

# PHIL 478M: Modal Logic

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Semester:	Fall 2015
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Course Website:	myelms.umd.edu/courses/1154654
Office:	Skinner 1103A
Office Hours:	W 2 - 3.30 PM
Class Times:	MW 1:00pm - 1:50pm
Class Location:	Skinner 1115

## 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. The main objective is that students should be able to confidently apply techniques from modal logic to problems in their area of research. After completing the course, students will be able to apply existing modal logics where appropriate and design new logical systems when necessary, and rigorously analyze their properties.

**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.

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.

Sten Lindström and Krister Segerberg. Modal Logic and Philosophy. In P. Blackburn, J. van Benthem, and F. Wolter, editors, *Handbook of Modal Logic*, pages 11491214. Elsevier, 2007.

Eric Pacuit. Neighborhood Semantics for Modal Logic. 2015.

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):95105, 2004.

Johan van Benthem. *Modal Logic for Open Minds*. CSLI Publications, 2010.

Yde Venema. Temporal Logic. In L. Goble, editor, *The Blackwell Guide to Philosophical Logic*, pages 203223. Blackwell, 2001.

Seth Yalcin. Epistemic Modals. *Mind*, 116(464):9831026, 2007.

## Grading Policy

The course requirements are: Participation & quizzes (10%), problem sets (40%), midterm paper (20%), and a final exam (30%). I may periodically give quizzes (either in-class or online).

**Participation & quizzes (20 points): Attendance is mandatory.** Each student will start with 20 points. You will lose points for failing to show up to the lectures, missing quizzes, or not keeping up-to-date with the readings.

**Problem Sets (100 points):** For the problem sets, you are encouraged to work in small groups. You may discuss the problems with one another or with me as much as you want. *But you must always do the final write-up completely on your own.* A good strategy when working together is to use a blackboard and erase it completely before writing up your (separate) answers. Please write the name of your discussion partner(s) on the front page of your assignments. Solutions to the

problem sets will be made available after the assignment is due and will be discussed in class. ***Late assignments will not be accepted for full credit.*** The tentative due dates for the problem sets are (the dates are subject to change based on how fast we go through the material):

	Assigned	Due Date
Problem Set 1	Sep. 2	Sep. 7
Problem Set 2	Sep. 7	Sep. 14
Problem Set 3	Sep. 14	Sep. 21
Problem Set 4	Sep. 23	Oct. 12
Problem Set 5	Oct. 19	Oct. 26
Problem Set 6	Dec. 7	Dec. 14

**Midterm paper (80 points):** You are required to write a short paper (5-10 pages) summarizing an application of propositional modal logic. Topics include: modal logics for reasoning about games, preference modal logics, deontic logics, topological semantics for modal logic, justification logic, provability logic. The idea is to select a few papers that make use of modal logic (you may also select a Chapter from [MLOM]), describe the modal systems used in the papers, and offer you own observations. There are two requirements for the paper. The first is a clear description of a modal logic (i.e., a precise description of the syntax and semantics) found in the literature, and a discussion of any interesting properties of the chosen logical system. The second is to explain the intended interpretation of the modal operators. The due dates for the paper are:

Nov. 2 - 11	Schedule a meeting with me to select some papers
Nov. 23 - 25	Schedule a meeting with me to discuss your papers
Dec. 7	Papers Due

**Final Exam (100 points):** The final will be an in-class exam given during finals week. It will be a cumulative exam covering all the topics discussed throughout the semester.

# Tentative Syllabus

Below is a tentative schedule for the semester (consult the course site for more details).

## Part I: Propositional Modal Logic

Aug. 31 (Mo)	<b>Course Overview</b> No readings
Sep. 2 (We)	<b>Sets, Relations, Functions</b> Reading: Partee et al. 1990, chapters 1-3. Problem Set 1 due in class Sep. 9. Special session on LaTeX for problem sets (date/time TBD, if there is interest).
Sep. 7 (Mo)	<b>No Class: Labor Day</b>
Sep. 9 (We)	<b>Basic Language and Semantics</b> Readings: [MLOM], Chapter 2; [EP-ML], Section 1
Sep. 14 (Mo)	<b>Expressive Power and Invariance I</b> Readings: [MLOM] Chapter 3; [EP-ML], Section 3; Notes on Model Constructions
Sep. 16 (We)	<b>Expressive Power and Invariance II</b> Readings: [MLOM] Chapter 3; [EP-ML], Section 3; Notes on Model Constructions
Sep. 21 (Mo)	<b>Validity and Decidability I</b> Readings: [MLOM], Chapter 4; [EP-ML], Section 2
Sep. 23 (We)	<b>Validity and Decidability II</b> Readings: [MLOM], Chapter 4; [EP-ML], Section 2
Sep. 28 (Mo)	<b>Axioms, Proofs, and Completeness I</b> Readings: [MLOM], Chapter 5; [EP-ML], Section 4
Sep. 30 (We)	<b>Axioms, Proofs, and Completeness II</b> Handout on modal completeness proofs
Oct. 5 (Mo)	<b>Correspondence Theory</b> Readings: [MLOM] Sections 9.1-9.2; [EP-ML], Section 3.1
Oct. 7 (We)	<b>The Landscape of Normal Modal Logics</b> Readings: [MLOM], Chapter 8
Oct. 12 (Mo)	<b>Non-Normal Modal Logics I</b> Reading: [Pac-NBHD], Chapter 1
Oct. 14 (We)	<b>Non-Normal Modal Logics II</b> Reading: [Pac-NBHD], Chapter 2

- Oct. 19 (Mo)      **Modal Fragments of First-Order Logic**  
 Readings: [MLOM], Section A.1, 7.1-7.3, 7.5, 25.1
- Oct. 21 (We)      **Advanced Topics**  
 Reading: TBD

## Part II: Applications

- Oct. 26 (Mo)      **Logics of Knowledge and Belief I**  
*Class Canceled (Speaking at a Conference in Taiwan: LORI 2015)*  
 There will be online lectures this week. If needed, we will schedule a make-up class.  
 Readings: Holliday 2012; Pacuit, 2013
- Oct. 28 (We)      **Logics of Knowledge and Belief II**  
*Class Canceled (Speaking at a Conference in Taiwan: LORI 2015)*  
 There will be online lectures this week. If needed, we will schedule a make-up class.  
 Readings: Holliday 2012; Pacuit, 2013
- Nov. 2 (Mo)      **Logics with Transitive Closure Operators: Common Knowledge/Belief**  
 Readings: [MLOM], Chapters 12 & 22
- Nov. 4 (We)      **Dynamic Epistemic Logic**  
 Readings: [MLOM], Sections 15.1-15.4, 15.6-15.7; van Benthem 2004; Pacuit 2013
- Nov. 9 (Mo)      **Counterfactuals I**  
 Readings: Lewis 1973, Sections 1.1-1.4, 2.3
- Nov. 11 (We)      **Counterfactuals II**  
 Reading: Lewis 1973, Sections 1.5-1.8
- Nov. 16 (Mo)      **Temporal Logic I**  
 Readings: Fitting and Mendelsohn 1998, Section 1.10; [MLOM], Section 18.1-18.3;  
 Venema 2001, Sections 1-3, 4-5
- Nov. 18 (We)      **Temporal Logic II**  
 Readings: Fitting and Mendelsohn 1998, Section 1.10; [MLOM], Section 18.1-18.3;  
 Venema 2001, Sections 1-3, 4-5
- Nov. 23 (Mo)      **Logics of Action and Ability I**  
 Reading: Horty, 2001, Chapter 2
- Nov. 25 (We)      **Logics of Action and Ability II**  
 Reading: Horty, 2001, Chapter 2

## Part III: Introduction to Quantified Modal Logic

Nov. 30 (Mo)	<b>Quantified Modal Logic I</b> Readings: Fitting and Mendelsohn 1998, Sections 4.1-4.5 Recommended: Lindström and Segerberg 2007, Section 1 on the history of QML in philosophy
Dec. 2 (We)	<b>Quantified Modal Logic II</b> Readings: Fitting and Mendelsohn 1998, Sections 4.6-4.9, [MLOM], Chapter 11
Dec. 7 (Mo)	<b>Quantified Modal Logic III</b> Reading: Fitting, 2004
Dec. 9 (We)	<b>Extra Topics/Concluding Remarks</b> No Readings
Dec. ??	<b>Course Review</b> Date/time TBD
Dec. 14-19	<b>Exam week (Date: TBA)</b>