

## Engineering Tripos Part IIB, 4F14: Computer Systems, 2021-22

### 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.

Coursework	Format	Due date & marks
<b>Multithreaded programming</b>  <u>Learning objectives:</u> <ul style="list-style-type: none"><li>• To gain practical experience with the C++11/14/17 threading library.</li><li>• To design and implement thread-safe data structures.</li><li>• To practice concurrency control so as to avoid race conditions and starvation.</li></ul>	Individual  Demonstrating your software  Not anonymously marked	Software to be Lent Term or  Assessment Term  [15/60]

### 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].

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### Links

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[2] <mailto:ahg13@cam.ac.uk>, [pok21@cam.ac.uk](mailto:pok21@cam.ac.uk)

[3] <https://teaching23-24.eng.cam.ac.uk/content/form-conduct-examinations>