

Modal Logic

MW 2:55–4:10pm · Uris Hall G26

PHIL 3340/MATH 3850

Prof: Arc Kocurek
Email: awk78@cornell.edu
Office Hours: R 3–4pm · 237 Goldwin Smith Hall

Description

Modal logic is a general logical framework for systematizing reasoning about qualified and relativized truth. It has been used to study the logic of possibility, time, knowledge, obligation, existence, and much more. This course will explore both the theoretical foundations and the various philosophical applications of modal logic. On the theoretical side, we will cover basic metatheory, including Kripke semantics, soundness and completeness, correspondence theory, and expressive power. On the applied side, we will examine temporal logic, epistemic logic, deontic logic, counterfactuals, two-dimensional logics, and quantified modal logic.

Prerequisites: an introductory course on deductive logic (PHIL 2310 or equivalent)

Required Materials

van Benthem, *Modal Logic for Open Minds*

All other required readings will be made available on Canvas.

Optional texts

- Velleman, *How to Prove It* (general introduction to proofs)
- Chellas, *Modal Logic: An Introduction* (a classic; excellent introduction)
- Sider, *Logic for Philosophy* (great text for beginners; second half covers modal logic)
- Priest, *An Introduction to Non-Classical Logic* (has several accessible chapters on modal logic)
- Hughes and Cresswell, *A New Introduction to Modal Logic* (“new” in 1996. . . but still good; intermediate, not for beginners; old notation)
- Blackburn, de Rijke, and Venema, *Modal Logic* (advanced; graduate-level; the bible of modal logic; also known as “the Dutch book”)

Grades

Problem Sets	50%	11 in total (lowest problem set grade dropped)
Midterm Problem Set	15%	take-home
Final Paper	35%	2200–2500 words

Assignments

Problem Sets

There will be weekly problem sets due every **Friday by 3pm** at **218 Goldwin Smith Hall**. The problem sets will generally cover the material from the previous week's lectures (so you will have more than a week after lectures to work on the problem set). There will be 11 problem sets in total, each worth 5% of your total grade. Your lowest problem set grade will be dropped.

No late problem sets will be accepted, as the solutions will be posted online shortly afterwards. All problems sets must be neatly handwritten or typed in LaTeX.

You are permitted (indeed, encouraged!) to work in groups on problem sets, so long as (1) your solutions are your own work and not the result of just copying others' work, and (2) you write the names of those you worked with on the problem set.

Midterm Problem Set

Midway through the semester, there will be a midterm problem set that covers all the material discussed in Unit 1 (Theory). The midterm is due by **October 25th at 3pm**. Late midterms will not be accepted without written permission from the instructor. You are permitted to work in groups so long as the same conditions as for problem sets are met.

Final Paper

At the end of the semester, you will be asked to submit a paper that applies modal logic to a philosophical problem. The paper will be between 2200–2500 words (approx. 7–8 pages with 1.5 line spacing) and must be submitted as a PDF online by the end of the day on **December 18th**. More details will be provided as we get closer to the due date.

Prior to submitting the paper, you will be asked to submit a short proposal outlining the topic and your aims in the final paper. This is due by the end of the day on **December 11th**.

Academic Integrity

In this course, we will strictly adhere to the University Policy on Academic Integrity, as outlined in the Code of Academic Integrity (<http://cuinfo.cornell.edu/aic.cfm>). Any violation of this policy will be reported immediately. Violations will, at the very least, result in an F on the assignment in question, but may also lead to an F in the class, suspension, or other penalties.

Schedule

Modal Logic for Open Minds = van Benthem 2010.

Theory

Week 1

09/04 | **Overview**
Reading: van Benthem 2010, ch. 1 (optional); Fitting and Mendelsohn 1998, § 1.1–1.5 (optional); Blackburn et al. 2001, § 1.7 (optional)

Week 2

09/09 | **Sets**
Reading: Partee et al. 1990, ch. 1

09/11 | **Relations**
Reading: Partee et al. 1990, § 2.1–2.2 and ch. 3 (§ 2.3–2.4 recommended)

09/13 | **PS1 DUE**

Week 3

09/16 | **Kripke Semantics**
Reading: Pacuit 2009, § 1; van Benthem 2010, § 2.1–2.2; Fitting and Mendelsohn 1998, § 1.6–1.7 (optional)

09/18 | — Arc is away (no class) —

09/20 | **PS2 DUE**

Week 4

09/23 | — Arc is away (no class) —

09/25 | **Validity and Consequence**
Reading: Pacuit 2009, § 2; van Benthem 2010, § 2.3 (§ 2.4 optional); Fitting and Mendelsohn 1998, § 1.8–1.9 (optional)

09/27 | **PS3 DUE**

Week 5

09/30 | **Modal Equivalence**
Reading: Pacuit 2009, § 3 (up to Definition 3.3); Blackburn et al. 2001, pp. 51–57

10/02 | **Bisimulation**
Reading: Pacuit 2009, § 3 (pp. 8–10); van Benthem 2010, § 3.1–3.4 (§ 3.5 optional); Blackburn et al. 2001, § 2.2 (optional, advanced)

10/04 | **PS4 DUE**

Week 6

- 10/07 | **Axiomatic Proofs**
Reading: van Benthem 2010, § 5.1–5.6; Blackburn et al. 2001, § 1.6
- 10/09 | **Soundness and Completeness**
Reading: van Benthem 2010, § 5.7–5.8; Blackburn et al. 2001, § 4.2 (optional, advanced)
- 10/11 | **PS5 DUE**

Week 7

- 10/14 | ——— Fall break (no class) ———
- 10/16 | **Correspondence Theory and the Landscape of Modal Logics**
Reading: van Benthem 2010, § 7.1–7.2, § 8.1–8.2, §9.1–9.3
- 10/18 | **PS6 DUE**

Applications

Week 8

- 10/21 | **Temporal Logic I**
Reading: Fitting and Mendelsohn 1998, § 1.10; Venema 2001, § 1–3 (up to Theorem 3.1); van Benthem 2010, § 18.1–18.3 (optional)
- 10/23 | **Temporal Logic II: Future Contingents and the Master Argument**
Reading: Fitting and Mendelsohn 1998, pp. 35–40; Venema 2001, § 4; van Benthem 2010, § 18.5 (optional)
- 10/25 | **MIDTERM PROBLEM SET DUE**

Week 9

- 10/28 | **Counterfactuals I**
Reading: Lewis 1973, § 1.1–1.4, § 2.3; van Benthem 2010, § 13.4 (optional)
- 10/30 | **Counterfactuals II: Counterfactual Fallacies**
Reading: Lewis 1973, § 1.5–1.8, § 3.4
- 11/01 | **PS7 DUE**

Week 10

- 11/04 | **Deontic Logic I**
Reading: Hilpinen 2001, § 8.1–8.4; van Benthem 2010, § 16.1–16.3
- 11/06 | **Deontic Logic II: Chisholm’s Paradox**
Reading: Chisholm 1963; Hilpinen 2001, § 8.5; Lewis 1973, § 5.1

11/08 | **PS8 DUE**

Week 11

11/11 | **Epistemic Logic I**

Reading: Fitting and Mendelsohn 1998, §1.11; Holliday 2016a; van Benthem 2010, § 12.1–12.3 (§ 13.1–13.3 optional); Stalnaker 2006 (optional)

11/13 | **Epistemic Logic II: The Surprise Exam Paradox**

Reading: Sorensen 1988, pp. 253–255, 289–292, 317–320; Holliday 2016b (optional)

11/15 | **PS9 DUE**

Week 12

11/18 | **Two-Dimensional Modal Logic I**

Reading: Davies and Humberstone 1980, § 1–2; Kripke 1971 (optional, background); Evans 1979 (optional, background)

11/20 | **Two-Dimensional Modal Logic II: The Contingent A Priori**

Reading: Davies and Humberstone 1980, pp. 17–26 (pp. 13–17 optional); Sider 2010, § 10.4 (optional)

11/22 | **PS10 DUE**

Week 13

11/25 | **Intuitionistic Logic**

Reading: Priest 2008, § 6.1–6.3, § 6.5–6.6, § 6.8; van Benthem 2010, § 20.1–20.4

11/27 | ——— Thanksgiving (no class) ———

Week 14

12/02 | **Quantified Modal Logic I**

Reading: Fitting and Mendelsohn 1998, § 4.1–4.3, § 4.5–4.7

12/04 | **Quantified Modal Logic II: The Paradox of Nonbeing**

Reading: van Benthem 2010, ch. 11.1–11.3; Fitting and Mendelsohn 1998, § 4.9, § 8.1, § 8.3–8.8

12/06 | **PS11 DUE**

Week 15

12/09 | **Quantified Modal Logic III: Frege’s Puzzle**

Reading: none

12/11 | **FINAL PAPER PROPOSAL DUE**

Week 16

12/18 | **FINAL PAPER DUE**

References

- Blackburn, Patrick, de Rijke, Maarten, and Venema, Yde. 2001. *Modal Logic*. Cambridge University Press.
- Chisholm, Roderick M. 1963. "Contrary-to-Duty Imperatives and Deontic Logic." *Analysis* 24:33–36.
- Davies, Martin and Humberstone, Lloyd. 1980. "Two Notions of Necessity." *Philosophical Studies* 38:1–30.
- Evans, Gareth. 1979. "Reference and Contingency." *The Monist* 62:161–189.
- Fitting, Melvin and Mendelsohn, Richard L. 1998. *First-Order Modal Logic*. Kluwer Academic Publishers.
- Hilpinen, Risto. 2001. "Deontic Logic." In Lou Goble (ed.), *The Blackwell Guide to Philosophical Logic*, 159–182. Blackwell.
- Holliday, Wesley H. 2016a. "Epistemic Logic and Epistemology." In S. O. Hansson and V. F. Hendricks (eds.), *Handbook of Formal Philosophy*. Springer.
- . 2016b. "Simplifying the Surprise Exam." Manuscript.
- Kripke, Saul A. 1971. "Identity and Necessity." In Milton Karl Munitz (ed.), *Identity and Individuation*, 135–164. New York: New York University Press.
- Lewis, David K. 1973. *Counterfactuals*. Cambridge, MA: Harvard University Press.
- Pacuit, Eric. 2009. "Notes on Modal Logic."
- Partee, Barbara H., ter Meulen, Alice, and Wall, Robert E. 1990. *Mathematical Methods in Linguistics*. Springer.
- Priest, Graham. 2008. *An Introduction to Non-Classical Logic*. Cambridge University Press.
- Sider, Theodore. 2010. *Logic for Philosophy*. Oxford University Press.
- Sorensen, Roy. 1988. *Blindspots*. Oxford University Press.
- Stalnaker, Robert C. 2006. "On Logics of Knowledge and Belief." *Philosophical Studies* 128:169–199.
- van Benthem, Johan. 2010. *Modal Logic for Open Minds*. CSLI Publications.
- Venema, Yde. 2001. "Temporal Logic." In Lou Goble (ed.), *The Blackwell Guide to Philosophical Logic*, 203–223. Blackwell.