The University of Calgary
Department of Philosophy

# Philosophy 279L05
# LOGIC I
## Winter 2006 — Richard Zach
### Course Outline

| | Instructor | Teaching Assistant | |
|---|---|---|---|
| | **Richard Zach** | **Rafał Urbaniak** | |
| Office: | 1254 Social Sciences | 1227 Social Sciences | |
| Office Hours: | TuTh 12:30–1:15 | W 12–1 | |
| | or by appointment. Note that OH may be changed; check the website for change notices. | | |
| Phone: | 220–3170 | 220–6463 | |
| email: | rzach@ucalgary.ca | rafal.urbaniak@ucalgary.ca | |
| Meetings: | **Lectures** | **Tutorials** | |
| | TuTh 2–3:15 | W 10-11 (Sec 13) | 59 Science Theatres |
| | 143 Science Theatres | W 11–12 (Sec 14) | 59 Science Theatres |
| | | Th 9:30–10:30 (Sec 15) | 57 Science Theatres |

### Course Description

The course will introduce you to the semantics and proof-theory of first-order logic. We will learn how to "speak" the language of FOL, study the method of truth tables, become proficient in giving formal and informal proofs, and learn how to construct and argue about first-order interpretations. These methods will enable us to answer, in particular cases, the questions that logic is primarily concerned with: When does something follow from something else? What are logical truths? Which arguments are logically valid? We will also look at some results and notions which are important for the applications of formal logic, such as normal forms and expressive power of propositional and first-order logic, and prove, in outline, some important theorems relating semantics and proof theory (soundness, completeness). We will touch on some applications of logic to philosophy and mathematics.

### Evaluation

6 homework assignments, a midterm exam, a Registrar-scheduled final exam, and participation in lecture, tutorial, and in discussions on the class website. The lowest homework score will be dropped, the remaining 5 assignments each count 10% towards the final grade. The midterm counts 20%, the final 25%, and class participation counts 5%. You must hand in all 6 assignments, and you must take the midterm and final exams to pass the course. You must receive a D or better on the final to receive a D or better in the course.

Each assignment will be graded on a scale of 0–100. The final score is then computed according to the percentages given above. The following table will be used to convert the final score to letter grades (the ranges include the lower score and exclude the upper, e.g., 83 earns a B, not a B–):

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 98–100 | A+ | 87–90 | B+ | 77–80 | C+ | 67–70 | D+ |
| 93–98 | A | 83–87 | B | 73–77 | C | 60–67 | D |
| 90–93 | A– | 80–83 | B– | 70–73 | C– | $< 60$ | F |

The grades will not be curved.

**Textbook and Software**

Jon Barwise and John Etchemendy, *Language, Proof and Logic*, CSLI/Chicago University Press

*The Grade Grinder.* The text comes with a CD and a non-transferable use license for software (the "Grade Grinder") which you will be using to prepare your homework assignments. For this reason, you have to buy a new copy of the text. On the CD sleeve you find a registration ID. **Write this ID down in a safe place**—without it, you will not be able to turn in your assignments.

*Contents of Software CD.* The software CD that comes with the text contains three programs (*Tarski's World*, *Boole*, and *Fitch*) which you will use to complete homework problems. The program *Submit* lets you turn in your completed solutions to the Grade Grinder. The CD also contains the entire textbook in PDF format. **Please take the time to read the software manual.** It contains useful information, in particular, keyboard shortcuts for logical symbols, which will make typing formulas much easier.

Because the text is bundled with software, the book cannot be returned once the seal is broken. If you'd like to take a look at the text before opening yours, you can check out a copy at the Reserves Desk in MacKimmie Library, or come by my office. The software can be run from CD on any computer running Windows, so you can take the CD on reserve up to the Information Commons to play with the software, or later to do your homework. (The software also runs on MacOS, but not directly from CD). LPL is also installed in the TRI Computer Lab in the basement of Social Sciences.

*LPL Website.* The LPL team maintains a website with helpful information. Check it out at:

http://lpl.stanford.edu/

Among other things, the website contains hints and solutions to selected exercises, and a download area where you can obtain the contents of the CD with your registration ID. Thus, if you lose your CD, you will still have access to the software.

**Assignments and Policies**

Exercise sets will in general be due on Fridays at 12:00 noon. Written parts of the assignment should be dropped off in a box just inside the Philosophy Department (Social Sciences, 12th floor), electronic parts have to be turned in using Submit (one of the four programs in LPL). The written parts of the assignments must be submitted on paper; emailed copies will not be accepted.

Your TA is in charge of the homework marking; please pick up your marked assignments during tutorial or in office hours from him.

*Late work and extensions.* The lowest homework score is dropped, this allows you to hand in one assignment late without penalty. Therefore, no late assignments will be accepted for credit. However, **you have to turn in all six assignments within one week of the due dates**.

There will be no make-up exams under normal circumstances; for the final exam, university policies for deferral of exams apply.

*Collaboration.* Collaboration on exercises is encouraged. However, you must write up your own solutions. This means that for the electronic parts, **you must create solution files completely from scratch.** The LPL software can tell if you've copied someone else's exercise files. You are also required to list the names of the students with whom you've collaborated on the assignment. **If the Grade Grinder flags an exercise on your assignment as not being created independently (i.e., it is "similar" or "identical" to another student's), your assignment and those of whoever you received the file from or gave the file to will receive a score of 0.**

You're not allowed to collaborate on the midterm and final exams, of course. Midterm and final will be closed-book. Be aware that cheating on an exam is a serious academic offense and can result in suspension or expulsion.

*Participation.* 5% of your grade will be determined by class participation. This includes participation in discussions on the class website. Five serious posts on the website (asking a question, giving a hint, providing an answer to someone else's question) over the course of the term will earn you full marks (5 points) for the participation part of your final grade. Only posts made before the time of the final exam count. If all your posts occur within one 7-day period, you will receive a maximum of 3 points. Consistent participation in class discussions during lecture or tutorials of course also counts.

**Lecture and Tutorial**

This class is accompanied by scheduled tutorials. Tutorials are led by Rafał Urbaniak, who guides you through the material in a more hands-on manner than is possible in lecture. This is where you should go to pick up tips for the assignments, ask questions, and go over problems in detail.

Some students find the material relatively easy to pick up on their own, and the software makes self-directed study particularly easy. Note, however, that only very good students can get away with that. Many students who don't attend lecture or tutorial just end up failing the class; thus, although attendance in lecture and tutorial is not mandatory, it is highly encouraged. Although, generally, studying the textbook is sufficient for completing the homework assignments and tests, you are nevertheless *responsible for knowing what is covered in lecture and tutorial.* Conversely, you are also responsible for studying the assigned chapters in the textbook.

**Course Website**

A course website on U of C's Blackboard server has been set up. You should be automatically registered on the first day of class if you're registered in the class. You can find the website at

http://blackboard.ucalgary.ca/

To access the BlackBoard site, you can either go directly to blackboard.ucalgary.ca and log in with your IT account name and password, or you can access it through the myUofC portal (my.ucalgary.ca; log in with your eID). If you don't have an eID or IT account, see

http://elearn.ucalgary.ca/help.html

**You must log on at least once by the end of the second week of class.**

If you are not registered in the course on the first day of class, you will be added to the website within a day of registering.

We will use the email function on BlackBoard to send out important notices. Therefore, **please make sure your email address on file with the University is current.** You can change it on InfoNet (http://www.ucalgary.ca/infonet/).

**What You Have to Do Now**

1. Attend lecture and tutorial the first two weeks of class (tutorial starts the second week).
2. Buy the textbook (remember, you need a new copy).
3. Register for a UCID and eID, and make sure your email address is current in InfoNet.
4. Log on to the class website and familiarize yourself with the discussion board.
5. If you register your email address with Submit, make sure you choose an email address which will be working throughout the semester.

**Three Most Frequently Asked Questions**

*This is a philosophy course at an introductory level. So it's really easy, right?*

No. This is a course in formal logic. Some people (especially science, computer science, and math majors) find the material easy. Some people (including, surprisingly, many computer science majors) find the material very hard. In terms of work required and "feel" it is much more like a math course than a philosophy course. You don't need to know (much) math to do well here, but you do need a certain ability to think in abstract terms.

The average grade is about a C+/B–. In any given term, roughly 25% of registered students end up getting A-range grades; 25% between B– and B+; 20% between C– and C+; 5% a D or D+; 5% of those taking the final exam got F's; and about 20% withdraw. If you're worried that only science majors do well here: Some of the top students in previous classes majored in fine art, religious studies, philosophy, and management.

*So how much work does it require?*

It is not unusual for students to spend 10–15 hours on an assignment (including studying the material in the notes and reading the textbook). It takes less time if you keep on top of the reading and do the assignments as we cover the material in class. Some students aren't very good at budgeting time and leave assignments to a day before the due date. Then it certainly will take a lot of time, and it will be difficult to complete the assignment.

10–15 hours per assignment isn't that much on average. With six assignments, this works out to about 5–7 hours a week, or about 2 hours per our spent in class. The rule of thumb for class work in North American universities is 2–3 hours of work outside of class for every hour in class.

*What's with the grade scale? 60 points for a D, 93 for an A! That's harsh!*

In many courses (including other sections of PHIL 279/377) the grade scale is set so that 50 is a D, and sometimes anything over 90 is an A. In those other courses, however, it is much harder to attain these scores. In this course, your assignments count for 50% of the final grade, in others it is usually much less. It is easier in general to score well on homework assignments: there is no time pressure, you have textbook and notes available, and you can talk to the instructors about the problems. In this course, in addition, you are encouraged to collaborate with your colleagues, and the final score is the average of your five best assignments (lowest score dropped). Also, since about 75% of the problems are done on the computer, you can have the computer check your solutions before you submit them. Thus, for 75% of your assignments, there is almost no reason other than lack of time for you not to get a perfect score. In addition, 5% of your grade consists in participation (in class, on the website). That is another 5% which are (almost) "free."

So, the grade scale, although it "looks" harsh, is in fact just as harsh (or lenient) as in other courses. Experience shows that the grade scale, as it stands, results in a perfectly average grade distribution, and the final letter grades students receive on the whole corresponds closely to the definitions of those letter grades in the University Calendar.

More questions and answers at http://www.ucalgary.ca/∼rzach/279/.

**Syllabus**

This is a tentative syllabus to give you a rough idea what parts of the book we will cover when. The assignment and midterm dates are firm, however.

**Week 1: The Language of FOL** 2 lectures (Jan 10, 12); Chapter 1.

*Learning goals:* Understanding formal first-order languages. Syntax of FOL: Predicate symbols, individual constants, function symbols. Examples of first-order languages: the blocks language, the language of arithmetic.

**Week 2: The Logic of Atomic Sentences** 1 lecture (Jan 17); Chapter 2.

*Learning goals:* Understanding logical validity of arguments. How to show arguments are valid: Basic properties of the identity predicate: reflexivity, principle of the substitutability of identicals. Basic properties of other predicate symbols (transitivity, reflexivity, symmetry, inverse relations). Informal proofs. Fitch and formal proofs. How to show that arguments are not valid: the method of counterexamples..

**Introduction to the Boolean connectives** 1 lecture (Jan 19); Chapter 3.

*Learning goals:* Syntax and semantics of Boolean connectives: Formation rules for sentences of FOL using $\wedge$, $\vee$, $\neg$. Truth tables for the Boolean connectives.

Tutorials start Wednesday, Jan 18.

**Week 3: The Boolean Connectives (cont'd)** 1 lecture (Jan 24); Chapter 3.

*Learning goals:* Translating sentences from English into FOL using the Boolean connectives. Expressive power of the Boolean connectives: "neither ... nor —" and "not both ... and —"; how to express complicated things using the blocks language and the Boolean connectives.

**The Logic of Boolean Connectives** 1 lecture (Jan 26): Chapter 4.

*Learning goals:* Understanding logical truth, tautologies, and TW-necessities. Tautological equivalence, consequence, and validity. The method of truth tables (Ch. 4)

You must complete the "You try it" exercise on pp. 8–10 of the text and submit "World Submit Me 1" by Tuesday, Jan 24, midnight.

Assignment 1 due Friday, Jan 27 (covers Ch. 1–3)

**Week 4: Chains of equivalences and normal forms** 1 lecture (Jan 31): Chapter 4.

*Learning goals:* Tautological equivalences: De Morgan's Laws and other equivalent transformations. Proving tautological equivalence by a chain of equivalences. Negation, conjunctive and disjunctive normal forms.

**Formal and informal proofs using Boolean connectives** 1 lecture (Feb 2): Chapters 5, 6.

*Learning goals:* Proving arguments valid by informal and formal proofs. Basic properties of $\wedge$ and $\vee$. Formal rules for $\wedge$ and $\vee$.

**Week 5: Formal and informal proofs using Boolean connectives (cont'd)** 2 lectures (Feb 7, 9): Chapter 6.

*Learning goals:* Basic properties of $\neg$. Indirect proof and formal proofs with $\neg$. Arguments with inconsistent premises. Informal proofs about FOL. Formal proofs of tautologies. Strategies for formal proofs.

Assignment 2 due Friday, Feb 10 (covers Ch. 4–5, parts of 6)

**Week 6: The Conditionals** 1 lecture (Feb 14): Chapter 7 and 8.

*Learning goals:* Truth tables for $\rightarrow$ and $\leftrightarrow$. Translations from English to FOL using the conditionals. Conversational implicature. Rules for formal proofs involving $\rightarrow$ and $\leftrightarrow$.

**Truth-functional completeness** 1 lecture (Feb 16): Section 7.4.

*Learning goals:* Understanding the aims of meta-theory. Definition and proof of truth-functional completeness for $\wedge$, $\vee$, and $\neg$. The Sheffer stroke.

Reading week: Feb 18–26.

**Week 7: Introduction to Quantification** 2 lectures (Feb 28, Mar 2): Chapter 9

*Learning goals:* Understanding syntax and semantics of quantifiers: well-formed formulas, free and bound variables, satisfaction. The Aristotelian forms. Simple translations.

Assignment 3 due Friday, Mar 3 (covers Ch. 6–8)

**Week 8: First-order validity and consequence** 1 lecture (Mar 9): Sections 10.1, 10.2.

*Learning goals:* The truth-functional form algorithm: when are sentences of FOL tautologies? The replacement method. First-order interpretations. First-order validity and consequence.

**Midterm exam in class, Tuesday, Mar 7**

**Week 9: First-order validity and first-order interpretations continued** 1 lecture (Mar 14): Chapter 10.

*Learning goals:* Constructing first-order interpretations. Using Venn diagrams to specify interpretations. Relations between logical notions.

**Multiple quantification** 1 lecture (Mar 16): Chapter 11

*Learning goals:* Meaning and use of multiple occurrences of the same quantifier. Translation mistakes: different variables does not mean different objects. Meaning and use of mixed quantifiers. The step-by-step method of translation. Understanding why the order of quantifiers matter, ambiguity. Expressing complicated properties using quantifiers, in particular in the language of arithmetic.

Assignment 4 due Friday, Mar 17 (covers Ch. 9–10)

**Week 10: Multiple quantification continued** 1 lecture (Mar 21): Section 11.4, 11.5

*Learning goals:* Understanding and translating anaphora. Recognizing ambiguity and translating ambiguous sentences.

No lecture Mar 23, review.

**Week 11: Formal proofs with quantifiers** 2 lectures (Mar 28, 30): Chapter 13

*Learning goals:* Understanding and applying the introduction and elimination rules for $\forall$, $\exists$. Strategies for proofs with quantifiers. Proofs with multiple and mixed quantifiers. Proofs with equality.

Assignment 5 due Friday, Mar 31 (covers Ch. 10–11)

**Week 12: Numerical Quantification and Definite Descriptions** 1 lecture (Apr 4): Sec. 14.1, 14.3

*Learning goals:* Understanding numerical quantification: how to express 'there are exactly/at most/at least $n$ things of a certain kind.' Russell's and Strawson's analyses of definite descriptions. How to express 'both' and 'neither' in FOL.

**Basic metatheory** 1 lecture (Apr 6): Section 8.3

*Learning goals:* Understanding the significance of soundness and completeness. Sketch of a soundness proof.

**Week 13: Catchup, Outlook, Review** 2 lectures (Apr 11, 13)

*Learning goals:* Understanding the 'big picture.' Significance and application of logic. Limitations of logic: undecidability, incompleteness.

Assignment 6 due Friday, Apr 14 (covers Ch. 13, Sec. 14.1–2, Sec. 8.3)