

PHIL 478M/688V: Modal Logic

Instructor:	Eric Pacuit (pacuit.org)
Semester:	Fall 2023
Email:	epacuit@umd.edu
Course Website:	umd.instructure.com/courses/1353445
Office:	Skinner 1103A
Office Hours:	Mondays, 1:30pm - 2:45pm
Class Times:	MW 3:00pm - 4:15pm
Class Location:	JMZ 0122

Course Description

Modal logic began as the study of different sorts of modalities, or modes of truth: alethic (“it is necessarily true that”), epistemic (“it is known that”), deontic (“it ought to be the case that”), temporal (“it has always been the case that”), among others. By now, modal logic has become a broad area of research, forming a sort of lingua franca between many disciplines, especially philosophy, computer science, economics, and linguistics.

The course covers core concepts and basic metatheory of propositional modal logic, including relations to first-order logic; the basics of quantified modal logic; and selected applications of modal logic. Topics that may be discussed (the final choice of topics may be adapted to fit students’ interests) include (dynamic) epistemic/doxastic logic, conditional logic, non-normal modal logics, logics of action and agency, temporal logics, and applications of modal logic in game theory. Students will come away from this course with a working knowledge of modal logic and its use in philosophy, computer science and game theory.

Prerequisites: PHIL370 (or equivalent logic course), or permission from the instructor.

Literature

The required texts for the course are:

1. *Modal Logic for Open Minds* ([MLOM]) by Johan van Benthem, available at the bookstore.
2. Notes on Modal Logic ([EP-ML]) by Eric Pacuit, available on the course website.

Additional Readings

Excerpts from these additional readings will be posted on the ELMS site.

Patrick Blackburn, Maarten de Rijke, and Yde Venema. *Modal Logic*. Cambridge, 2001.

Brian F. Chellas. *Modal logic: an introduction*. Cambridge University Press, 1980.

[FM] Melvin Fitting and Richard L. Mendelsohn. *First-Order Modal Logic*. Kluwer, Dordrecht, 1998.

Wesley H. Holliday. Epistemic Logic and Epistemology. In S.O. Hansson and V.F. Hendricks, editors, *Handbook of Formal Philosophy*. Springer, 2012.

John F. Horty. *Agency and Deontic Logic*, Oxford University Press, 2009.

David Lewis. *Counterfactuals*. Blackwell, 1973.

[NBHD] Eric Pacuit. *Neighborhood Semantics for Modal Logic*. Springer, 2017.

Eric Pacuit. Dynamic Epistemic Logic I & II, *Philosophy Compass*, 2013.

Barbara H. Partee, Alice ter Meulen, and Robert E. Wall. *Mathematical Methods in Linguistics*. Springer, 1990.

Johan van Benthem. What One May Come to Know. *Analysis*, 64(2):95–105, 2004.

Yde Venema. Temporal Logic. In L. Goble, editor, *The Blackwell Guide to Philosophical Logic*, pages 203–223. Blackwell, 2001.

R. Stalnaker (2006). On logics of knowledge and belief. *Philosophy Studies*, 128, pp. 169 - 199

Yifeng Ding (2021). On the Logic of Belief and Propositional Quantification. *Journal of Philosophical Logic*, 50, pp.1143 - 1198.

Learning Outcomes

Students who successfully complete this course will be prepared to:

- Demonstrate a working knowledge of modal logic and its use in philosophy, computer science and game theory.
- Apply existing modal logics where appropriate and design new logical systems to problems in philosophy, game theory and linguistics.
- Analyze properties of modal logics.

Grading Policy

The course requirements are:

- **Participation** (30% of your final grade): There are two parts for your participation grades:
 1. **Tutorials:** There will be tutorials containing questions that will be discussed during the lectures. These are low-stakes problems designed to give students a chance to practice with the concepts introduced in the lectures. Many of the questions and answers will be discussed during the lectures, and students are encouraged to discuss the questions with fellow students. Most of the tutorial questions will be answered on Gradescope.

2. **Weekly questions/comments:** You must submit a weekly question/comment on Piazza (available on the course website). This could be a question about something that you did not understand in the reading or lectures, a question or topic that you would like to discuss in more detail during the lectures, or some general comments you have about the material we are discussing that week. You can also report on a question that you raised during a lecture and the answer that was discussed. Questions for the week must be submitted by **Tuesday at 11pm**. Students will receive 1 point for each substantive question that is asked during the semester on Piazza. The grade for the weekly questions will be out of 12, so to receive full credit, **you must ask 12 substantive questions during the semester (roughly 1 question per week)**.

You will receive extra credit for any question asked beyond the 12 points for a maximum of 20 points.

- **Problem sets** (40% of your final grade). There will be approximately 5 problem sets assigned this semester. Problem sets will be submitted through Gradescope (accessible through the course website). You can use your notes and the readings, but you should not discuss your answers with your classmates or use any AI tools, such as ChatGPT, to answer these questions. Consult the course website for the due dates.
- **Exams** There will be two exams:

Midterm (15% of your final grade): The midterm will be an online exam assigned roughly half-way through the semester. The answers will be submitted on Gradescope.

Final exam (15% of your final grade): The final will be cumulative and given as an in-class exam given during finals week. A study guide will be provided during the last week of the semester. Consult Testudo for the date, time and location of the final exam.

See undergraduate catalogue for description of grades, e.g., A+, A, A-, etc.: <http://www.umd.edu/catalog/index.cfm/show/content.section/c/27/ss/1584/s/1534>. Your final grade may be curved.

Grades will be assigned according to the following weights:

Participation	30%
Problem Sets	40%
Midterm	15%
Final Exam	15%

Your final grade may be curved, but the final grade cutoffs are typically as follows:

A+	> 100%	B+	88%	C+	78%	D+	68%	F < 60%
A	93%	B	83%	C	73%	D	63%	
A-	90%	B-	80%	C-	70%	D-	60%	

See undergraduate catalogue for description of grades, e.g., A+, A, A-, etc.: <https://registrar.umd.edu/current/Policies/acadregs.html#plusminus>.

For students enrolled in PHIL 688V

There will be a short final paper (around 2200-2500 words, 5-7 pages) where you are asked to survey some papers on modal logic, or apply modal logic to a philosophical problem. You must schedule a meeting with me during the first two weeks of November to discuss the topic of your paper. The paper is due by **December 12**.

Tentative Syllabus

Below is a tentative syllabus for this semester. This is subject to change. Please consult the course website for an up-to-date overview of the material discussed in the course.

Date	Topic	Reading
8/28 8/30	Introduction and motivation, Relational structures	[MLOM], Ch. 2 [EP-ML], Section 1
9/4 9/6	No class - Labor Day Modal languages, Models and frames, Validity	[EP-ML], Sect. 1
9/11 9/13	Invariance and bisimulation	[MLOM], Ch. 3 [EP-ML], Sect. 3
9/18 9/20	Frame definability	[MLOM], Ch. 9 [EP-ML], Sect. 3
9/25 9/27	Axioms and proofs, Soundness	[MLOM], Ch. 5
10/2 10/4	The canonical model, Completeness	[MLOM], Ch. 5 [EP-ML], Sect. 4
10/9 10/11	Decidability: Online lectures - Away at a conference	[MLOM], Ch. 4
10/16 10/18	Advanced topics (e.g., incompleteness, undefinability)	TBA
10/23 10/25	Alternative semantics for modal logic	eg., [Pac-NBHD], Ch. 1
10/30 11/1	Topics (e.g., multi-agent epistemic logic, common knowledge)	[MLOM], Part III
11/6 11/8	Topics (e.g., public announcements, doxastic logic)	[MLOM], Part III
11/13 11/15	Topics (e.g., temporal logic, logics of action and ability)	[MLOM], Part III
11/20 11/22	Quantified modal logic I No class - Thanksgiving break	TBA
11/27 11/29	Quantified modal logic II	[FM], Sect. 4.1-4.5
12/4 12/6	Quantified modal logic III	TBA
12/11	Review	

Course Policies

A full list of course-related policies and relevant links to resources may be found at:

<http://www.ugst.umd.edu/courserelatedpolicies.html>.

Communication about this Course I will use ELMS announcements and Piazza (available on the course website) to convey important information, and students are responsible for keeping their email address up to date, and must ensure that forwarding to another email address functions properly. Failure to check email, errors in forwarding, and returned email are the responsibility of the student, and do not constitute an excuse for missing announcements or deadlines.

Names/Pronouns and Self-Identifications The University of Maryland recognizes the importance of a diverse student body, and we are committed to fostering inclusive and equitable classroom environments. I invite you, if you wish, to tell us how you want to be referred to both in terms of your name and your pronouns (he/him, she/her, they/them, etc.). The pronouns someone indicates are not necessarily indicative of their gender identity. Visit trans.umd.edu to learn more.

Additionally, how you identify in terms of your gender, race, class, sexuality, religion, and dis/ability, among all aspects of your identity, is your choice whether to disclose (e.g., should it come up in classroom conversation about our experiences and perspectives) and should be self-identified, not presumed or imposed. I will do my best to address and refer to all students accordingly, and I ask you to do the same for all of your fellow Terps.

Accessibility and Disability Services The University of Maryland is committed to creating and maintaining a welcoming and inclusive educational, working, and living environment for people of all abilities. The University of Maryland is also committed to the principle that no qualified individual with a disability shall, on the basis of disability, be excluded from participation in or be denied the benefits of the services, programs, or activities of the University, or be subjected to discrimination. The Accessibility & Disability Service (ADS) (<https://www.counseling.umd.edu/ads/>) provides reasonable accommodations to qualified individuals to provide equal access to services, programs and activities. ADS cannot assist retroactively, so it is generally best to request accommodations several weeks before the semester begins or as soon as a disability becomes known.

For assistance in obtaining an accommodation, contact Accessibility and Disability Service at 301-314-7682, or email them at adsfrontdesk@umd.edu.

Student Resources and Services

- Note taking assistance (<https://counseling.umd.edu/ads/notetakers>)
- Counseling Center (<https://www.counseling.umd.edu/>)
- UMD's Student Academic Support Services website (<http://tutoring.umd.edu/>)
- UMD's Writing Center (<http://www.english.umd.edu/academics/writingcenter/schedule>)
- UMD's Student Resources and Services website (<https://sph.umd.edu/content/student-resources-and-services>)
- Basic Needs Security (<https://studentaffairs.umd.edu/basic-needs-security>)

Class Cancellations The University may be closed in the event of an emergency, in which case class will be cancelled. To find out if the University is closed you can check its main site (<http://www.umd.edu>), its emergency preparedness site (<http://www.umd.edu/emergencypreparedness/>), or call the “snow phone line” at 301-405-7669 (which covers more than just snow caused closings). If class is cancelled while the University remains open, then there will be an announcement posted on the course ELMS page.

Emergency Protocol: In the case of an extended closure to the University (e.g., because of inclement weather), consult the ELMS course page for announcements and changes to any due dates.

Attendance and Absences Students are expected to attend classes regularly. Consistent attendance offers students the most effective opportunity to gain command of course concepts and materials. Events that justify an excused absence include: religious observances; mandatory military obligation; illness of the student or illness of an immediate family member; participation in university activities at the request of university authorities; and compelling circumstances beyond the student’s control (e.g., death in the family, required court appearance). Absences stemming from work duties other than military obligation (e.g., unexpected changes in shift assignments) and traffic/transit problems do not typically qualify for excused absence. Students claiming an excused absence must notify the course instructor in a timely manner and provide appropriate documentation. The notification should be provided either prior to the absence or as soon afterwards as possible. In the case of religious observances, athletic events, and planned absences known at the beginning of the semester, the student must inform the instructor during the schedule adjustment period. All other absences must be reported as soon as is practical. The student must provide appropriate documentation of the absence. The documentation must be provided in writing to the instructor by the means specified in this syllabus. The full university attendance/absence policy can be found here: <http://www.ugst.umd.edu/courserelatedpolicies.html>.

Academic Integrity The UMD Honor Code prohibits students from cheating on exams, plagiarizing papers, submitting the same paper for credit in two courses without authorization, buying papers, submitting fraudulent documents and forging signatures. On every examination, paper or other academic exercise not exempted by the instructor, students must write by hand and sign the following pledge:

I pledge on my honor that I have not given or received any unauthorized assistance on this examination (or assignment).

Allegations of academic dishonesty will be reported directly to the Student Honor Council: <https://studentconduct.umd.edu/>

Copyright Notice Class lectures and other materials are copyrighted. They are the property of the instructor - do not sell them, do not post them on a website. They may not be reproduced for anything other than personal use without written permission from the instructor. Copyright infringements may be referred to the Office of Student Conduct.

Academic Accommodations for Students who Experience Sexual Misconduct The University of Maryland is committed to providing support and resources, including academic accommodations, for students who experience sexual or relationship violence as defined by the University's Sexual Misconduct Policy. To report an incident and/or obtain an academic accommodation, contact the Office of Civil Rights and Sexual Misconduct at 301-405-1142. If you wish to speak confidentially, contact Campus Advocates Respond and Educate (CARE) to Stop Violence at 301-741-3555. As 'responsible university employees' faculty are required to report any disclosure of sexual misconduct, i.e., they may not hold such disclosures in confidence. For more information: <http://www.umd.edu/ocrsm/>

Diversity The University of Maryland values the diversity of its student body. Along with the University, I am committed to providing a classroom atmosphere that encourages the equitable participation of all students regardless of age, disability, ethnicity, gender, national origin, race, religion, or sexual orientation. Potential devaluation of students in the classroom that can occur by reference to demeaning stereotypes of any group and/or overlooking the contributions of a particular group to the topic under discussion is inappropriate.

For information on elms, counseling, health, learning workshops, tutoring, writing help, student rights in undergrad courses, questions about graduation or add/drop/withdraw, please see <http://www.ugst.umd.edu/courserelatedpolicies.html>.