MPhil in Advanced Computer Science
Topics in Logic and Complexity

Leader:	Anuj Dawar
Timing:	Lent
Prerequisites:	Complexity Theory, Computation Theory, First-Order Logic
Structure:	16 Lectures

AIMS

This module aims to provide an introduction to topics in complexity theory beyond that covered in the undergraduate course and a grounding in research that connects this with methods from logic. The topics covered in the last four lectures will focus on current research and may vary from year to year.

SYLLABUS

1. Complexity Theory—a review of the major complexity classes (space, time, nondeterministic, etc.) and their interrelationships (3L).
2. First-order and second-order logic—their expressive power and computational complexity (3L).
3. Lower bounds on expressive power—the use of games and locality (3L).
4. Fixed-point logics and descriptive complexity (3L)
5. A selection of topics from the following (4L):
   (a) finite-variable logics;
   (b) complexity of constraint satisfaction problems;
   (c) random structures;
   (d) parameterized complexity;
   (e) complexity of logical theories;
   (f) logic and circuit complexity.
   (g) logics of polynomial time computation.

OBJECTIVES

On completion of this module students should:

- be familiar with the basic relationship between the expressive power of logic and computational complexity;
- be able to formulate simple game-based inexpressibility arguments;
- be able to identify current research issues relating logic to complexity.

COURSEWORK

PRACTICAL WORK

None.

ASSESSMENT

- The component being assessed: the lecture syllabus
- How it will be assessed: a take-home test.
- Who will set and mark the assessments: The principal lecturer.
- Its weighting toward the final module mark—100%.
- Form of the final module mark: a percentage

RECOMMENDED READING

Arora and Barak, *Computational Complexity*, CUP 2009.
Grädel *et al.*, *Finite Model Theory and its Applications*, Springer 2007.
Libkin, *Elements of Finite Model Theory*, Springer 2004
Immerman, *Descriptive Complexity*, Springer 1999.
Ebbinghaus and Flum, *Finite Model Theory* (2nd ed.), Springer 1999.

Last updated: August 2010