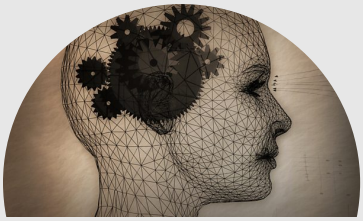

Logic I

24.241, Fall 2023

Instructor Info

- Benjamin Brast-McKie
- Office Hrs: Mon & Wed 1-2p
- 32-D966
- Carnap Website
- Canvas Website
- brastmck@mit.edu

TA Info

- Gareth Norman
- garethn@mit.edu
- 32-D978

Course Info

- Prereq: None
- Tues & Thurs
- 9:30am - 11am
- 32-124

Problem Sets

- Due Fridays
- 5pm sharp
- Online or scanned

Overview

During the first part of this course, we will study sentential deduction (SD) also known as propositional logic (PL). This is the logic of truth-functional connectives, including 'not,' 'and,' 'or,' 'if-then,' and 'if and only if.'

In the second part, we will study quantifier deduction (QD) also known as first-order logic (FOL). This is the logic of 'for all' and 'some,' plus our earlier sentential logic. In both parts, we will present a syntax for a formal language along with a semantics to interpret that language. We will use our formal languages to regiment natural language sentences, providing proofs within a corresponding deductive system. We will also cover the semantics needed to interpret our the formal languages and to define logical entailment. For both parts of the course, we will do basic meta-logic, proving that our proof systems are sound and complete.

Material

Required Texts (It's a free PDF)

ForAllX: MIT Edition (Fall 23).

Other

Any other required readings will be provided on Canvas.

Grading Scheme

55%	Problem Sets (11 assignments at %5 each)
20%	Midterm
25%	Final Exam

Grades will follow the standard scale: A = 89.5-100; B = 79.5-89.4; C = 69.5-79.4; D = 60-69.4; F <60. Grades will not be curved.

Problem Sets

There will be 12 graded problem sets, due Fridays by 5pm. Your lowest score will be dropped. Many of these will be online using a program called 'Carnap' so that you can get real-time feedback as you work. All work submitted MUST BE YOUR OWN, instantiating a direct causal relation to your own pen, pencil, or keyboard—written in your own voice without someone there with you or texting you answers. As you will find, even logic leaves room for creativity, and it will be important to get a sense of that for yourself. You are welcome to work through the problem set with at most two other students IN PREPARATION, but when it comes time to submit answers, you must be on your own. If you choose to work with others, please indicate your teammates' names at the top of each assignment.

Carnap

Most of the problem sets will be assigned on Carnap. You will need to enrol which you can find demonstrated here. Using Carnap will require some syntactic care: it is fussy about how things are entered, so you will have to learn to use the right syntax. Please don't hesitate to get in touch if you run into any issues.

FAQs

Is logic math?

We will use formal symbols as in mathematics, but this does not make logic a type of math any more than it makes physics a type of mathematics. Rather, logic has a subject mater all its own, though saying what this is will require some care.

Is logic philosophy?

Philosophical Logic concerns the philosophy of logic. There are also formal approaches to philosophy which employ methods from proof theory and model theory. *Mathematical Logic* is a sub-discipline that falls considerably closer to mathematics. We will be doing a bit of all of these.

Is logic a descriptive science?

No! Logic is a *normative* science insofar as it aims to regiment how we ought to reason in an artificial language, not merely how we happen to reason in a natural language like English.

Why learn logic?

Logic seeks to describe an ideal for reasoning. Of course, we are all engaged in reasoning. Learning logic is something akin to upgrading your firmware. It will literally change how you think.

What does logic have to show for itself?

Logic played a critical role in putting mathematics on a solid foundation (ZFC is accepted by most working mathematicians) and gave birth to the modern theory of computation as well as modern linguistics.

Academic Integrity

Blindly copying someone else's solution (written or typed) is cheating. By contrast, you are encouraged to talk through a solution step-by-step with a classmate or two where in doing so, everyone involved comes to understand each part. However, when it comes time to write up and submit the solutions, it is important that you do this for yourself without consulting others throughout the process.

Learning logic requires practice! Compare learning to speak a natural language like English. There are some tricks and techniques to get acquainted with where once you gain some familiarity, this course should be fun. But getting comfortable using these techniques takes time, making this a very difficult course to cram for the night before an exam. The good news is that with consistent practice, you should be able to master the techniques of this course long in advance of the exam.

Doing problem sets is the best way to practice throughout the course. Cheating on problem sets will be to your own disadvantage in preparing for the exams. If you cheat on an exam, the academic consequences will be severe, so please don't consider it. There is more to life than grades; don't let them distract from learning!

Instead of worrying about your grade, I recommend that you focus on mastering logic, doing your best work and feeling good about it. Logic is an extremely deep subject, and foundational for this information age that we are all a part of. This course should provide you with an important tool kit that I hope you enjoy learning to use and that will serve you well beyond the end of this course.

Make-up Policy

Make-up exams or problem-sets are only permitted for students in the midst of a medical or family emergency. Making arrangements IN ADVANCE of the due date is required except in particularly difficult circumstances.

Learning Objectives

- Practice regimenting a range of natural language sentences into propositional and first-order languages.
- Learn how to assess complex natural language arguments for validity.
- Practice applying the rules of a proof system, regimenting valid reasoning.
- Develop an appreciation for meta-logical proofs about our proof systems and their corresponding semantics.
- Contemplate elements of the philosophy of logic, exploring such questions as: What is logic? What unites it as a discipline? What can logic do, and what are its limits? Do the rules of logic describe something universal or conventional?

Diversity and Inclusivity Statement

In all course-related activities and communications, you will be treated with respect. I welcome individuals of all ages, backgrounds, cultures, beliefs, ethnicities, gender identities and expressions, national origins, religious affiliations, abilities, sexual orientations, and other visible and non-visible differences. All members of this class are expected to help create a respectful, welcoming, and inclusive environment for every other member of the class.

Accommodations for Students with Disabilities

If you are a student with learning needs that require accommodation, please contact Disability and Access Services at `das-student@mit.edu` (or for assistive technology, `atic-staff@mit.edu`) as soon as possible, to make an appointment to discuss your needs and to obtain an accommodations letter. Please also e-mail me as soon as possible to set up a time to discuss your learning needs. As someone who has used these services in the past, you can assume that you will have my full support.

Class Schedule

Part 1: Sentential Logic

Week 0	Introduction to Logic	ForAllX Ch. 0
Sep 07		Problem Set 0 (meet Carnap — not graded)
Week 1	Syntax for SL	ForAllX Ch. 1
Sep 12, 14	Regimentation in SL	Problem Set 1 Due Friday 9/15
Week 2	Semantics for SL	ForAllX Ch. 2 & 3
Sep 19, 21	Entailment, Validity, Satisfiability	Problem Set 2 Due Friday 9/22
Week 3	Trees Proof System (ST)	ForAllX Ch. 4
Sep 26, 28		Problem Set 3 Due Friday 9/29
Week 4	Mathematical Induction & Recursive Definitions	ForAllX Ch. 5
Oct 3, 5	Soundness	Problem Set 4 Due Friday 10/6
Week 5	Completeness	ForAllX Ch. 5
Oct 12		Problem Set 5 Due Friday 10/13
Week 6	Natural Deduction (SD)	ForAllX Ch. 6
Oct 17, 19		Problem Set 6 Due Friday 10/20
Week 7	Midterm Review	Review Handout
Oct 24, 26	— MIDTERM —	Problem Set 7 (not graded)

Part 2: Quantifer Logic (QL)

Week 8	Syntax for QL	ForAllX Ch. 8
Oct 31, Nov 2	Regimentation in QL	Problem Set 8 Due Thurdsay 11/3
Week 9	Semantics for QL	ForAllX Ch. 9
Nov 7, 9	Entailment, Validity, Satisfiability	Problem Set 9 Due Friday 11/10
Week 10	Syntax $QL^{=}$	ForAllX Ch. 10
Nov 14, 16	Semantics for $QL^{=}$	Problem Set 10 Due Friday 11/17
Week 11	Natural Deduction (QD)	ForAllX Ch. 11
Nov 14, 16	Identity	Problem Set 10 Due Friday 11/17

Part 3: Metalogic

Week 12	Soundness of QD	ForAllX Ch. 12
Nov 28, 30		Problem Set 12 Due Friday 12/1
Week 13	Completeness of QD	ForAllX Ch. 13
Dec 5, 7		Problem Set 13 Due Friday 12/8
Week 14	Review for the Final	Handout
Dec 12, 14		No Problem Set
Week 15	FINAL EXAM (3 hours)	Time & Location TBD