MPhil in Advanced Computer Science
Category Theory for Computer Science

Leaders:	Marcelo Fiore
Timing:	Michaelmas
Prerequisites:	Basic mathematical background
Structure:	16 Lectures

AIMS

This module aims to provide foundations on the mathematical theory of categories as needed in applications to computer science.

SYLLABUS

1. The language of categories: universal properties; categories; isomorphism; monomorphisms and epimorphisms.
2. Constructions in categories: graphs; diagrams; limits and colimits.
3. Constructions on categories: duality; products; sums; slices.
4. Functors (I): covariance, contravariance, mixed variance; full and faithfulness; equivalences.
5. Functors (II): variable sets; representable functors.
6. Natural transformations: functor categories; Yoneda lemma and embedding.
7. Adjunctions: free constructions; triangular laws; preservation properties; reflections; cartesian closed categories; quantifiers as adjoints.
8. Monads: adjunctions and monads; algebras and the Eilenberg-Moore category; free algebras and the Kleisli category; free monads.

OBJECTIVES

On completion of this module students should:

- be fluent in the basic language and proof methods of category theory, and thereby
- be able to read and study research papers in computer science that use and/or are based on category theory.

COURSEWORK

Exercise sheets will be provided.

PRACTICAL WORK

N/A

ASSESSMENT

All assessment will be set and marked by the course lecturer, and will take place in two stages.

- Firstly, students will be evaluated on a given list of problems for which written solutions should be provided halfway through the course. This will account for 25% of the total mark for the course.
- Secondly, students will be evaluated on a take home exam at the end of the course. This will account for 75% of the total mark for the course.

RECOMMENDED READING

Books (available from the CL library)

[1] S. Awodey. *Category Theory*. Oxford University Press, 2006.

[2] M. Barr and C. Wells. *Category Theory for Computing Science*. Centre de Recherches Mathématiques, third edition, 1999.

[3] R. Crole. *Categories for Types*. Cambridge University Press, 1993.

[4] F. W. Lawvere and S. Schanuel. *Conceptual Mathematics*. Cambridge University Press, 1997.

[5] P. Taylor. *Practical Foundations of Mathematics*. Cambridge Studies in Advanced Mathematics 59, Cambridge University Press, 1999.

On-line material

[1] M. Barr and C. Wells. *Category Theory*. Lecture Notes for ESSLLI, 1999.

[2] M. Fiore. *Rough notes on presheaves*. Notes for a postgraduate mini-course, PPS, Université Paris Diderot - Paris 7, 2001.

[3] D. Turi. *Category Theory Lecture Notes*. LFCS, University of Edinburgh, 1996–2001.

Last updated: May 2010