

Formal Logic (80-310/80-610)

Fall 2022

Monday/Wednesday/Friday 12:20–1:10, GHC 5222

<https://canvas.cmu.edu/courses/31412>

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Course Description: Among the most significant developments in modern logic is the formal analysis of the notions of provability and logical consequence for the logic of relations and quantification, known as first-order logic. These notions are related by the soundness and completeness theorems: a logical formula is provable if and only if it is true under every interpretation. This course provides a formal specification of the syntax and semantics of first-order logic and then proves the soundness and completeness theorems. Other topics may include: basic model theory, intuitionistic, modal, and higher-order logics.

Text: Course notes will be provided; no textbook is required.

Course Objectives: The primary objective of this course is to develop mathematical competence in propositional and first-order logic, along with the ability to apply this competence in useful ways. This means being able to:

- read and comprehend different logical formalisms;
- understand the difference between proofs and models, and the deep connections between them;
- formalize intuitions and analyze real problems using logical tools and methods;
- probe and critically assess the underlying assumptions of standard logics.

Evaluation: Problem sets 60%; tests 30%; quizzes 10%.

Every other Friday a problem set will be released, covering the previous 2 weeks of material, due 10 days after it is released (so always on a Monday).

- These are the foundation of the class—where I will push you to *really* engage with what you've learned. The bulk of the work for this course is here.
- You are encouraged to collaborate with classmates—just be sure to write up your own solutions, and clearly indicate on the first page with whom you have collaborated.
- All problem sets will be submitted via Gradescope, which is integrated with Canvas and can be accessed through the sidebar. They are due by the beginning of class; late submissions will be considered provided arrangements have been made in advance.

Each Monday there will be an in-class evaluation.

- On days when a problem set is due there will be a 20-minute test at the beginning of class. These tests are essentially in-class components of the problem sets; they cover exactly the same material but consist of shorter/easier problems.
- On the weeks in between problem set due dates, there will instead be a 10-minute quiz based on the material covered during the previous two weeks. Quizzes are not worth very much; they are intended primarily as self-assessment tools.

There is no final exam.

Engagement & Community:

- To the extent you feel comfortable doing so, please try to be an active participant in class.
- Post on the Piazza forum freely and frequently—not only to ask questions but also to help answer questions that others have raised.
- Treat each other with respect. I take this very seriously and invite you to reach out to me if at any point you feel uncomfortable for any reason.

My hope is for this class to be useful and interesting for you, and not just another source of stress. If you find yourself struggling, you need help, or any aspect of this course is problematic for you (for any reason), please reach out to me. I'm also very happy to hear general feedback and constructive criticisms about the class at any time.

Take care of yourself. Try to get enough sleep, go for walks in the fresh air, and connect as you can with the people you love. Take time to relax. You can't achieve your goals if you're sick from stress or burnt out.

All of us benefit from support during tough times. You are not alone—an important part of the college experience is learning how to ask for help. If you or anyone you know needs help, consider reaching out to a friend, faculty member, or family member you trust. Counseling and Psychological Services (CaPS) is also here to help: call 412-268-2922 or visit their website at <https://www.cmu.edu/counseling/>.

Finally, if you are worried about affording food or feeling insecure about food, there are resources on campus who can help. Email the CMU Food Pantry Coordinator to schedule an appointment:

Pantry Coordinator
cmu-pantry@andrew.cmu.edu
412-268-8704 (SLICE office)

Schedule

Date	Topic (rough guideline; subject to change)	Evaluation (immutable)
8/29	introduction	–
8/31	the language of propositional logic	–
9/2	structural induction	–
9/5	<i>no class (Labor day)</i>	–
9/7	semantics for propositional logic	–
9/9*	<i>remote class / special session</i>	PS1 released
9/12	equivalence relations	quiz 1
9/14	the algebraic perspective	–
9/16	review/catchup	–
9/19	deduction in propositional logic	PS1 due; test 1
9/21	the deduction theorem	–
9/23*	<i>remote class / special session</i>	PS2 released
9/26		quiz 2
9/28	soundness and completeness of propositional logic	–
9/30		–
10/3	quantifiers and relations	PS2 due; test 2
10/5	the language of predicate logic	–
10/7		PS3 released
10/10		quiz 3
10/12	semantics for predicate logic	–
10/14		–
10/17–21	<i>Fall Break</i>	–
10/24*	<i>guest lecture</i>	PS3 due; test 3
10/26*	<i>guest lecture</i>	–
10/28	<i>no class (Tartan Community Day)</i>	–
10/31		–
11/2	validity, closure, and duality	–
11/4		PS4 released
11/7		quiz 4
11/9	deduction in predicate logic	–
11/11		–
11/14		PS4 due; test 4
11/16	soundness and completeness of predicate logic	–
11/18		PS5 released
11/21	the Henkin construction	quiz 5
11/23	<i>no class (Thanksgiving)</i>	–
11/25	<i>no class (Thanksgiving)</i>	–
11/28		PS5 due; test 5
11/30	topics (e.g., model theory)	–
12/2		PS6 released
12/5		quiz 6
12/7	topics (e.g., modal/intuitionistic logic)	–
12/9		PS6 due; no test

Campus Resources

Academic Integrity Carnegie Mellon's Policy on Academic Integrity is available here: <http://www.cmu.edu/policies/student-and-student-life/academic-integrity.html>. It applies to all courses at this university, including this one.

Student Academic Success Center (SASC): SASC focuses on creating spaces for students to engage in their coursework and approach learning through a variety of group and individual tutoring options. They offer many opportunities for students to deepen their understanding of who they are as learners, communicators, and scholars. Their workshops are free to the CMU community and meet the needs of all disciplines and levels of study. SASC programs to support student learning include:

- Academic Coaching
<https://www.cmu.edu/student-success/programs/coaching.html>
- Peer Tutoring
<https://www.cmu.edu/student-success/programs/tutoring.html>
- Communication Support
<https://www.cmu.edu/student-success/programs/communication-support/index.html>
- Language and Cross-cultural Support
<https://www.cmu.edu/student-success/programs/language-support/index.html>
- Supplemental Instruction
<https://www.cmu.edu/student-success/programs/supp-inst.html>

For more information, visit <https://www.cmu.edu/student-success/>.

Disability Services: The Office of Disability Resources at Carnegie Mellon University has a continued mission to provide physical and programmatic campus access to all events and information within the Carnegie Mellon community. They work to ensure that qualified individuals receive reasonable accommodations as guaranteed by the Americans With Disabilities Act (ADA) and Section 504 of the Rehabilitation Act of 1973. For more information, visit: <http://www.cmu.edu/disability-resources/>.

If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at access@andrew.cmu.edu.