UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE AND ENGINEERING

COMPUTER SCIENCE THREE

COMPUTER ARCHITECTURE

Thursday 25 May 2000

14:00 to 15:30

Examiners:

Prof. K. Turner (External)

Prof. G. Brebner (Chairman)

INSTRUCTIONS TO CANDIDATES

Answer any TWO questions.

All questions carry equal weight.

1. (a) Describe the concept and idealized performance of **pipelining** in general terms and then explain its application to the implementation of a typical RISC instruction cycle, using diagrams as appropriate. [*8 marks*]

   (b) Discuss the three main classes of **hazard** which impact upon the performance of a RISC instruction pipeline. [*9 marks*]

   (c) Explain, with the help of a simple example, the concept of **delayed branching**, indicating the conditions under which it can be usefully exploited. [*8 marks*]

2. (a) Discuss the phenomenon of **locality of reference** and explain how and why it is exploited in a multi-level memory system. [*6 marks*]

   (b) i. Explain, with the help of a simple diagram, the structure and operation of a **two-way set associative cache**. [*9 marks*]

   ii. A colleague on your design team proposes a 24 block first level cache with three sets of 8 blocks. Explain why this is unlikely to be a good idea. [*4 marks*]

   (c) Derive and explain *Amdahl's law*, then describe its relevance to the use of cache memory. [*6 marks*]

3. (a) The **CPU time** of a program has been defined as the product of the CPI (cycles per instruction) for the processor on which it runs, the total number of instructions executed (I) and the processor clock period (ϕ).

    i. Discuss the ways in which CPI, I and ϕ are related, in the sense that architectural attempts to improve one may impact upon the others. [*6 marks*]

    ii. Suggest why the simple formula outlined above may be over-simplistic when applied to a modern pipelined processor with a hierarchical memory system. [*5 marks*]

   (b) Define and explain the terms **MIPS** and **MFLOPS** and suggest why they are bad indicators of CPU performance, illustrating your answer with extreme examples. [*6 marks*]

   (c) Discuss the use and abuse of **kernels**, **synthetic benchmarks** and **benchmark suites** in measuring and reporting the performance of computer systems. [*8 marks*]