Software Engineering 2F03

Logic for Software Engineering

Fall 2005

Course Outline

Revised: 2 September 2005

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

Instructor

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Teaching Assistants

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Course Web Site

`http://www.cas.mcmaster.ca/~wmfarmer/SE-2F03-05/`

Schedule

Lectures		
M	12:30–13:20	HSC 1A4
T	13:30–14:20	HSC 1A4
R	12:30–13:20	HSC 1A4
Tutorials		
R	08:30–09:20	BSB 318
R	10:30–11:20	JHE 210

Calendar Description

"Foundations of propositional, predicate, higher-order, multiple-value logic; normal forms; deduction systems, models; practical examples of usage of logic in software engineering; introduction to automated theorem-proving systems."

Mission

Logic is the study of the principles underlying sound reasoning. It is the foundation for scientific inquiry and communication. Logic is particularly important to Software Engineering; it is the intellectual technology that Software Engineers use to create, analyze, and interconnect precise specifications and descriptions of software systems. It has often been said that logic is to Software Engineering what calculus is to other areas of Engineering. The mission of this course is to introduce Software Engineering students to the basic concepts of logic—e.g., theories, models, logical consequence, and proof—by examining a variety of logical systems that are employed by Software Engineers and Computer Scientists. Applications of logic in software development will be highlighted.

Required Text

M. Huth and M. Ryan, *Logic in Computer Science: Modelling and Reasoning about Systems*, Cambridge University Press, 2004. ISBN: 0-521-54310-X.

Work Plan

There will be lectures, tutorials, assignments, two midterm tests, and a final exam. The lectures will be given by the instructor during regular lecture periods, and the tutorials will be conducted by the teaching assistants during the tutorials session.

The midterm tests will be held on Tuesday, October 11, 2005 at 13:30–14:20 and on Tuesday, November 15, 2005 at 13:30–14:20 . The final exam will be 3 hours long. It will take place on the date scheduled by the University.

Log Book

Each student is expected to keep a detailed, up-to-date log book that records all the steps performed on the assignments. Sources of information, consultations with instructors, teaching assistants, and fellow students, lessons learned, etc. should be recorded. The entries in the log book should be listed chronologically with dates and times.

A copy of the student's log book must be included as part of each assignment.

Academic Dishonesty

Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and 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 kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at

`http://www.mcmaster.ca/senate/academic/ac_integrity.htm`

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, or that you have consulted with people not mentioned in your log book, it will be considered as academic dishonesty.

Students may be asked to defend their written work orally.

Other Policy Statements

1. Significant study and reading outside of class is required.
2. Regular class attendance is required. Attendance will be taken, and absences will be excused only in highly exceptional cases.
3. The student is expected to ask questions during class.
4. You may want to discuss the assignments with your fellow students. *If you do that, you must record a summary of your discussions in your log book including a list of all those with whom you had discussions and a description of what information you received.* It is part of your professional responsibility to give credit to all who have contributed to your work.
5. A student may use his or her texts and notes during the midterm test and final exam.
6. Assignments may not be submitted late and the midterm test may not be taken later without *prior* approval from the instructor.
7. The instructor reserves the right to require a deferred final exam to be oral.
8. Calculators are *not* permitted during the midterm tests and final exam.

9. 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.

10. Suggestions on how to improve the course and the instructor's teaching methods are always welcomed.

Grading

The course grade will be based on the student's performance on the assignments, midterm tests, and final exam as follows:

Assignments	20%
Midterm tests (2)	40%
Final exam	40%
Total	**100%**

Notes:

1. *A student who fails the final exam automatically fails the course.*

2. A student's final score will be reduced by one half point for each missed class (there is no penalty for the first *four* missed classes).

3. The instructor reserves the right to adjust the marks for an assignment, midterm test, or final exam by increasing or decreasing every score by a fixed number of points.

Syllabus

00 Preliminaries (.5 lecture)

01 Introduction (1.5 lectures)

1. What is logic?
2. Why is logic needed in software engineering?
3. Syntax vs. semantics
4. Language vs. metalanguage
5. Theory vs. model
6. Truth vs. proof

02 Propositional Logic (6 lectures)

1. Propositional connectives
2. Truth tables
3. Conjunctive and disjunctive normal forms
4. Proof systems for propositional logic
5. Applications of propositional logic
6. Automatic means of checking validity and satisfiability

03 First-Order Logic (12 lectures)

1. Terms and formulas
2. Quantifiers
3. Equality
4. Prenex normal form
5. Proof systems for first-order logic
6. Partial and total functions
7. Tabular expressions
8. Definite and indefinite description
9. Induction
10. Many-sorted first-order logic
11. Applications of first-order logic
12. Computer theorem proving systems

04 Temporal Logic and Model Checking (4 lectures)

1. Linear-time temporal logic (LTL)
2. Modeling checking for LTL
3. Applications of model checking
4. Modeling checking tools

05 Higher-Order Logic (4 lectures)

1. Church's type theory
2. Higher-order functions
3. Types
4. Lambda notation
5. Applications of higher-order logic
6. Higher-order theorem proving systems

06 Hoare Logic and Program Verification (4 lectures)

1. Hoare triples
2. Partial and total correctness

07 Other Logics (2 lectures)

1. Equational logic
2. Logics with undefinedness
3. Multivalued logics