

# PHIL 305: Introduction to Formal Methods

Brian Weatherson

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**Office Hours:** Wednesday 10-12 (via Zoom)

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## Course Description

This course will introduce some important formal tools that are used elsewhere in philosophy. We will look at propositional logic, probability theory and the logic of modals and conditionals. Obviously that's a lot to cover in a short time - the aim here is to make sure you understand the basics, and the symbolism, so you can follow simple applications of these tools, and you have the foundations to understand more complicated applications.

## Canvas

There is a Canvas site for this course, which can be accessed from <https://canvas.umich.edu>. Course documents (syllabus, lecture notes, assignments) will be available from this site. Please make sure that you can access this site. Consult the site regularly for announcements, including changes to the course schedule. And there are many tools on the site to communicate with each other, and with me.

## Required Materials

There are three textbooks for the course. All of them are open access, and hence free. The third is on Canvas, the other two have to be downloaded from elsewhere.

- forall x: Calgary by P. D. Magnus, Tim Button, J. Robert Loftis, Robert Trueman, Aaron Thomas-Bolduc and Richard Zach. Available at <http://forallx.openlogicproject.org>.
- Odds and Ends by Jonathan Weisberg. Available at <https://jonathanweisberg.org/vip/>.
- Boxes and Diamonds: Ann Arbor remix by Richard Zach and edited by Brian Weatherson. Available on Canvas.

## Course Requirements

- There will be 11 weekly assignments. Of these your best 9 will count towards your grade, with each counting for about 9%.
- There will also be a final exam, given through Canvas, that counts for 20% of the grade.

## Summary of Grading System

1. Weekly assignments – 8.9% each, 9 assignments count, 80% total.
2. Final exam – 20%.

## Grading Schema

By default, we've set up Canvas with the automatic system for converting numerical grades to letter grades. If the questions turn out to be harder than we expected, we might move those numbers around a little bit – the line between a B+ and an A- might get moved down a point or two. We won't move any of the lines up though – so the changes can only improve your letter grade.

## Plagiarism

Although team-work, and even co-authorship, is encouraged, plagiarism is strictly prohibited. You are responsible for making sure that none of your work is plagiarized. Be sure to cite work that you use, both direct quotations and paraphrased ideas. Any citation method that is tolerably clear is permitted, but if you'd like a good description of a citation scheme that works well in philosophy, look at <http://bit.ly/VDhRJ4>.

You are encouraged to discuss the course material, including assignments, with your classmates, but all written work that you hand in under your own name must be your own. If work is handed in as the work of two people, you are affirming that each person did a fair share of the work. (Note that when you're submitting work on Canvas, you have to each submit the paper, even if it is co-authored. That way Canvas knows that everyone has turned in work.)

You should also be familiar with the academic integrity policies of the College of Literature, Science & the Arts at the University of Michigan, which are available here: <http://www.lsa.umich.edu/academicintegrity/>. Violations of these policies will be reported to the Office of the Assistant Dean for Student Academic Affairs, and sanctioned with a course grade of F.

## Disability

The University of Michigan abides by the Americans with Disabilities Act of 1990, Section 504 of the Rehabilitation Act of 1973, and other applicable federal and state laws that prohibit discrimination on the basis of disability, which mandate that reasonable accommodations be provided for qualified students with disabilities.

If you have a disability, and may require some type of instructional and/or examination accommodation, please contact me early in the semester. If you have not already done so, you will also need to register with the Office of Services for Students with Disabilities. The office is located at G664 Haven Hall.

For more information on disability services at the University of Michigan, go to <http://ssd.umich.edu>.

## Class Schedule

The readings will all be from the three textbooks. I've produced short videos going over the material in the books, and occasionally other philosophically interesting points. Then the time in class will be entirely spent on questions people have, and going over worked examples. So you should do the reading, and watch the lectures, before the scheduled class.

Most of the readings are from the two textbooks. The other readings are all in the UM library or online. You might have to be logged in to UM to get them though. The names of the papers are links to a source where you can get a copy of the paper.

The video lectures will have a number of the form  $x.y$ , where  $x$  is the week they are for, and the  $y$  is their order in the week. You should watch these **before** class, and we can discuss the material in class.

Most weeks have a fairly simple structure. There are in person classes with me on Tuesday and Thursday, and you have a smaller in person class with Mica as well. There are video lectures before each of my classes. And at the end of the week there is a Canvas quiz assigned about the material we covered. But there are exceptions, especially around late January-early February. I'm going to be away on **January 27**, and that leads to the following complications.

- There is no in person class with me on Thursday, January 27.
- The assignment in week 4 will just be about the material through class on Tuesday, January 25.
- There is no assignment in week 5.
- The assignment in week 6 will be about the material through class on Thursday, February 3, i.e., the end of week 5.
- The assignment in week 7 will cover the material in weeks 6 and 7.

There is also no assignment the week after Spring Break, so we can all get a bit of a soft relaunch of the term before the final push to the end of term.

## **Week 1: Introduction**

**Tuesday, January 04**

No class, classes haven't started.

**Thursday, January 06**

**Topic** Introduction

**Reading** forall x, Chapters 1-2.

**Lectures** 1.1-1.3.

## **Week 2: Symbols and Truth Tables**

**Tuesday, January 11**

**Topic** Symbolization

**Reading** forall x, Chapters 4-6.

**Lectures** 2.1-2.3.

**Thursday, January 13**

**Topic** Truth Tables

**Reading** forall x, Chapters 9-11.

**Lectures** 2.4-2.6.

## **Week 3: Validity and Trees**

**Tuesday, January 18**

**Topic** Truth Tables and Validity

**Reading** forall x, Chapter 12.

**Lectures** 3.1-3.4

**Thursday, January 20**

**Topic** Truth Trees

**Reading** Boxes and Diamonds, Sections 2.1-2.3

**Lectures** 3.5-3.6.

## **Week 4: Validity and Trees, Continued**

**Tuesday, January 25**

**Topic** Using Truth Trees

**Reading** Boxes and Diamonds, Sections 2.4-2.5

**Lectures** 4.1-4.3b

Note that there will be no in person class on Thursday; I'm away at a conference. The weekly assignment for this week will just cover the material from Tuesday.

**Thursday, January 27**

**Topic** Introducing Natural Deduction

**Reading** forall x, Chapter 15 and sections 16.1-16.4.

**Lectures** 4.4-4.7

## **Week 5: Natural Deduction**

**Tuesday, February 01**

**Topic** Rules for Natural Deduction

**Reading** forall x, Sections 16.5-16.8.

**Lectures** 5.1-5.3

Note that there is no assignment this week.

**Thursday, February 03**

**Topic** Strategies for Natural Deduction

**Reading** forall x, Chapter 17.

**Lectures** 5.4-5.6

## **Week 6: Starting on Probability**

**Tuesday, February 08**

**Topic** Probability Basics

**Reading** Odds and Ends, chapters 1 and 5

**Lectures** 6.1-6.2.

The assignment this week is about the material from week 5

**Thursday, February 10**

**Topic** Probability Trees

**Reading** Odds and Ends, chapter 1

**Lectures** 6.3-6.4.

## **Week 7: Conditional Probability**

**Tuesday, February 15**

**Topic** Conditional Probability

**Reading** Odds and Ends, chapter 6

**Lectures** 7.1-7.2.

**Thursday, February 17**

**Topic** Inverting Conditional Probability

**Reading** Odds and Ends, chapter 8

**Lectures** 7.3-7.6.

## **Week 8: More Conditional Probability**

**Tuesday, February 22**

**Topic** Base Rates

**Reading** Odds and Ends, chapter 9

**Lectures** 8.1-8.2.

**Thursday, February 24**

**Topic** Multiple Updates

**Reading** Odds and Ends, chapter 9

**Lectures** 8.3-8.5

## **Week 9: Probability and Decision**

**Tuesday, March 08**

**Topic** Expected Utility

**Reading** Odds and Ends, chapters 11 and 12

**Lectures** 9.1-9.4.

No assignment this week.

**Thursday, March 10**

**Topic** Utility and Money

**Reading** Odds and Ends, sections 12.5 and 13.1.

**Lectures** 9.5-9.6.

## **Week 10: Probability and Learning**

**Tuesday, March 15**

**Topic** Theories of Probability

**Reading** Odds and Ends, chapters 4, 15, 16 and 18.

**Lectures** 10.1-10.5.

**Thursday, March 17**

**Topic** Statistical Learning

**Reading** Odds and Ends, chapters 19 and 20.

**Lectures** 10.6-10.7.

### **Week 11: Introduction to Modal Logic**

**Tuesday, March 22**

**Topic** Varieties of Modality

**Reading** Boxes and Diamonds, sections 3.1-3.3.

**Lectures** 11.1-11.3

**Thursday, March 24**

**Topic** Models and Frames

**Reading** Boxes and Diamonds, sections 3.4-4.5.

**Lectures** 11.4-11.7

### **Week 12: Proofs in Modal Logic**

**Tuesday, March 29**

**Topic** Modal Tableau

**Reading** Boxes and Diamonds, chapter 5.

**Lectures** 12.01-12.04

**Thursday, March 31**

**Topic** Examples

**Reading** No new reading

**Lectures** 12.05-12.17

### **Week 13: Conditionals**

**Tuesday, April 05**

**Topic** Varieties of Conditionals

**Reading** Boxes and Diamonds, chapter 6.

**Lectures** 13.1-13.4

**Thursday, April 07**

**Topic** Counterfactual Conditionals

**Reading** Boxes and Diamonds, chapter 7.

**Lectures** 13.5-13.6

### **Week 14: Counterfactuals**

**Tuesday, April 12**

**Topic** The Logic of Counterfactuals

**Reading** Boxes and Diamonds, chapter 7.

**Lectures** 14.1-14.2

**Thursday, April 14**

**Topic** Puzzles about Counterfactuals

**Reading** No new reading

**Lectures** 14.3-14.4

There will be a revision class on Tuesday, April 19, with no new material, to go over the sample exam.