PHIL 140A - Intermediate Logic

Professor Wes Holliday | TuTh 11am-12:30pm

UC Berkeley, Fall 2019 | 222 Wheeler

Syllabus[1]

Description

Major concepts, results, and techniques of modern logic. Basic set-theoretic tools. Model-theoretic treatment of propositional and first-order logic (completeness, compactness, Löwenheim-Skolem). Philosophical implications of these results.

Prerequisites

12A (or equivalent) or consent of instructor. A solid grasp of the material on propositional and first-order logic from 12A is essential for understanding the content of this course.

Texts

- *Mathematical Logic* by Ian Chiswell and Wilfrid Hodges, available at the bookstore.
- There is a reader for the course sold by Copy Central at 2411 Telegraph.
- Additional readings will be posted on bCourses (see the Readings section below).

Requirements

- Weekly problem sets (not on exam weeks), due in class (40% of grade).
- Take-home midterm exam, due Oct. 8 in class (15% of grade).
- Take-home midterm exam, due Nov. 5 in class (15% of grade).
- Final exam on December 18, 8-11am with location TBA (30% of grade).

Class, section, and Piazza participation are taken into account for borderline grades. (CDC recommendation: if you are sick, stay home until 24 hours after symptoms stop.)

Sections

All enrolled students must attend a weekly discussion section. Sections will be led by GSI Yifeng Ding, a Ph.D. candidate in the Group in Logic and Methodology of Science.

Contact

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[1] The electronic version at philosophy.berkeley.edu/people/page/141 contains hyperlinks to readings and resources.

Weekly Schedule

Part I: Propositional Logic (PL)

Aug. 29 **Course Overview**
Reading: none.

Sets, Relations, and Functions
Reading: Chs. 1-2 of Partee et al. 1990.

- Problem Set 1 due in class Sept. 3.

Sept. 3 & 5 **Syntax of PL, Top Down**
Reading: §3.1 of Chiswell and Hodges 2007; pages 5-8 of van Dalen 2008.

Induction and Recursion
Reading: pages 9-14 of van Dalen 2008.

Syntax of PL, Bottom Up
Reading: §3.2-3.3 of Chiswell and Hodges 2007.

- Problem Set 2 due in class Sept. 10.

Sept. 10 & 12 **Semantics of PL**
Reading: §1-3 of Hodges 1983; §3.5 of Chiswell and Hodges 2007.

Validity and Decidability
Reading: §4, page 16, and §6 of Hodges 1983; §3.6-3.7 of Chiswell and Hodges 2007.

Infinite Sets and Compactness
Reading: pages 59-60 of Enderton 2001.

- Problem Set 3 due in class Sept. 17.

Sept. 17 & 19 **Properties of PL**
Truth-Functionally Complete Sets of Connectives, Post's Theorem, Normal Forms
Reading: page 17-18 Hodges 1983; §3.8 of Chiswell and Hodges 2007.

Formal Deduction
Reading: Ch. 2 and §3.4 of Chiswell and Hodges 2007; §7 of Hodges 1983.

Soundness
Reading: §3.9 of Chiswell and Hodges 2007.

- Problem Set 4 due in class Sept. 24.

Sept. 24 & 26 **Completeness**
Reading: §3.10 of Chiswell and Hodges 2007.

- Problem Set 5 due in class Oct. 1.

Part II: First-Order Logic (FOL)

Oct. 1 & 3 **Syntax of FOL**
Reading: §9-15 of Hodges 1983; §5.1-5.3 and §7.1-7.2 of Chiswell and Hodges 2007.

Semantics of FOL
Reading: §9-15 of Hodges 1983; §5.5-5.7 and §7.3 of Chiswell and Hodges 2007.

- Take-home midterm on Part I due in class Oct. 8.

Oct. 8 & 10 **Semantics of FOL cont.**
Reading: §9-15 of Hodges 1983; §5.5-5.7 and §7.3 of Chiswell and Hodges 2007.

Motivating Examples: Arithmetic, Graph Theory, and Set Theory
Reading: §7.7 of Chiswell and Hodges 2007; Appendices B and C of Hodges 1983.

- Problem Set 6 due in class Oct. 15.

Oct. 15 & 17 **Formal Deduction for FOL**
Reading: §5.4 and §7.4 of Chiswell and Hodges 2007.

Soundness for FOL
Reading: §5.9 and Thm 7.6.1 of Chiswell and Hodges 2007.

- Problem Set 7 due in class Oct. 22.

Oct. 22 & 24 **Completeness for FOL**
Reading: §5.10 and §7.6 of Chiswell and Hodges 2007; §16 of Hodges 1983.

- Problem Set 8 due in class Oct. 29.

Part III: Expressivity

Oct. 29 & 31 **Compactness and Applications**
Non-elementary classes, non-standard models
Reading: page 193 of Chiswell and Hodges 2007; page 70 of Hodges 1983.

Isomorphism, Elementary Equivalence, and Definability
Reading: §7.9 of Chiswell and Hodges 2007.

- Take-home midterm on Part II due in class Nov. 5.

Nov. 5 & 7 **Löwenheim-Skolem Theorems**
Reading: §7.8-7.9 of Chiswell and Hodges 2007.

Categorical Theories
Reading: pages 209-211 of Chiswell and Hodges 2007.

- Problem Set 9 due in class Nov. 12.

Nov. 12 & 14 **Using What You've Learned to Understand a Philosophy Paper**
Reading: Putnam 1980 (you may skip the passage between "To show what bearing. . . " on page 467 and "Operational constraints . . . " on page 469)..

- Problem Set 10 due in class Nov. 19.

Nov. 19 & 21 **Second-Order Logic**
Reading: Enderton 2012.

- Problem Set 11 due in class Nov. 26.

Nov. 26 & Dec. 3 **Using What You've Learned to Understand a Philosophy Paper II**
Reading: Boolos 1984a,b, 1981.

- No class Nov. 28—Thanksgiving.

Dec. 5 **Course Recap**

Dec. 18 (W) **Final Exam** (8-11am, location TBA)

Readings

George Boolos. For Every A There is a B. *Linguistic Inquiry*, 12(3):465–467, 1981.

George Boolos. To Be is to be a Value of a Variable (or to be Some Values of Some Variables). *The Journal of Philosophy*, 81(8):430–449, 1984a.

George Boolos. Nonfirstorderizability Again. *Linguistic Inquiry*, 15(2):343, 1984b.

Ian Chiswell and Wilfrid Hodges. *Mathematical Logic*. Oxford University Press, 2007.

Herbert B. Enderton. *A Mathematical Introduction to Logic*. Harcourt Academic Press, 2001.

Herbert B. Enderton. Second-order and Higher-order Logic. In Edward N. Zalta, editor, *The Stanford Encyclopedia of Philosophy*. Fall 2012 edition, 2012.

Wilfrid Hodges. Elementary Predicate Logic. In D.M. Gabbay and F. Guenthner, editors, *Handbook of Philosophical Logic*, volume 1, pages 1–131. D. Reidel, 1983.

Barbara H. Partee, Alice ter Meulen, and Robert E. Wall. *Mathematical Methods in Linguistics*. Springer, 1990.

Hilary Putnam. Models and Reality. *Journal of Symbolic Logic*, 45(3):464–482, 1980.

Dirk van Dalen. *Logic and Structure*. Springer, 2008.

Other Resources

Supplementary Texts

Logic in Action (www.logicinaction.org) is great for review, more practice, and another perspective. At a more advanced level, Enderton 2001 and van Dalen 2008 are classics.

LaTeX

For your problem sets, neatly handwritten submissions are fine. However, we recommend that you try LaTeX for typing your problem sets. LaTeX will beautifully typeset all of the logical symbols that you need to use in this course. Not only is this nice for those grading your work, but also it should help you to create clear and well-organized content. Knowing how to use LaTeX is a useful skill for other courses too.

Related Courses

- PHIL 140B - *Intermediate Logic*. "Major concepts, results, and techniques of modern logic. Turing machines, computability theory, undecidability of first-order logic, proof theory, Gödel's first and second inompleteness theorms. Philosophical implications of these results."
- PHIL 142 - *Philosophical Logic*. "The course aims at introducing students to the basic topics in philosophy of logic. Among the topics to be treated are the notions of validity, truth and truth functionality, quantification, and necessity."
- PHIL 143 - *Modal Reasoning*. "An introduction to the logical study of modality in its many forms: reasoning about necessity, knowledge, obligation, time, counterfactuals, provability, and other modal notions. Covers core concepts and basic metatheory of propositional modal logic, including relations to first-order logic; basics of quantified modal logic; selected philosophical applications ranging from epistemology to ethics, metaphysics to mathematics."

Course Policies

Academic Integrity

- You are welcome to work together on problem sets, but you must write up answers on your own and indicate on your submission the student(s) with whom you worked.
- For exams, you may not collaborate or consult sources not listed on this syllabus.
- Students who are found to have cheated or plagiarized in the course will receive an F.

"Any test, paper or report submitted by you and that bears your name is presumed to be your own original work that has not previously been submitted for credit in another course unless you obtain prior written approval to do so from your instructor.

In all of your assignments, including your homework or drafts of papers, you may use words or ideas written by other individuals in publications, web sites, or other sources, but only with proper attribution. "Proper attribution" means that you have fully identified the original source and extent of your use of the words or ideas of others that you reproduce in your work for this course, usually in the form of a footnote or parenthesis."

—Report of the UCB Academic Dishonesty and Plagiarism Subcommittee, June 18, 2004

Extensions and Late Work

- Extensions will be granted only in case of medical and family emergencies.
- Late problem sets without prior notification of an emergency will not be accepted.
- Your lowest score on a problem set during the semester will be dropped.

Regrades

- You have one week after a problem set is returned to request a regrade of a problem.
- Requests must come with a written explanation of why you would like a regrade.
- When a problem is regraded, the score may go up, down, or remain the same.

Accommodations for Students with Disabilities

If you have a letter of accommodation from the Disabled Students Program, please let us know as soon as possible so that we can do whatever we can to help you in the course.

Our Policy on Sexual Violence and Harassment

Sexual violence and sexual harassment have no place in a learning environment. Therefore, in alignment with Title IX of the Education Amendments of 1972, it is the policy of the University of California (Sexual Harassment and Sexual Violence Policy) to prohibit sexual harassment, sexual assault, domestic/dating violence, and stalking. The UC Sexual Violence and Sexual Harassment Policy requires that the University immediately implement interim remedies and permanent support measures, when necessary, for victims/survivors. If you or someone you know experiences sexual violence or harassment, there are options, rights, and resources, including assistance with academics, reporting, and medical care. Visit survivorsupport.berkeley.edu or call the 24/7 Care Line at 510-643-2005.

Conflicts with Extracurricular Activities

- "It is the student's responsibility to notify the instructor(s) in writing by the second week of the semester of any potential conflict(s) and to recommend a solution, with the understanding that an earlier deadline or date of examination may be the most practicable solution."
- "It is the student's responsibility to inform him/herself about material missed because of an absence, whether or not he/she has been formally excused."

—Spring 2014 Academic Calendar - Campus Policies and Guidelines email, January 8, 2014

For recommendations about handling scheduling conflicts, see:
teaching.berkeley.edu/checklist-scheduling-conflicts-academic-requirements