

MA 58500 Mathematical Logic I

Fall Semester 2024

updated September 24th 2024

As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do.
Accountable together – we are Purdue.

Course Information

Course Number	MA 58500
Course Title	Mathematical Logic I
Course Section	001
CRN	29346
Course Credit	3 credit hours
Prerequisites	None
Recommended	Some background in Abstract Algebra and Real Analysis would be highly beneficial (and it would make studying the material in this course much more meaningful).
Lecture Times	Monday, Wednesday, Friday 1:30pm
Meeting Location	MATH 215
Instructional Modality	Face-to-Face
Office Hours	Monday 5-6pm, Wednesday 4-5pm, Friday 2:30-3:30pm

Instructor

Name	Prof. Margaret E. M. Thomas
Email Address	memthomas at purdue.edu (you must use your official Purdue email; emails MUST include MA58500 in the subject line)
Office	MATH 638

Catalog Course Description

Propositional and predicate calculus; the Gödel completeness and compactness theorem, primitive recursive and recursive functions; the Gödel incompleteness theorem; Tarski's theorem; Church's theorem; recursive undecidability; special topics such as nonstandard analysis.

Learning outcomes

Students completing the course will

- (i) acquire an understanding of the semantics and syntax of first-order logic, and how to use these to solve foundational problems in mathematical logic;
- (ii) acquire basic skills in applying tools and techniques from mathematical logic to other areas of mathematics, such as algebra, number theory and combinatorics;
- (iii) be prepared to undertake more advanced studies in mathematical logic, such as in model theory, computability theory or proof theory.

Course Description from the Math Graduate Course Descriptions List

A first course in mathematical logic, oriented towards model theory, the study of mathematical structures in terms of their logical properties. The goal is to introduce the most central ideas of mathematical logic as well as certain tools needed to explore a variety of classical and modern subjects, in particular motivated by applications of model theory (such as the Ax—Kochen—Ershov

Theorem; or applications of o-minimal structures to diophantine geometry, Hodge theory, and dynamical systems; or the role of NIP and related tame structures in combinatorics; or the interaction between continuous logic and functional analysis; or connections between model theory and machine learning; etc.). Students are encouraged to participate if they are interested in possible research involving model theory, or if they are keen to learn a perspective from logic that might be applicable to other areas of mathematics.

The course will start with an introduction to predicate calculus (first-order logic), covering languages, structures, theories, formal proof, Gödel's Completeness Theorem and the Compactness Theorem of first-order logic. Thereafter, the focus will shift to central concepts in model theory, which could include definable sets, model completeness, quantifier elimination, elementary extensions, types, categoricity, saturation and ultraproducts. Set theory concepts would be introduced as needed. The emphasis will be on certain key examples, such as algebraically closed fields and o-minimal structures, with a view to some of the applications of model theory mentioned above. If there is time and interest, further topics from the foundations of mathematical logic could also be surveyed, such as a formalization of elementary number theory and the beginnings of computability, leading to the Gödel incompleteness theorems and the undecidability of arithmetic (however, given the intended focus of this course, these would not be covered in depth here).

Course Webpages

Official Course Page:

<https://www.math.purdue.edu/academic/courses/semester/202510/ma58500/index.html>

The main website for the course will be in [Brightspace](#). **You will be expected to check Brightspace regularly.** Course information, materials and announcements will be posted there, including reading lists, assignment problems (see **Assessment Methods** below) and exam information.

Some information may also be found on the instructor's course website as follows (in particular, in the event that Brightspace is not accessible, the syllabus will be available at the following page):

<https://www.math.purdue.edu/~thoma922/teaching/ma58500/ma58500fs24.html>

Textbook

There will likely be several books recommended for this class. At least at the start of the semester, we will follow this book most closely, and you should make sure that you can obtain access:

Marker, David – An Invitation to Mathematical Logic, Graduate Texts in Mathematics no. 301, Springer (2024)

This can be downloaded as an e-book (.pdf or .epub) through the Purdue Library. [Here is the link to the library catalogue entry](#). In the catalogue entry, select the "Online Access Available" link to access the Springer website (Career Account username and password required) from which the book may be downloaded.

Please note: You are not recommended to purchase a hard copy of this book at this time. At the moment there are quality control issues with the printing of the book at Springer, and until these are resolved you will likely receive a copy that was not printed correctly. The instructor has reported these issues to Springer, and Springer has promised to provide updates in due course.

Please also note: Since the above book has only just been published, it is possible that there will be errors and typos. There will be a running list kept on [Brightspace](#) of any errata that we have identified. If you find (what you think is) an error in the book, then please check the list on

[Brightspace](#) first; if what you have identified is not on the list, then please do a public service by emailing the instructor so that it can be checked and added if appropriate!

More suggestions of suitable reading will appear here in due course (see also [Brightspace](#)).

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Technology

- [Brightspace](#) - for course resources and announcements, including details/instructions for the assignments, and exam information; **you are expected to check announcements on Brightspace regularly.**
- [Gradescope](#) (course link within Brightspace) - for submission of assignments. (See Brightspace for instructions on using [Gradescope](#), as well as **Assessment Methods** → [Assignments](#) → **Submitting to Gradescope** below.)
- [Zoom](#) (meeting links, if they are ever needed, will appear within Brightspace) - not to be used as a rule, but available in case of unexpected developments, e.g. if it happens that a class has to pivot online, then the expectation is that this would take place on Zoom.

Use of AI

Use of AI tools is not recommended for this course. Your goal should be to acquire an understanding of and appreciation for the mathematics involved, in particular (since this is a logic class) the underlying mechanics of the mathematical reasoning process itself. Therefore, it is essential that you engage actively with that process, not seek shortcuts through AI. Moreover, AI tools may very possibly be inaccurate or misleading, and therefore actively undermine your learning. In addition, you should be aware that if you provide AI tools with information about this course and its materials, for example by asking questions incorporating course material, then this could be in breach of copyright law and thus is strictly prohibited. (See also **Copyright** below.)

Assessment Methods

<u>Midterm Examination</u>	One (1) written closed-book test in class of 50 minutes duration.
<u>Final Examination</u>	One (1) cumulative written closed-book final examination of 2 hours duration (date/time TBA during Finals week).
<u>Assignments</u>	Six (6) written assignments, approximately once every two weeks (see Schedule below), consisting of problems, some of which might be from textbooks listed above (see Textbook).

The assigned problems will be posted each week to Brightspace. You must submit your work for each assignment before the **deadline** listed in the **Schedule** below (unless you have an extension, in which case see “**Extensions**” below). Answers should be submitted to [Gradescope](#) (see “**Submitting to Gradescope**” below for instructions on how to submit your work.)

Please note: do not just look in [Gradescope](#) for the list of assigned problems, as [Gradescope](#) does not display any additional/altered instructions, hints, or the details of any problems that have been set that are not from the textbook. See Brightspace for this information.

You are allowed - indeed, you are encouraged - to work together with other students from the class on the assignments. If necessary, you may also use resources other than the textbook/class notes, although for preference you are encouraged to come to office hours to ask for help with assignments (see also **Use of AI** above).

In any event, it is important that you understand the material well enough to write up solutions in your own words, and you **must do so**. You **must also state clearly**: (a) the names of anyone with whom you collaborated on the work, and (b) any resources (other than textbook/class notes) that you used (including online materials).

Presenting work that is not your own as though it were your own is cheating, and could result in sanctions and referral to the OSRR (see also **Academic Integrity** below).

Submitting to Gradescope: You must finish (not start) submitting by the deadline, so please be careful to start the submission process through [Gradescope](#) early enough to finish in time.

Basic instructions for using [Gradescope](#) and the [Gradescope Mobile App](#) (including preparing your work in a suitable manner for submission) can be found on Brightspace. **Please note:**

- You can submit your work using the [Gradescope Mobile App](#) or the [Gradescope](#) website.
- If you handwrite your solutions on paper, then you should scan them as a **.pdf file** for uploading, e.g. by using the [Gradescope Mobile App](#). If you write your solutions in electronic form (typed or handwritten), then please save them as a **.pdf file** for uploading. ([Gradescope](#) allows .jpg uploads, but they are harder for the grader to work with, so please use .pdf files otherwise your work might not be gradable.)
- Please make every effort to ensure that your scans are **legible**; in particular, the scans should be of a good quality, and not just photos of your notebook taken from a strange angle!
- You can find the [Gradescope](#) link for this course in Brightspace. Use this to connect to [Gradescope](#) for the first time if you have not used [Gradescope](#) before. If you have used Gradescope before, then you can log in directly to [Gradescope](#), but you might need to wait until the roster is set up there before you see the course listed – otherwise, use the link in Brightspace.
- While submitting your work, you are asked to “**assign pages**” to all your solutions so that they can be located correctly. **Do this. You might score 0 if you do not, as the grader might not be able to find your solution to a question.** If you forget to do it (or are in a hurry to submit), then please note that **you may still go back and assign pages after the deadline.**
- Please review your submission after uploading, and assign pages at that point if still needed.

Late submissions: For each assignment, there will be a “late deadline” listed in [Gradescope](#) as well as the regular deadline. You may submit your work late, that is, after the regular deadline, at any time up until the “late deadline”. However, you will lose 5% of the points for that assignment if the work is late (i.e. after the regular deadline), and then a further 5% for every 24 hour period that elapses between the deadline and the time that you submit. (For example, if an assignment is worth 30 points, its deadline is on Monday at 11:59pm, and you submit two days later on Wednesday at 3pm, then you would automatically be deducted 3 (= 5% + 5% of the 30) points for the assignment.)

If you are too late to submit through [Gradescope](#) at all, then email the instructor your **entire .pdf submission** (NOT picture files) with an explanation; it will be at the instructor’s discretion whether or not to accept your submission or to impose a late penalty.

Extensions: Contact the instructor **by email** as early as possible if you would like to request an extension for an assignment. If the extension is granted, then the deadline in [Gradescope](#) will be adjusted for you. (See also policies regarding **Attendance** below.)

Make-Up Exams: You must contact the instructor **by email** as early as possible (at least a week in advance, and preferably longer, except in case of an emergency) if you would like to request to sit an examination at an alternative time due to a clash or an excused absence (see **Attendance** below for more details). It will be at the instructor’s discretion how to accommodate such a request.

Grading: If you wish to obtain more detailed feedback on your work, then please come to office hours to ask. Please note that grading could differ between assignments and exams, even for assignment problems that appear on exams (which is possible).

Schedule

The following schedule for assignment due dates and exams is **tentative** and very much subject to change!

Assessment	Date	Deadline/Time
<i>LABOR DAY</i>	<i>Monday September 2 2024 (no class)</i>	
Assignment 1	Tuesday September 3 2024	11:59pm EDT
Assignment 2	Monday September 16 2024	11:59pm EDT
Assignment 3	Wednesday October 2 2024	11:59pm EDT
<i>OCTOBER BREAK</i>	<i>Monday October 7 - Tuesday October 8 2024 (no class)</i>	
Midterm Exam	Monday October 14 2024	1:30pm EDT in class
Assignment 4	Monday October 28 2024	11:59pm EDT
Assignment 5	Monday November 11 2024	11:59pm EST
Assignment 6	Monday November 25 2024	11:59pm EST
<i>THANKSGIVING BREAK</i>	<i>Wednesday November 27 - Saturday November 30 2024 (no class)</i>	
Final Exam	TBA (during Final Exams week, the week starting Monday December 9 2024)	

Course Evaluation

Final grades will be calculated according to the following weighting of the above assessments:

Assignments	50%	(highest 5 assignment scores count for 10% each)
Midterm Exam	20%	
Final Exam	30%	

Students who get at least 97% of the total points in this course are guaranteed an A+, 93% guarantees an A, 90% an A-, 87% a B+, 83% a B, 80% a B-, 77% a C+, 73% a C, 70% a C-, 67% a D+, 63% a D, and 60% a D-; for each of these grades, it's possible that at the end of the semester a somewhat lower percentage will be enough to get that grade.

The instructor reserves the right to adjust this grading scheme at the end of the course; this adjustment will be applied uniformly and in a manner which only increases individual grades.

Attendance

Students need to inform the instructor of any conflict that can be anticipated and will affect the timely submission of an assignment or the ability to take an examination. Only the instructor can excuse a student from a course requirement or responsibility.

Under academic regulations, excused absences may be granted for cases of grief/bereavement, military service, jury duty, parenting leave, or emergent or urgent care medical care. In such cases, you or your representative should contact or go to the [Office of the Dean of Students](#) website to complete appropriate forms for instructor notification. For details, see the [Academic Regulations & Student Conduct section](#) of the University Catalog website.

In other situations, when conflicts or absences can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the

situation as far in advance as possible **in writing, by email**. Please note that attending personal events (such as weddings or other family occasions) would **not** qualify.

For **unanticipated or emergency absences** when advance notification to the instructor is not possible, the student should contact the instructor as soon as possible thereafter **by email**.

Learning Resources

The Helen Bass Williams [Academic Success Center](#), provides a variety of proactive, practical and approachable academic support services for you to strengthen your approaches and strategies for learning, including study skills consultations, peer coaching, workshops, and online handouts. Visit the [ASC website](#) for more information and to access resources.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu, or by calling 765-494-8778, or by contacting the [Office of the Dean of Students](#). While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern. More details are available on the course Brightspace under University Policies and Statements.

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty" (Section B.2.a of the [Student Regulations concerning Conduct](#)).

Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of ghostwritten papers, the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest."

Incidents of academic misconduct in this course will be addressed by the course instructor and referred to the [Office of Student Rights and Responsibilities \(OSRR\)](#) for review at the university level. Any violation of course policies as it relates to academic integrity will result minimally in a failing or zero grade for that particular assignment or test, and at the instructor's discretion may result in a failing grade for the course. In addition, all incidents of academic misconduct will be forwarded to OSRR, where university penalties, including removal from the university, may be considered.

Commercial Note Taking in Classes

Notes taken in class are generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. **No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, without the express written permission of the course instructor.** To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

See the [Regulations on Student Conduct: Miscellaneous Conduct Regulations \(point 10\)](#).

Copyright

See the University Policies and Statements section of Brightspace for guidance on Use of Copyrighted Materials. Effective learning environments provide opportunities for students to reflect, explore new ideas, post opinions openly, and have the freedom to change those opinions over time. Students and instructors are the authors of the works they create in the learning environment. As authors, they own the copyright in their works subject only to the university's right to use those works for educational purposes. Students may not copy, reproduce, or post to any other outlet (e.g., YouTube, Facebook, or other open media sources or websites, **including AI tools**) any work in which they are not the sole author, or the joint author having obtained the permission of the other author(s). In particular, disseminating notes, assignments, solutions, textbook extracts, exams or other course materials (**including to AI tools**) is strictly prohibited.

Nondiscrimination

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue's nondiscrimination policy: https://www.purdue.edu/purdue/ea_eou_statement.php

Academic Accommodation of Students with Disabilities

Purdue University strives to make learning experiences accessible to all participants. If you anticipate or experience physical or academic barriers based on disability, you are encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247, as soon as possible.

If the Disability Resource Center (DRC) has determined reasonable accommodations that you would like to utilize in this class, you must send your Course Accommodation Letter to the instructor. Instructions on sharing your Course Accommodation Letter can be found by visiting: <https://www.purdue.edu/drc/students/course-accommodation-letter.php>. Additionally, you are strongly encouraged to contact the instructor as soon as possible to discuss implementation of your accommodations.

Such accommodations may only be possible to arrange if the instructor is informed about them in a timely way. In particular, **requests to take any exam at Purdue Testing Services should follow the requirements of PTS** (e.g. for midterm exams, requests should be made **four days** in advance and, for final exams, requests should be made by PTS' deadline, which will be announced at the PTS link just given above). If booking through PTS, you must make the booking using the RegisterBlast link in Brightspace.

Mental Health

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try [Therapy Assistance Online \(TAO\)](#), a web and app-based mental health resource available courtesy of Purdue Counseling and Psychological Services (CAPS). TAO is available to all students at any time by creating an account on the [TAO Connect website](#), or downloading the app from the App Store or Google Play. It offers free, confidential well-being resources through a self-guided program informed by psychotherapy research and strategies that may aid in overcoming anxiety, depression and other concerns. It provides accessible and effective resources including short videos, brief exercises, and self-reflection tools.

If you need support and information about options and resources, please see the [Office of the Dean of Students](#). Call 765-494-1747. Hours of operation are M-F, 8am- 5pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a [Purdue Wellness Coach at RecWell](#). Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is free and can be done on BoilerConnect.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact [Counseling and Psychological Services \(CAPS\)](#) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS offices in [West Lafayette](#) or [Indianapolis](#).

Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday.

Major Campus Emergency

In the event of a major campus emergency, course requirements, deadlines, and grading are subject to change that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted on course websites or sent by email. You are expected to read your @purdue.edu email on a frequent basis.

A link to Purdue's Information on [Emergency Preparation and Planning](#) is located in Brightspace under "University Policies and Statements." This website covers topics such as Severe Weather Guidance, Emergency Plans, and a place to sign up for the Emergency Warning Notification System. You are encouraged to download and review the [Emergency Preparedness for Classrooms document](#), which is also included at the end of this syllabus.

The first day of class, the instructor will review the Emergency Preparedness plan for the specific classroom, following Purdue's required [Emergency Preparedness Briefing](#). Please make note of items such as:

- The location to where we will proceed after evacuating the building if we hear a fire alarm.
- The location of our Shelter in Place in the event of a tornado warning.
- The location of our Shelter in Place in the event of an active threat such as a shooting.

Current information for the building for this class, which is MATH, is also given below:

Fire Alarm: Immediately evacuate the building and proceed to the **parking lot area away from the building**.

Shelter in Place Location:

Tornado: If a tornado warning has been issued for campus, **move to the lowest level possible away from exterior doors and windows**. Seek more information on storm conditions from National Weather Service weather radio or application on mobile device.

Major hazardous materials release: Shelter in nearest **building or classroom, shutting any open doors and windows**.

Active Shooter etc.: If one cannot get away, **shelter in a room that is securable preferably without windows.**

If you are directed to shelter in place, but you are unaware of the specific reason, proceed to the lowest level of the building but continue to seek additional information by all possible means to determine the type of incident.



EMERGENCY PREPAREDNESS for Classrooms

EMERGENCY NOTIFICATION PROCEDURES are based on a simple concept – if you hear a fire alarm inside, proceed outside. If you hear a siren outside, proceed inside.

- **Indoor Fire Alarms** mean to stop class or research and immediately evacuate the building.
 - Proceed to your Emergency Assembly Area away from building doors. **Remain outside** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.
- **All Hazards Outdoor Emergency Warning Sirens** mean to immediately seek shelter (**Shelter in Place**) in a safe location within the closest building.
 - “Shelter in place” means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, an active threat such as a shooting or release of hazardous materials in the outside air. Once safely inside, find out more details about the emergency*. **Remain in place** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

**In both cases, you should seek additional clarifying information by all means possible...Campus Emergency Status page, text message, email alert, TV, radio, etc...review the Purdue Emergency Warning Notification System multi-communication layers at http://www.purdue.edu/ehps/emergency_preparedness/warning-system.html*

EMERGENCY RESPONSE PROCEDURES:

- Review the **Emergency Procedures Guidelines**
https://www.purdue.edu/emergency_preparedness/flipchart/index.html
- Review the **Building Emergency Plan** (available on the Emergency Preparedness website or from the building deputy) for:
 - evacuation routes, exit points, and emergency assembly area
 - when and how to evacuate the building.
 - shelter in place procedures and locations
 - additional building specific procedures and requirements.

EMERGENCY PREPAREDNESS AWARENESS VIDEO

- **"Run. Hide. Fight.®"** is a 6-minute active shooter awareness video that illustrates what to look for and how to prepare and react to this type of incident. See:
https://www.youtube.com/watch?v=5mzl_5aj4Vs

MORE INFORMATION

Reference the Emergency Preparedness web site for additional information:
http://www.purdue.edu/ehps/emergency_preparedness