Introduction to Logic
Johns Hopkins Center for Talented Youth (CTY)
3 Week Intensive Seminar

Instructor: Alex Rausch

Course Description

Philosophers take *logic* to be the study of good reasoning. Mathematicians take *logic* to be the study of the structural properties of formal languages. Computer scientists take *logic* to be the study of programs and algorithms. These differences are more of the result of a division of labor than they are of competing interpretations; the study of logic in higher academia is an interdisciplinary endeavor. In this course, we'll learn about logic from all of these perspectives, making a special effort to trace the interesting relationships between them along the way. Since this is a first course in logic, it presupposes no philosophical or mathematical knowledge. Still, we'll roughly cover the content of a college-level introductory logic course at an accelerated rate.

The languages of formal logic, which look something like mathematical equations, can be used to display the intended meanings of English sentences more clearly. The following English sentence, for example, is ambiguous: `Everybody loves somebody.' On one interpretation, this sentence means that every person loves some person or another—their mother, for instance. On another interpretation, it means that there's some lucky individual who *absolutely everybody* loves! (Can you hear both interpretations?) In this course, we'll learn how philosophers and linguists translate English sentences into logical notation so as to make different interpretations like these transparent. Once we're able to translate between natural language English and the languages of formal logic, we'll learn about some interesting properties that these sentences can have. Some sentences, for example, *entail* other sentences. Some sentences are *consistent* (or *inconsistent*) with others. Some sentences are *always true*; some are *always false*; and some are *true under certain circumstances but false under others*. In this course, we'll make these ordinary concepts precise with formal rigor, and we'll learn how to test for when sentences have these properties by using both truth-tables and derivations. Finally, the formal languages we'll study and the techniques we'll use to study them bear an intimate relationship to the languages and tools used by computer scientists in the construction of programs and algorithms. We'll learn about the most basic computers, Turing Machines, and we'll build some of our own in the computer lab. Along the way, we'll enjoy scavenger hunts, escape rooms, and trivia contents that test our knowledge of logic.

In addition to learning the ins and outs of logic, this course also serves as a brief introduction to some genuinely philosophical themes. We'll use the logical tools detailed above in order to evaluate arguments concerning the existence of the divine, the nature of morality, and the nature of the mind. Our aim here is to understand how the tools of logic can help us evaluate abstract positions in an objective and unbiased manner. We'll take most interest in the logic—arguments, objections, and replies—developed by historical and contemporary philosophers on these perennial questions.

"*Logic issues in tautologies, mathematics in identities, philosophy in definitions; all trivial, but all part of the vital work of clarifying and organizing our thought.*"
- Frank Ramsey (The Foundations of Mathematics)

Course Goals

• Translate between sentences of natural language English and formal logic (sentential and quantificational).

• Construct truth-tables and derivations with sentences of formal logic.

• Prove that arguments and sets of sentences have various logical properties like *truth-functional (and quantificational) validity*, *truth-functional (and quantificational) soundness*, *truth-functional (and quantificational) truth*, *truth-functional (and quantificational) equivalence*, and *truth-functional (and quantificational) consistency*.

• Write code for and construct Turing Machines in the computer lab that compute various mathematical functions like *multiply by two*.

• Gain exposure to contemporary treatments of some perennial philosophical themes

• Practice clear, evidence-based writing and speech through short essays and debates.

Course Textbooks

1. *The Logic Book (6th edition)*
   Merrie Bergmann, James Moor & Jack Nelson | McGraw Hill (2014)
   ISBN: 978-0-07-803841-9

Course Materials

1. Notebook (3 subject)
2. Index cards (100)

Course Schedule

Week 1 Day 1	Pre-test, Introductions & Ice-Breaker 9:00-9:30 Community Agreement, Honor Code, Technology Policy 9:30-9:45 Logic Brainstorm 10:00-10:30 Break 10:30-10:45 *TLB* 1.1 & 1.2: Class Reading / Exercises 1.2 10:45-12:00	*TLB* cont'd / Introduction to Philosophy 1:00-2:00 Break 2:00-2:15 Slides on Validity, Soundness, & Necessary and Sufficient Conditions 2:15-3:00	• Recapitulation • Exercises 1.2 cont'd • Worksheet #1 • Reading *Mackie*, "Evil and Omnipotence" • Discuss Reading

Week 1 Day 2	Reminder Questions 9:00-9:20 *TLB* 2.1 Class Reading / Exercises 2.1 9:20-10:30 Break 10:30-10:45 *TLB* 2.2 (up to p. 29) Class Reading / Exercises 2.2 10:45-12:00	Seminar: The Problem of Evil 1:00-2:00 Break 2:00-2:15 Seminar cont'd—Short Writing: what is the weakest premise of Mackie's argument? Why? 2:15-3:00	• Recapitulation • Review table on p. 54 • 2.3 Exercises (no paraphrasing) • Reading van Inwagen, *The Problem of Evil* §7
Week 1 Day 3	Reminder Questions 9:00-9:20 *TLB* 3.1 Class Reading / Exercises 3.1 9:20-10:30 Break 10:30-10:45 *TLB* 3.1 cont'd 10:45-12:00	Seminar: The Free Will Defense 1:00-2:00 Break 2:00-2:15 Seminar cont'd—Argumentation Exercise: persuade an audience for or against the Problem of Evil / Free Will Defense	• Recapitulation • More truth-table practice! • Reading Aquinas, *2nd & 5th way*
Week 1 Day 4	Reminder Questions 9:00-9:20 *TLB* 3.2 Class Reading / Exercises 3.2 9:20-10:30 Break 10:30-10:45 *TLB* 3.3 Class Reading / Exercises 3.3 10:45-12:00	Seminar: *a priori* Proofs of Theism 1:00-2:00 Break 2:00-2:15 Seminar: *a posteriori* Proofs of Theism	• Recapitulation • Complete Exercises 3.2 & 3.3 • Begin debate setup

Week 1 Day 5	Reminder Questions 9:00-9:20 *TLB* 3.4– & 3.5 Class Reading / Exercises 3.4 & 3.5 9:20-10:30 Break 10:30-10:45 *TLB* cont'd; Prepare for Debate 10:45-12:00	Prepare for Debate 1:00-2:00 Break 2:00-2:15 Debate Presentations #1 cont'd 2:15-3:00	No session
Week 2 Day 1	Reminder Questions 9:00-9:20 *TLB* 5.1.1 Introduction to Proofs: Class Reading / Exercises 5.1.1 9:20-10:30 Break 10:30-10:45 *TLB* cont'd 10:45-12:00	Seminar: Utilitarianism 1:00-1:45 Break 1:45-2:00 Seminar cont'd 2:00-3:00	• Recapitulation • Proof Practice (exercises 5.1.1 and Worksheet #2) • Reading Kant, *Groundwork of the Metaphysics of Morals* (excerpt)•
Week 2 Day 2	Reminder Questions 9:00-9:20 *TLB* 5.1.2 Class Reading & Exercises 9:20-10:30 Break 10:30-10:45 *TLB* cont'd (5.1.3 Exercises) 10:45-12:00	Seminar: Deontology 1:00-1:45 Break 1:45-2:00 Seminar cont'd 2:00-3:00	• Recapitulation • Proof Practice (Exercises 5.3) • Reading MacIntyre, *Moral Pluralism*
Week 2 Day 3	Reminder Questions 9:00-9:20 *TLB* 5.4 Class Reading & Exercises 9:20-10:30 Break 10:30-10:45 *TLB* cont'd 10:45-12:00	Seminar: Metaethics and Relativism 1:00-2:00 Break 2:00-2:15 Seminar cont'd—Short Writing: what's the correct ethical theory? why? 2:15-3:00	• Recapitulation • Proof Practice (5.4 cont'd)

Week 2 Day 4	Reminder Questions 9:00-9:20 *TLB* 7.1 Class Reading / Exercises 7.1 9:20-10:30 Break 10:30-10:45 *TLB* 7.2 Class Reading / Exercises 7.2 10:45-12:00	Seminar: Metaethics and Relativism cont'd 1:00-2:00 Break 2:00-2:15 Debate #2 Preparation 2:15-3:00	• Recapitulation • Quantificational Symbolization Practice (Exercise 7.3)
Week 2 Day 5	Reminder Questions 9:00-9:20 *TLB* 7.4 Class Reading (up to p. 302) / Exercises 7.5 9:20-10:30 Break 10:30-10:45 Cumulative Review: truth-tables, truth-functional notions, sentential derivations, ... 10:45-12:00	Prepare for Debate 1:00-2:00 Break 2:00-2:15 Debate #2 2:15-3:00	No session
Week 3 Day 1	Reminder Questions 9:00-9:20 Introduction to Model Theory 9:20-10:30 Break 10:30-10:45 *TLB* 8.1 Class Reading (up to p. 333) 10:45-12:00	Seminar: Introduction to Philosophy of Mind 1:00-2:00 Break 2:00-2:15 Exercises 8.1 2:15-3:00	• Recapitulation • Exercises 8.1 cont'd • Reading Descartes *Meditations* (excerpt) and Princess Elizabeth correspondence

Week 3 Day 2	Reminder Questions 9:00-9:20 *TLB* 8.2 Class Reading / Exercises 8.2 9:20-10:30 Break 10:30-10:45 Exercises 8.2 cont'd 10:45-12:00	Seminar: Dualism 1:00-2:00 Break 2:00-2:15 Seminar cont'd—Argumentation Exercise: persuade an audience of materialism or dualism 2:15-3:00	• Recapitulation • Escape Room!
Week 3 Day 3	Reminder Questions 9:00-9:20 *TLB* 8.3 Class Reading / Exercises 8.3 9:20-10:30 Break 10:30-10:45 Exercises 8.3 cont'd 10:45-12:00	Seminar: Functionalism 1:00-2:00 Break 2:00-2:15 Seminar cont'd—introduction to Turing Machines 2:15-3:00	Building Turing Machines in computer lab (http://morphett.info/turing/turing.html)
Week 3 Day 4	Reminder Questions 9:00-9:20 *TLB* 8.4 Class Reading / Exercises 8.4 9:20-10:30 Break 10:30-10:45 Exercises 8.4 cont'd 10:45-12:00	Instructional Staff-led Review for Post-test 1:00-2:00 Break 2:00-2:15 Individual Studying Session for Post-test 2:15-3:00	• Post-test
Week 3 Day 5	Instructor/TA evaluations Celebration of Class Accomplishments	No session	No session