R3, R1     / R3 <- R1 /
I2: Add R4, R3, 1   / R4 <- R3 + 1 /
I3: Add R3, R5, 4   / R3 <- R5 + 4 /
I4: Add R7, R3, R4  / R7 <- R3 + R4 /
```

   (10 marks)

4. (a) Explain what page the table (PT) and the translation lookaside buffer (TLB) are and how they are used in a paging system. (10 marks)

   (b) Assume that

   - accessing and searching the TLB takes 5 ns,
   - transferring the data from the TLB into a register takes 10 ns,
   - updating a record in the TLB takes 15 ns,
   - accessing and searching the PT takes 50 ns,
   - transferring the data from the PT into a register takes 70 ns,
   - the TLB hit ratio is 0.6.

How many nanoseconds are needed in average to perform all the TLB and PT operations needed to compute the physical address for a given virtual address (assuming that all referenced pages are in main memory). (10 marks)

5. (a) Explain the importance of input/output (I/O) management in the context of operating systems. List some techniques that are used to improve the speed and efficiency of I/O operations. (8 marks)

   (b) A hard disk spins at 6000 rpm (revolution per minute), and it takes 100 microseconds (on average) for the head to traverse one track. Consider the following sequence of disk track requests: 27, 129, 110, 186, 147, 41, 10, 64, 120. Assume that initially the head is at track 30 and is moving in the direction of decreasing track number. Compute the time it takes to serve the requests using FIFO, SSF (shortest seek first) and SCAN (elevator) algorithms. (12 marks)