Module Leader
Dr AH Gee [1]

Lecturers
Dr AH Gee and Prof Per Ola Kristensson [2]

Timing and Structure
Lent Term. 75% exam / 25% coursework

Prerequisites
Part 1 Digital Circuits and Computing, including an understanding of C++ as taught in the Mars Lander project and the Part 1B Device Programming exercise. Students will be expected to write small programs in C++.

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, Prof 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>
</tr>
</thead>
<tbody>
<tr>
<td>Multithreaded programming</td>
<td>Individual</td>
<td>Software to be submitted during Lent Term or Assessment Term</td>
</tr>
<tr>
<td>Learning objectives:</td>
<td>Demonstrating your software</td>
<td>[15/60]</td>
</tr>
<tr>
<td></td>
<td>Not anonymously marked</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To gain practical experience with the C++11/14/17 threading library.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To design and implement thread-safe data structures.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To practice concurrency control so as to avoid race conditions and starvation.</td>
<td></td>
</tr>
</tbody>
</table>

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

Last modified: 21/05/2021 12:07

Source URL (modified on 21-05-21): http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4f14-computer-systems-2021-22

Links
[1] mailto:ahg13@cam.ac.uk
[2] mailto:ahg13@cam.ac.uk, pok21@cam.ac.uk