

15-317 Constructive Logic

Course Syllabus
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1 Overview

This multidisciplinary junior/senior-level course is designed to provide a thorough introduction to modern constructive logic, its roots in philosophy, its numerous applications in computer science, and its mathematical properties. The core topics of this class are intuitionistic logic, natural deduction, Heyting arithmetic, proofs as programs, connections between classical and constructive logic, inductive definitions, sequent calculus, and decidable classes. Advanced topics may vary from year to year and include type theory, logic programming, proof search, logical frameworks, temporal logic and model checking, modal logic.

Additional information, including a lecture schedule, homework policy, lectures notes, etc. can be found on the course home page at:

<http://lfcps.org/course/constlog.html>

2 Course Information

Lectures see course web page

Recitations see course web page

Credit 9 units

Prerequisites 15-150 Functional Programming with a minimum grade C.

For the cross-listed graduate version, 15-657, experience with functional programming is recommended.

Textbook There is no textbook, but lecture notes will be on the course web page if available.

Grading 40% Homework, 15% Midterm I, 15% Midterm II, 30% Final

Absent exceptional circumstances (such as unusually large discrepancies of exam and homework scores), grade assignment is based on total score percentages:

total score:	$\geq 90\%$	$\geq 80\%$	$\geq 70\%$	$\geq 60\%$	$< 60\%$
grade:	A	B	C	D	R

Homework Weekly, usually Thursday to Thursday. 5 late days total, at most 3 per assignment.

1 extra late day can be reclaimed per assignment that was submitted at least 2 days early. If you submit a homework beyond your remaining late days, 25% will be docked of the possible score per late day.

Midterm I in class, closed internet, open book, date on course web page.

Midterm II in class, closed internet, open book, date on course web page.

Final closed internet, open book, date on course web page.

Home <http://lfcps.org/course/constlog.html>

Piazza discussion board linked from course web page

Gradescope homework submission

Tools Resources on the software tools used in this course are listed on the course web page.

Please carefully read the entire syllabus to make yourself familiar with the contents and expectations and policies in this course. It is also your go-to reference later.

Pandemic Provisions

The Covid-19 pandemic will force numerous challenges upon us all, and we will do the best we can to mitigate its impact.

Lectures and recitations will happen remotely. 15-317/657 is design as a synchronous remote course and your attendance is required especially during exams. You are expected to join via life video conferencing, because that gives you an opportunity to think through the development of the material actively and participate. We will try to make some partial recordings

available, but they cannot be shared outside the course due to FERPA regulations.

If available, lecture notes give you a complementary way of internalizing material at your own pace, especially for subtleties that you may have missed at first. But the lecture notes are not a substitute for lectures, because they do not cover everything discussed in class. If you had to miss a lecture or recitation, you should catch up as quickly as possible to avoid falling behind.

Staying up to speed can be a challenge in a remote teaching situation, especially for students in other time zones. The course moves at a careful pace but course topics build on one another. You will need to develop a strong understanding of earlier concepts in this course to not get lost in later lectures.

During remote lectures and recitations you are not required to turn your camera on. However, keep in mind that it will be easier for you to interact with others in class if you can see each other. Especially during recitations, we, thus, strongly encourage you to be actively and visually present.

Please make sure that your Internet connection and equipment are set up to use Zoom and able to share audio and video during class meetings (see [network resources](#)). Unless you are adept at LaTeXing proofs quickly enough in exams, you should also make sure you have access to a device with which you can scan handwritten solutions legibly, such as with a cell phone camera, scanner, or tablet. Let me know if there is a gap in your technology set-up as soon as possible to find solutions.

3 Learning Objectives

1. Understand the working principles of logic
2. Understand how the meaning of a proposition comes from its verifications
3. Distinguish propositions from judgments
4. Use proof rules to conduct formal proofs
5. Formalize informal problems into precise logical language
6. Justify how proof rules fit to one another in sound and complete ways
7. Assess the validity of a formal proof

8. Relate constructive logic to computation and constructive proofs to functional programs
9. Understand propositions as types and proofs as programs
10. Relate induction to recursion and use induction to prove properties in and about logical systems
11. Relate deductive proof search to computation in logic programming
12. Understand formulas as programs
13. Understand the principles and applications of logic programming
14. Identify logical core working principles of an algorithm or a data structure
15. Relate logical reasoning to operational reasoning
16. Distinguish classical reasoning from constructive reasoning
17. Ability to conduct proofs of appropriate scope in simple proof assistants

4 Take Care of Yourself

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

5 Policies

5.1 Collaboration and Academic Integrity

You are expected to comply with the [University Policy on Academic Integrity](#), which will be applied rigorously. Please read this policy carefully to

understand the penalties associated with academic dishonesty at Carnegie Mellon.

The value of your degree depends on the academic integrity of yourself and your peers in each of your classes. It is expected that, unless otherwise instructed, the work you submit as your own is your own work and not someone else's work or a collaboration between yourself and other(s). It is also expected that, unless otherwise instructed, you cannot share your work or any assignments or exams with anyone else.

In this class, cheating/copying/plagiarism means copying all or part of any program or homework or or proof etc. from another student or unauthorized source such as the Internet, knowingly giving such information to another student, or giving or receiving unauthorized information during an examination. *Each solution you submit must be your own work.* In the event that you use information by another person in your solution, you must clearly cite the source of this information (and receive prior permission if unsure whether this is permitted). It is considered cheating to compare or discuss complete or partial solutions.

It is *not* considered cheating to clarify vague points in the assignments, or lecture material, or to give help or receive help in *general use* of the computer systems or tools, or other facilities. It is permitted and encouraged to share general advice on how to use provers or general discussions about course assignments. Any assistance, though, must be limited to discussion of the *problems in general*, and cannot be about the solutions of the assignments. You must also refrain from looking at other students' homework and proofs while you are getting or receiving help for these tools.

It is an academic integrity violation due to *unauthorized assistance to share assignments, exams, or proofs between different iterations of the course*. Do not post any material concerning this course publicly, e.g. to GitHub or BitBucket and remember to keep all repositories private at all times.

5.2 Exams

Any communication with anyone other than course staff during the exams of this course constitutes an academic integrity violation. Resolution of exam conflicts must be requested within one week of release of the schedule of the respective exam. For reasons of course logistics, makeup exams cannot necessarily be given. In exceptional medical emergencies during an exam, go seek medical care immediately and immediately notify the instructor by email. Keep documentation of your health care in case your advisor or the Office of Student Affairs wants to check in with you. In

these rare circumstances an oral exam may be used to expedite the process. If you experience technical difficulties during an exam, save your work and notify the course instructor immediately, attaching a copy of your exam so far.

5.3 Accommodation

Carnegie Mellon University makes every effort to provide accessible facilities and programs for individuals with disabilities. If you have a disability and require accommodations, contact the Office of Disability Resources at access@andrew.cmu.edu. Please let the instructors know early in the semester so that your needs may be appropriately met. Special accommodation for exams must be requested as early as your case arises and at least one week before each exam.

5.4 Recording

No student may record any classroom activity without express written consent from the instructor. If you have (or think you may have) a disability such that you need to record or tape classroom activities, you should contact the Office of Disability Resources to request an appropriate accommodation.

Any recordings of course sessions that the instructors provide are provided solely for educational use by students enrolled in the course and, due to regulations under the Family Educational Rights and Privacy Act (FERPA), must **not** be shared with anyone else under any circumstance.