CO1108 Foundations of Computation

Credits: *15* **Convenor:** *Prof. M.R. Mousavi and Dr. I. Ulidowski* **Semester:** *2nd*

Prerequisites:	*Essential: CO1103* *Desirable: CO1102*				
Lectures:	*22*	*hours*	**Class Test Hours:**	*2*	*hours*
Tutorials:	*11*	*hours*	**Independent Study:**	*115*	*hours*
Assessment:	*Coursework: 40% + Two hour exam in May/June: 60%*				

Formative Coursework	*Summative Coursework*		
None	**Class Tests:**	*2*	*in total*
	Assignments:	*1*	*in total*

Learning Outcomes **Students should be able to:**

- Explain in broad terms the idea of foundations and theory in Computer Science;
- Discuss and classify grammars and formal languages; solve simple problems;
- Define and explain models of computation such as register and Turing machines, simple automata; construct simple models to solve problems.

Explanation of Prerequisites

Very rudimentary understanding of logic and discrete mathematics will be helpful. Some programming experience is also useful, but not essential.

Module Description

In this module we are primarily concerned with what computers can do. It turns out that there are problems that cannot be solved by computer or, at least, by machines corresponding to the mathematical models of computers we shall present. It is clearly sensible to investigate which problems cannot be solved; there is no point trying to program a computer to solve a problem that is unsolvable! A problem may be unsolvable in the sense that no computer program exists that will solve it or in the sense that any program that would solve it would take longer than the lifetime of the universe to run. We will give some precise mathematical models of the process of computation; within these models, we will see what sort of tasks can be performed.

At first sight, it may appear that these models are unduly simple and do not really capture all the subtleties of the process of computation. The advantages of using such models is two-fold. First, they are very simple to reason about, so that we can reach our conclusions much more simply than (for example) considering actual hardware and software components in fine detail. Second, they have proved to be very robust, in that successive generations of computers have all been shown to be no more powerful than the most general model we will present, and so the analysis based on these models has been useful throughout the history of Computer Science, whereas an analysis based on the specifics of various machines and programming languages quickly becomes obsolete.

Syllabus

Revision of basic mathematical pre-requisites.

Models of computation for regular languages such as finite automata and regular grammars and language-transformations between them.

Models of computation for context-free languages such as pushdown automata and context-free grammars. Their application in parsing, i.e., in recognising computer languages.

Turing machines as the universal model of computation and its application in specifying algorithmic concepts and its limitations, i.e., the halting problem.

Reading List

[C] H. R. Lewis and C. H. Papadimitriou, *Elements of the Theory of Computation, second edition; ISBN: 0132727412,* Prentice Hall, 1998.

[C] J. E. Hopcroft, R. Motwani and J. D. Ullman, *Introduction to Automata Theory, Languages and Computation; ISBN: 0321210298,* Addison-Wesley, 2007.

[C] J. G. Brookshear, *Formal Languages, Automata and Complexity,* Benjamin Cummings, 1989 (out of print, but copies available in the Library).

[C] D. Kelley, *Automata and Formal Languages - an Introduction,* Prentice Hall, 1995 (out of print, but copies available in the Library).

[C] D. Wood, *Theory of Computation,* Wiley, 1987 (out of print, but copies available in the Library).

[C] D. I. A. Cohen, *Introduction to Computer Theory; ISBN: 0471137723,* Wiley, 1996.

[C] J. Martin, *Introduction to Languages and the Theory of Computation; ISBN: 0071198547,* McGraw-Hill, 2008.

[C] P. Linz, *An introduction to Formal Languages and Automata; ISBN: 0763714224,* Jones and Bartlett, 2001.

Convenor's Notes

Resources Course notes, web page, study guide, worksheets, handouts, lecture rooms with two OHPs, past examination papers, past tests.

Assessment This module has a final examination, and ongoing coursework during term. There are 3 individual hand-in courseworks, CW1, CW2, and CW3. These comprise two class tests and one independent study assignment. The 30% coursework mark breaks down as follows:

CW1: Test 1, S, 15% of module mark

CW2: Test 2, S, 15% of module mark

CW3: Ongoing Worksheet, S, 10% of module mark