Module Leader
Dr A H Gee

Lecturers
Dr A H Gee and Dr P O Kristensson

Coursework Leader
Dr P O Kristensson

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 handed in Lent Term or Assessment Term</td>
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<tr>
<td>Learning objectives:</td>
<td>Demonstrating your software</td>
<td>[15/60]</td>
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<tr>
<td>• To gain practical experience with the C++11/14/17 threading library.</td>
<td>Not anonymously marked</td>
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<tr>
<td>• To design and implement thread-safe data structures.</td>
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<td>• To practice concurrency control so as to avoid race conditions and starvation.</td>
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**Booklists**

Please see the [Booklist for Group F Courses](http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4f14-computer-systems-2018-19) [3] for references for this module.

**Examination Guidelines**

Please refer to [Form & conduct of the examinations](http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4f14-computer-systems-2018-19) [4].

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