

Computing and Software 734
Formalized Mathematics
McMaster University, Winter 2014
Course Outline

Revised: 18 January 2014

Note: This course outline contains important information that may affect your grade. You should retain it throughout the term as you will be assumed to be familiar with the rules specified in this document.

Instructor

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Course Web Site

<http://imps.mcmaster.ca/courses/CAS-734-14/>

Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Lecture Schedule

Tu & Th 10:00–11:30 ITB 222

Calendar Description

“Computer-supported, formalized mathematical reasoning for practical applications. Specification and verification in higher-order logic. Interactive theorem proving systems. Techniques for developing axiomatic theories.”

Mission and Course Objectives

Formalized mathematics is mathematics that is expressed and developed within a formal logic. It is the basis for *formal methods* employed in computing and other disciplines. Formal mathematics is usually done with the aid of a mechanized mathematics system called a *proof assistant* that provides support for the development of axiomatic theories and for proving conjectures. The *mission* of this course is to introduce students to the field of formalized mathematics and to teach them how to develop mathematics formally using a proof assistant. The *learning objectives* of the course are:

1. Students should know and understand:
 - (a) The costs and benefits of formalized mathematics.
 - (b) The techniques for specifying mathematical models as axiomatic theories.
 - (c) The techniques for developing axiomatic theories.
 - (d) The tools employed in practice-oriented logics.
 - (e) The little theories method.
2. Students should be able to:
 - (a) Express mathematical models as axiomatic theories.
 - (b) Develop axiomatic theories using a proof assistant.

Work Plan

The course will consist of lectures by the instructor and presentations by the students. The students will also be required to do a series of exercises outside of class. Working alone or with a partner, each student is expected to learn how to use a proof assistant chosen from the list of suggestions given below. Most of the exercises will require the use of the chosen proof assistant. The presentations will describe and demonstrate the proof assistants chosen by the students. A student's grade will be based on the quality of his or her presentations and exercises. There will be no midterm tests or final exam.

Suggested proof assistants: ACL2, Agda, Coq, HOL Light, Isabelle/HOL, Mizar, PVS.

Academic Integrity

You are expected to exhibit honesty and use ethical behavior in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This

behavior can result in serious consequences, e.g., the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at

<http://www.mcmaster.ca/academicintegrity/>

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g., the submission of work that is not one’s own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

Your work must be your own. Plagiarism and copying will not be tolerated! If it is discovered that you plagiarized or copied, it will be considered as academic dishonesty.

Students may be asked to defend their written work orally.

Discrimination

The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem, that cannot be resolved by discussion among the persons concerned, individuals are reminded that they should contact their Department Chair and the Human Rights and Equity Services (HRES) office as soon as possible.

Course Modifications

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster e-mail and course websites weekly during the term and to note any changes. Your McMaster e-mail is the one with the address ending in @mcmaster.ca. This is a separate e-mail address from your Avenue address.

Other Policy Statements

1. Each student is strongly urged to submit a completed Questionnaire and Biographical Sketch which is available on the course web site.

2. Significant study and reading outside of class is required.
3. Students are expected to regularly attend the lectures and student presentations and to ask questions.
4. Exercises that are submitted late and presentations that are given late will be penalized 2% for each late day. For example, if an exercise was given a mark of 80 but was turned in one week late, the actual mark will be $80 - 7 \cdot 2 = 66$.
5. Suggestions on how to improve the course and the instructor's teaching methods are always welcomed.

Marking Scheme

The course grade will be based on the student's performance on the exercises and presentations as follows:

Exercises	60%
Presentations	40%
Total	100%

Tentative Syllabus

- 00 Preliminaries
- 01 What is Formalized Mathematics?
- 02 Review of Mathematical Logic
- 03 Review of First-Order Logic
- 04 Simple Type Theory
- 05 Axiomatic Mathematics
- 06 Proof Assistants
- 07 Practice-Oriented Logics
- 08 The Little Theories Method
- 09 Student Presentations