Engineering Tripos Part IIB, 4F14: Computer Systems, 2018-19

Module Leader

Dr A H Gee [1]

Lecturers

Dr A H Gee and Dr P O Kristensson

Coursework Leader

Dr P O Kristensson [2]

Timing and Structure

Lent Term. 75% exam / 25% coursework

Prerequisites

Part 1 Digital Circuits and Computing assumed

Aims

The aims of the course are to:

- Describe the computer hardware that underlies modern information processing systems.
- Explain how to write multithreaded software that runs on such hardware.

Objectives

As specific objectives, by the end of the course students should be able to:

- Appreciate the basic components needed to construct a computer and the different ways to interconnect these components, including the various ways of exploiting parallelism.
- Compare the instruction sets, implementation issues and performance of CISC and RISC architectures.
- Design efficient hardware for computer arithmetic.
- Understand the operation of pipelined datapaths.
- Describe memory organisation, addressing schemes and the use of caches; and their effects on performance.
- Compare the various ways of handling input and output in a computer system.
- Understand the concept of a memory model.
- Understand basic concurrency concepts.
- Design and implement thread-safe algorithms in C++.

Content

Computer Systems (8L + 2 examples classes, Dr Andrew Gee)
• Computer architecture, historical perspectives.
• Instruction set architectures, RISC vs CISC.
• ALU design, datapaths and control, pipelining.
• Memory hierarchy, caches, virtual memory.
• Input/output, bus organization, polling and interrupt-driven I/O, DMA.
• Parallel processing, SIMD and MIMD architectures.

**Assessment:** examination (75%), candidates to attempt two questions from a choice of three

**Parallel Programming (4L, Dr Per Ola Kristensson)**

• C++11/14/17 memory model.
• Race conditions, mutual exclusion, synchronization, starvation.
• Thread-safe data structures.
• C++11/14/17 threading library.

**Assessment:** coursework (25%)

**Coursework**

Multithreaded programming using the C++11/14/17 memory model and threading libraries. The programming exercise is an opportunity to experience how theoretical concepts from the lectures translate into actual working code using a state-of-the-art industry standard threading library. Time required: 4-8 hours programming plus 15 minutes demonstrating and discussing your code with an assessor. Please note that coursework assessment is not anonymous.

<table>
<thead>
<tr>
<th>Coursework</th>
<th>Format</th>
<th>Due date &amp; marks</th>
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<tbody>
<tr>
<td>Multithreaded programming</td>
<td>Individual</td>
<td>Software to be submitted:</td>
</tr>
<tr>
<td>Learning objectives:</td>
<td>Demonstrating your software Not anonymously marked</td>
<td>[15/60]</td>
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</table>
• To gain practical experience with the C++11/14/17 threading library.
• To design and implement thread-safe data structures.
• To practice concurrency control so as to avoid race conditions and starvation.

**Booklists**

Please see the [Booklist for Group F Courses][3] for references for this module.

**Examination Guidelines**

Please refer to [Form & conduct of the examinations][4].

Last modified: 17/05/2018 14:25

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