Birkbeck

(University of London)

BSc/FD EXAMINATION

Department of Computer Science and Information Systems

COMPUTER ORGANIZATION AND SYSTEM SOFTWARE (BUCI055H5)

CREDIT VALUE: 15 credits

Date of examination: 06/06/2016
Duration of paper: 14:30–16:30

There are **five** questions on this paper.

Answer **all** questions.

Each question carries **20** marks in total.

The use of supplementary material (notes, textbooks) and electronic calculators is **not** permitted.

1. (a) Explain the concepts of instruction-level parallelism and machine-level parallelism. (**4** marks)

   (b) Consider the following assembly code:

```
I1: LOAD r1 #1   // r1 <- #1
I2: LOAD r2 #2
I3: ADD r1 r2    // r1 <- r1 + r2
I4: LOAD r2 #3
I5: MUL r1 r2    // r1 <- r1 * r2
I6: LOAD r2 #4
I7: ADD r1 r2
```

   i. Express in a single mathematical formula what the above code computes. (**4** marks)

   ii. Explain dependencies (true or otherwise) and show them in the above assembly code. (**12** marks)

2. Consider the computation $(m1 * m2) + (m3 * m4)$ where $m1, \ldots$ denote the content of memory locations.

   (a) Write assembly code typical of RISC machines for this computation. Use at most two operands for each instruction (e.g., `ADD r1 r2` for `r1 <- r1 + r2`) and use at most three registers altogether. (**6** marks)

   (b) Briefly describe the main idea for pipelining. (**4** marks)

   (c) Show the pipeline activity by drawing a diagram when your assembly code is executed on a pipelined processor. There are three pipeline stages: fetch–decode, execute and write-back. State explicitly the additional assumptions you made. (**10** marks)

3. (a) What is the difference between a virtual and a physical address? (**6** marks)

   (b) How does address translation work in a paging system? (**6** marks)

   (c) A system has 48-bit virtual addresses and 36-bit physical addresses. If the system uses 4 KB pages, how many virtual and physical pages can the address space support? How many page frames are there if the size of main memory is 128 MB? (**8** marks)

4. (a) Explain the benefits of multithreaded processes. (**5** marks)

   (b) Describe two ways in which multithreaded processes can be implemented and compare their benefits. (**5** marks)

(c) Consider the following file server, where a single process is running on a single-core machine. It takes 20 ms to fetch the requested file if it is in the (disk) cache. If a disk operation is needed, as is the case for one-third of the requests, an additional 80 ms is needed. Compute how many requests/sec the server can handle if it is single threaded. How does this change when the server is multithreaded? (**10** marks)

5. Consider the following concurrent code, where || indicates that the executions of processes P_1 and P_2 are interleaved:

input variables: $y_1 = 0,\ y_2 = 0$

$$P_1 \left[\begin{array}{ll} \textbf{while}(\text{true})\{ & \\ \textbf{noncritical}; & \\ \textbf{while}(y_2 == 1); & \text{// loop} \\ y_1 = 1; & \\ \textbf{critical}; & \\ y_1 = 0; & \\ \} & \end{array}\right] \quad || \quad P_2 \left[\begin{array}{ll} \textbf{while}(\text{true})\{ & \\ \textbf{noncritical}; & \\ \textbf{while}(y_1 == 1); & \text{// loop} \\ y_2 = 1; & \\ \textbf{critical}; & \\ y_2 = 0; & \\ \} & \end{array}\right]$$

(a) Briefly explain the concepts of critical section, mutual exclusion and deadlock. (**4** marks)

(b) Determine whether the above code achieves mutual exclusion. (**8** marks)

(c) Determine whether the above code avoids deadlock. (**8** marks)

