

# Formal Logic (80-310/80-610)

Fall 2020

Tuesday/Thursday 11:40–1:00, fully remote

<https://canvas.cmu.edu/courses/19085>

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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.

**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.

**Course Structure:** This course is *fully remote*, meaning all aspects happen online. All course resources and meetings will be posted on Canvas (see link above). The two main avenues for interaction are the class meetings (using Zoom) and the discussion forum (using Piazza).

- Tuesdays will typically focus on covering new content. These classes will be mostly lecture-style (though of course questions are always welcome). We will work through course notes that I will release each week ahead of class.
- Thursdays will typically focus on worked examples and student questions. These classes will be more like tutorials, driven largely by student participation. Come with questions, exercises you are stuck on, etc.
- All class meetings will be recorded and available (on Canvas) for the duration of the semester.
- Piazza is integrated with Canvas and is a great place to ask questions outside of class and to discuss the harder concepts and problems.

**Evaluation:** Problem sets 60%; canvas quizzes 30%; class engagement 10%.

Every other Thursday a problem set will be released, covering the previous 2 weeks of material, due 12 days after it is released (always on a Tuesday).

- These are the foundation of the class—where I will push you to *really* engage with what you've learned.
- You are encouraged to collaborate with classmates on the problem sets—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.

Each Friday a 30-minute Canvas quiz will be made available (all day) covering that week's material.

- They will consist of shorter questions designed to check whether you are keeping up with the course content, week by week.

The final portion of your grade is for general class engagement.

- This means participating in the Zoom sessions and/or posting on Piazza.
- It is relatively easy to score 10/10 on this: anyone who speaks up in class or posts on Piazza once or twice every week or two will get full credit.

**Community:** Especially in the context of remote learning, some sense of community is essential.

- 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.

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For many of us, these are stressful times. My hope is for this class to be useful and interesting for you, and not yet another source of stress. My (virtual) door is always open if you find yourself struggling or need help. If any aspect of this course is problematic for you (due to the present circumstances or for any other 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/>.

## Schedule

Weekly topics are subject to change; the below should only be considered a rough guideline. However, the evaluation schedule will *not* change.

<b>Date</b>	<b>Topic</b>	<b>Evaluation</b>
9/1 9/3	the language of propositional logic · structural induction	– –
9/8 9/10	semantics for propositional logic	PS1 released; Q1 (Fri)
9/15 9/17	equivalence relations · the algebraic perspective	– Q2 (Fri)
9/22 9/24	deduction in propositional logic	PS1 due PS2 released; Q3 (Fri)
9/29 10/1	soundness and completeness of propositional logic	– Q4 (Fri)
10/6 10/8	quantifiers and relations · the language of predicate logic	PS2 due PS3 released; Q5 (Fri)
10/13 10/15	semantics for predicate logic	– Q6 (Fri)
10/20 10/22	<i>Intermission</i>	PS3 due <i>no quiz</i>
10/27 10/29	validity · substitution · identity	– PS4 released; Q7 (Fri)
11/3 11/5	first-order structures · models & interpretations	– Q8 (Fri)
11/10 11/12	deduction in predicate logic	PS4 due PS5 released; Q9 (Fri)
11/17 11/19	soundness and completeness of predicate logic	– Q10 (Fri)
11/24 11/26	the Henkin construction <i>no class (Thanksgiving)</i>	PS5 due PS6 released; <i>no quiz</i>
12/1 12/3	topics (e.g., model theory, modal logic, intuitionistic logic, etc.)	– Q11 (Fri)
12/8 12/10	topics (e.g., model theory, modal logic, intuitionistic logic, etc.)	PS6 due Q12 (Fri)

## Campus Resources

**Academic Development (AD):** Academic Development is the place to go for help with your academic work. They offer everything from Academic Counseling in study skills to Peer Tutoring. They also offer Supplemental Instruction and EXCEL Groups for select courses. Their services are designed to help both students who are having academic difficulties and those who just want to improve their performance. For more information, visit <http://www.cmu.edu/acadev>.

**Global Communications Center (GCC):** The GCC, on the ground floor of Hunt Library, provides one-on-one tutoring in written, oral, and visual communication for any student, at any level, in any discipline, at any stage of the composing process (<http://www.cmu.edu/gcc>).

**Intercultural Communications Center (ICC):** The Intercultural Communication Center helps nonnative English speakers (both international students and students who attended high school in the U.S.) develop the English language skills and cultural understanding needed to succeed at Carnegie Mellon. The center offers classes and noncredit workshops and seminars (for example, Presentation Basics, Communicating Data Effectively, and Language and Culture for Teaching (for international TAs)). For more information, visit <http://www.cmu.edu/icc>.

**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](mailto:access@andrew.cmu.edu).