University of Calgary
Department of Philosophy

# Philosophy 379.01 Logic II

| Fall 2009 | MWF 14:00 - 14:50 | ST 027 |
|---|---|---|

*Instructor* Nicole Wyatt
Social Sciences 1214
403-220-3166
nicole.wyatt@ucalgary.ca
*Office Hours:* Fridays 12:30-1:30pm, and by appointment

*Text* Boolos, G.S., J.P. Burgess, and R.C. Jeffery. *Computability and Logic*. 5th edition. Cambridge University Press. (BBJ)

## Description

A formal logic consists of a symbolic language together with a semantics, which captures the possible meanings or truth-conditions of the sentences of the language, and a deductive system, which aims to capture which inferences are correct. In this course we study the scope and limits of formal logic by examining the relationship between these three parts of a logic. The major results to be presented include soundness ("the deductive system captures only truths") completeness ("the deductive system captures all the truths") undecidability ("there is no mechanical procedure for establishing whether or not an argument is valid"), and the Löwenheim-Skolem theorems (which concern some of the limits on the expressive power of first-order logic). Along the way we will study some set theory, recursive functions, Turing-machines, and the limits of computation. The course is fast paced and students are expected to supplement lectures with significant independent study.

This is a course in metalogic. It builds upon the material in Logic I (Phil 279), but is very different in character. In Logic II, we prove theorems about logical systems (and not in logical systems, i.e., there will be almost no formal proofs). Doing well in 279 is no guarantee that this will come easy to you. Some of the material we will be covering is discussed in your 279/377 text—if you used the Logic Book, review chapters 8 and 11; in Chellas' Elementary Formal Logic, review chapters 7 and 9 and the appendices; in Language, Proof and Logic, review chapters 15, 16, 18.1-18.3; in Formal Logic: Its Scope and Limits, sections 2.7-2.10, 313-3.15, 4.13-4.15.

## Provisional schedule of topics and readings

***Computability***

Week 1-2 Introduction: History, Basic set theory; Enumerability and diagonalization. BBJ 1,2

Week 2-3 Turing machines: Turing-computable functions and non-Turing-computable functions, the Church-Turing thesis, Unsolvability of the halting problem. BBJ 3, 4

***Logic***

Week 3-4 Review of first order logic: Formal semantics. Soundness, Completeness, Decidability, Compactness, Löwenheim-Skolem theorems. BBJ 9, 10, 12

Week 4-8 Proof of Compactness for first order logic with and without identity and terms: Satisfaction and closure properties, canonical models. BBJ 13

Week 9-10 Proof of Soundness and Completeness for first-order logic with and without identity and terms: The sequent calculus, soundness of the sequent calculus, completeness of the sequent calculus, soundness and completeness for alternate deductive systems. BBJ 14

### *Computability and Logic*

Week 11-13 Undecidability: The halting problem and the undecidability of first order logic. BBJ 11.1

## Evaluation

Grades in this class will be based on homework, four assignments, a take home midterm test, and a take home final examination.

### *Due Dates*

Homework questions will be due on Mondays, with the first due Sept 14th. There will be no homework due on Oct 19th, Nov 16th, or Dec 7th.

| | |
|---|---|
| Assignment 1 | Friday September 25th |
| Assignment 2 | Friday October 9th |
| Take Home Test | Friday October 23rd |
| Assignment 3 | Friday November 6th |
| Assignment 4 | Friday November 27th |
| Take Home Exam | Friday December 11th |

### *Grading*

1. *Ceteris paribus*, the homework will collectively be worth 10%, the assignments will be collectively worth 40%, the test will be worth 25%, and the final exam will be worth 25%.
2. Students must receive a passing grade (D or better) on the final exam in order to pass the course.
3. Homework will not be individually graded, but sample answers will be given and discussed in class. Grades for the homework as a whole will be assigned as follows: 10 weeks submitted=A, 9=A-, 8=B+, 7=B, 6=B-, 5=C+, 4=C, 3=C-, 2=D+, 1=D, 0 = F.
4. Later virtue will be allowed to redeem earlier sin.
5. Tests and assignments will be graded on both accuracy and quality of presentation. As noted below in the grading rubric, an A answer must be correct but also reasonably direct and elegant.

### *Grading rubric*

On each assignment and test question you will receive a letter grade reflecting the level of mastery of the material shown by the work you submit. According to the *Calendar* letter grades are defined as follows:

A Excellent—superior performance, showing comprehensive understanding of subject matter. (A solution to an assigned problem shows that you understand the problem, is complete and rigorously correct, and is reasonably direct and elegant.)

B Good—clearly above average performance with knowledge of subject matter generally complete. (You understand the problem and give a complete solution, although there may be minor gaps in the proof, or the solution is correct but circuitous.)

C Satisfactory—basic understanding of the subject matter. (You understand what the question is asking but your solution contains significant errors or gaps.)

D Minimal pass—marginal performance. (It is not clear that you understand what the question is asking, or your proposed solution goes completely in the wrong direction.)

F Fail—Unsatisfactory performance.

In computing your assignment or exam grade, your marks on individual questions will be converted to grade points as defined in the calendar (A = 4, B = 3, C = 2, D = 1, F = 0). "Slash" grades are possible and have grade point values 0.5 below the higher grade (e.g. A/B = 3.5). Each assignment or exam grade will be equal to the average of the grade point value of the questions (e.g. a 3 question assignment with grades A B B would receive a grade point score of 3.33). Your course gpa will be calculated according to the weights given above. *Ceteris paribus,* the final mark is the letter grade corresponding to the course gpa plus a margin of 0.1. For the final grade, +'s and –'s are possible too; as defined in the *Calendar*, +/– adds/subtracts 0.3 grade points. In other words, a course gpa of 3.9 or higher receives an final grade of A, at least 3.6 and less than 3.9 an A–, and so on. There is no D– grade. A+ is reserved for truly exceptional performance.

### *Late policy*

Assignments will not normally be accepted after the deadlines unless special permission has been given by the instructor. Failure to submit an assignment or test on time will normally result in a mark of zero. Students who cannot submit an assignment or a test due to medical reasons or other reasonable grounds should contact the instructor as soon as possible.

### *Collaboration*

Collaboration on homework and assignments is encouraged. However, you must write up your own solutions, and obviously you must not simply copy someone else's solutions. You are also required to list the names of the students with whom you've collaborated on the homework or assignment. ***If you collaborate without following these instructions, it constitutes cheating.***

### *Plagiarism*

You might think that it's only plagiarism if you copy a term paper off the Internet. However, you can also plagiarize in a logic course, e.g., by copying a proof verbatim from the textbook or lecture notes (and only making the necessary changes to apply it to the assigned problem.) The point of logic problems which are similar to the proofs in the text or notes is to make you work through those proofs, understand them, and then prove a similar result on the homework or an assignment. Hence, all homework and assignment solutions must be in your own words; copying or paraphrasing closely from the text will be treated as plagiarism.

## Course website

A course website on U of C's BlackBoard server has been set up. You will be automatically registered if you're registered in the class. To access the BlackBoard site, you can either go directly to blackboard.ucalgary.ca and log in with your UCIT 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 UCIT account, see elearn.ucalgary.ca/help.html.

The website will house lecture notes (no warranties express or implied, these are genuinely my lecture notes and are not a replacement for attending lectures or the textbook), links to supplemental reading materials, and model answers for homework and assignment questions. You may submit homework and assignments online using the Assignment link on the left hand menu.

The lecture notes and other materials may also be accessed at logic2.ucalgaryblogs.ca. The calendar for the class is available as a Google Calendar—the address may be found on the website.