

## PHL 345 INTERMEDIATE LOGIC

**Location and times** Sidney Smith Hall, room 1084, Friday 10-1. Directions for accessing the classroom can be found online here: <http://www.classfind.com/toronto/room/SS1084>

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### 1. Course policy and general information

**1.1. Required textbook** Theodore Sider, *Logic for Philosophy* (abbreviated *LP*), Oxford University Press, 2010, available for purchase at the University of Toronto bookstore (this can be done online at [http://uoftbookstore.com/buy\\_book\\_detail.asp?pf\\_id=12674169](http://uoftbookstore.com/buy_book_detail.asp?pf_id=12674169) or at the St. George location, 214 College Street, telephone number 416-640-7900). This is our main reading source. However, on the one hand we will not use the entirety of this text and on the other hand we will study some other sources. Sometimes we might depart from the order in which Sider arranges the material.

**Other texts** Peter Smith, the author of another excellent textbook (*Introduction to Formal Logic*, Cambridge University Press, 3<sup>rd</sup> corrected reprint, 2010) maintains a very rich website dedicated to logic at <http://www.logicmatters.net/>. There are many useful documents posted there, including his lectures, answers to exercises and sets of problems (the Cambridge worksheets). Some of these materials will be included on the Blackboard course page, where I will also make available my own notes and handouts, as well as the homework assignments. We will also use excerpts from Derek Goldrei's book *Propositional and Predicate Calculus. A Model of Argument* (Springer 2005).

The final take-home exam will include a short essay (5-6 pages, around 1600 words) on philosophical topics related to logic (presupposition, modal skepticism, knowability paradox) and a special folder on Blackboard (marked 'Final exam essay') will contain materials about this assignment.

**1.2 Character of the course** Contemporary logic is a highly developed science. It is impossible to present its main aspects in an informal way, and therefore this class will be rather technical. For instance, the most important proof technique used in the course is that of *proof by induction*, which we appear repeatedly in several guises.

It follows that some experience with elementary logic, discrete mathematics, algebra or computer science would be helpful (hence the prerequisites included in the course description: PHL 245 and a full course in PHL/CSC/MAT). Most important is the willingness to work hard on material that might be abstract to an unfamiliar degree! The course will also test your ability as a problem solver (under some degree of time pressure in the two tests).

**1.3 Online materials** As indicated above lectures, homework assignments, solutions to problems and some philosophical articles will be posted on Blackboard. **Students are expected to follow**

**closely the updates of these materials. I will also organize a discussion forum with the purpose of facilitating interaction between students, for example in organizing study groups.**

**1.4 Grading** The final grade will be calculated taking into account three factors: scores in homework and tests, and class participation. **There will be 5 homework assignments of which the first (designed to give you an idea of what you will be facing in this class) will be self-graded, an in-class midterm and a final take-home exam.** Each will be scored from 0 to 100. The average of the instructor graded homework scores will count for 30% and the average of the test scores for 60% of the final score. Class participation will count for the remaining 10%, and it includes as basic element (but is not limited to) attendance. **Attendance will be recorded beginning with the first meeting. Make sure that your name is on the attendance list after each class.**

The due dates for homework assignments are indicated in the schedule below and the problem sets will be announced in class and posted on Blackboard one week before those dates. **The penalty for late submission will be the equivalent in points of a one letter grade per day.** The midterm problem selection will be similar to that of the homework assignments, but the final take-home exam will include writing a short essay on one of several logical issues that have philosophical relevance. **This exam will be posted online three weeks before the end of the semester. Collaboration in the completion of homework and of this final assignment is strictly forbidden and if detected it will be treated as plagiarism. See the appendix to the syllabus on the matter of academic integrity.**

Students who miss the midterm **due to serious and documented reasons** will be offered a make-up test during my office hours. The documentation accepted includes UofT medical certificates, student health or disability related certificates, college registrar's letters and accessibility services letters.

## **2. Schedule**

**We will meet 12 times without interruption from September 18 to December 4; the dates are not specified below, but they should be easy to determine. Below you will find the intended content for each meeting.**

**A.** The first three weeks will be dedicated to a rigorous treatment of classical propositional logic. This treatment is given in a set-theoretical format introduced in the first lecture. A technical device that will be used extensively will be the method of *proof by induction* (Sider relegates the presentation of this essential technique to §2.7 of *LP* and does not give its set-theoretical justification).

After defining a formal language for propositional logic and the semantical notion of validity adequate for that language we will study several kinds of methods of proof based on it, with special emphasis on an axiom system whose completeness we will prove.

**Week 1.** Basic concepts of logic and set theory: *LP*, chapter 1.

**Week 2.** The language and semantics of classical propositional logic (*CPL*), sequent proofs: *LP*, §§2.1-5. **HW1**

**Week 3.** An axiomatic system for *CPL* and its properties: *LP*, §§2.6-9.

**B.** The second part of the class (ending with the midterm examination) will be focused on extensions of and alternatives to classical *propositional* logic.

Many-valued logic departs from classical logic by admitting more than two semantical values for sentences; more radically, starting from a verificationist viewpoint intuitionism abandons the notion of truth-value altogether in favor of that of justification (for a sentence); finally, modal logic enriches the language of propositional logic with operators for necessity and possibility.

The standard semantics for this modal language refines the idea of truth-value of a sentence by *relativizing* it to a set of circumstances (a *possible world*); we shall see that various notions of validity that can be defined on the basis of this idea correspond neatly to axiomatic systems for modal logic (i.e. the theorems of those systems are precisely the sentences valid according to those versions of possible world semantics).

**Week 4.** Many-valued logic: *LP*, §§3.3-3.4. **HW2**

**Week 5.** Intuitionistic logic and modal propositional logic (*MPL*): *LP*, §§3.5, 6.1-6.2.

**Week 6.** The semantics of *MPL*: *LP*, §6.3. **HW3**

**Week 7.** Axiomatic systems for *MPL*: *LP*, §6.4.

**Week 8.** Soundness and completeness of axiomatic systems for *MPL*: *LP*, §6.5. **HW4**

**Week 9. MIDTERM**

**C.** The final part of the class will be dedicated to classical and modal *first-order* quantificational logic.

**Week 10.** Classical first-order predicate logic: its language and semantics. *LP*, §§4.1-4.3 and an excerpt from Goldrei's book on the grammar and interpretation of first-order languages.

**Week 11.** Classical predicate logic continued: an axiom system and its soundness and completeness. *LP*, §§4.4-4.5, 5.1 and an excerpt from Goldrei's book on the completeness proof for this system using maximally consistent sets of sentences. **HW5**

## **Week 12. The language and semantics of modal quantificational logic: *LP*, §§9.1-9.6. TAKE-HOME EXAM**

### **APPENDIX ON ACADEMIC INTEGRITY**

Academic integrity is fundamental to learning and scholarship at the University of Toronto. Participating honestly, respectfully, responsibly, and fairly in this academic community ensures that the U of T degree that you earn will be valued as a true indication of your individual academic achievement, and will continue to receive the respect and recognition it deserves.

Familiarize yourself with the University of Toronto's *Code of Behaviour on Academic Matters* (<http://www.governingcouncil.utoronto.ca/policies/behaveac.htm>). It is the rule book for academic behaviour at the U of T, and you are expected to know the rules. Potential offences include, but are not limited to:

In papers and assignments:

- Using someone else's ideas or words without appropriate acknowledgement.
- Copying material word-for-word from a source (including lecture and study group notes) and not placing the words within quotation marks.
- Submitting your own work in more than one course without the permission of the instructor.
- Making up sources or facts.
- Including references to sources that you did not use.
- Obtaining or providing unauthorized assistance on any assignment including:
  - working in groups on assignments that are supposed to be individual work;
  - having someone rewrite or add material to your work while "editing".
- Lending your work to a classmate who submits it as his/her own without your permission.

On tests and exams:

- Using or possessing any unauthorized aid, including a cell phone.
- Looking at someone else's answers
- Letting someone else look at your answers.
- Misrepresenting your identity.
- Submitting an altered test for re-grading.

Misrepresentation:

- Falsifying or altering any documentation required by the University, including doctor's notes.
- Falsifying institutional documents or grades.

The University of Toronto treats cases of academic misconduct very seriously. All suspected cases of academic dishonesty will be investigated following the procedures outlined in the *Code*. The consequences for academic misconduct can be severe, including a failure in the course and a notation on your transcript. If you have any questions about what is or is not permitted in this course, please do not hesitate to contact me. If you have questions about appropriate research and citation methods, seek out additional information from me, or from other available campus resources like the [U of T Writing Website](#). If you are experiencing personal challenges that are having an impact on your academic work, please speak to me or seek the advice of your college registrar.