

Phil 5506: Metalogic
Spring 2020, CRN: 21336
Maj. Williams Hall 225: TR, 9:30 – 10:45am

Instructor: Ted Parent
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Office: Major Williams Hall 221 [in the stairwell]
Office Hours: TR 10:45 – 11:45am, and by appointment.

This is a second course in symbolic logic. (Proficiency in PHIL 3505/5505 is assumed.) The aim is to explore the scope and limits of “formalism,” the idea that deductive reasoning can be understood as algorithmic operations on uninterpreted symbols. We will see the successes and the limits of this idea, by studying the soundness and completeness proofs of propositional and predicate logics, and also the indefinability, undecidability, and incompleteness proofs of Tarski, Church, and Gödel.

Texts:

- Hunter, Geoffrey (1971), *Metalogic: An Introduction to the Metatheory of First-Order Logic*. U California, Berkeley Press. (Get the 6th printing since it contains corrections.)
- Nagel, Ernest & Newman, James (2001). *Gödel’s Proof*, revised edition. NYU Press. (Get the revised version, edited by Hofstadter, since it contains corrections.)
- Other materials posted on Canvas

Course Assignments:

- (1) Five homeworks are due at the *beginning* of class, at various points during the semester (see the schedule below). Group work is strongly encouraged!!! Homework is collectively worth 25% of the final grade. Note: When the homework is due, we will then review the answers in class. For this reason, there will be **NO LATE HOMEWORKS ACCEPTED!!!**
- (2) There will be three take-home exams (“open book, open notes”) scheduled throughout the semester. Group work is not allowed on the exams. Each exam is worth 20% of the final grade. I will allow you ONE opportunity to submit an exam late, if you notify me BEFORE the date that the exam is due.
- (3) 20 minute presentation (include 5 min for Q&A and discussion from the audience) on an article concerning the philosophical significance of various metalogical phenomena. The presentation is worth 15% of your final grade.

N.B., Excellent class participation will also raise your final grade.

NO LAPTOPS IN CLASS. Logic often requires a LOT of concentration, and laptops provide too much opportunity for distraction. Relatedly, *please do not be late and remember to turn off your cell phone.*

If you have special needs because of a disability (learning disability, attention deficit disorder, psychological, physical, etc.), I can certainly make accommodations. But please talk to me as soon as possible.

The grading scale for the course is as follows (raw scores will be rounded):

Percentage	Letter Grade	G.P.A. scale
93-100	A	4.0
90-92	A-	3.75
88-89	B+	3.5
83-87	B	3.0
80-82	B-	2.75
78-79	C+	2.5

73-77	C	2.0
70-72	C-	1.75
68-69	D+	1.5
63-67	D	1.0
60-62	D-	0.75
60 >	F	0.0

The office of Academic Integrity has asked that all syllabi include the following statement:

The Honor Code pledge that each member of the university community agrees to abide by states: **“As a Hokie, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do.”**

Students enrolled in this course are responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any assignment is responsible for obtaining specific guidance from the course instructor before submitting the assignment for evaluation. Ignorance of the rules does not exclude any member of the University community from the requirements and expectations of the Honor Code. For additional information about the Honor Code, please visit: www.honorsystem.vt.edu.

I heartily endorse this statement. Thank you.

Tentative Schedule

**indicates a text available on Canvas*

Part I: Preliminaries

WEEK ONE

Jan 21, 23 Intro to the course, Formal Languages, Basic Set Theory [Hunter, Preface and sections 1-8; *Papineau, ch. 1; *Barwise & Etchemendy, section 15.9].

WEEK TWO

Jan 28 Cantorian Theorems. [Hunter, sections 9-14 and Appendix].
Jan 30 *Jam session on Homework#1* (Ted's out of town).

WEEK THREE

Feb 4 **Homework #1 due.** The Languages P and SL. Mathematical Induction. [Hunter, sections 15-18; *Bergmann et al., section 6.1].
Feb 6 Mathematical Induction (cont').

Part II: Formalism's Successes

WEEK FOUR

Feb. 11, **Homework #2 due.** Truth-Functional Completeness. [*Bergmann et al., section 6.2].
Feb. 13 Semantics for P. [Hunter, section 19].

WEEK FIVE

Feb. 18 **Exam #1 due.** The System PS. Deduction Theorem. Soundness of PS. [Hunter, sections 22, 23; 26-28].

Feb. 20 Completeness of PS. [Hunter, sections 29, 32].

WEEK SIX

Feb. 25, 27 Completeness of PS (cont'). Compactness of PS. Decidability of PS. [Hunter, section 34].

WEEK SEVEN

Mar. 3 **Homework #3 due.** The Languages Q and Q+. Semantics for Q and Q+. [Hunter, sections 38-40].

Mar. 5 Semantics for Q and Q+ (cont').

WEEK EIGHT

Mar. 10, 12 NO CLASS (Spring Break)

WEEK NINE

Mar. 17, 19 Semantics for Q and Q+ (cont'). The System QS. Soundness of QS. [Hunter, sections 41, 43].

WEEK TEN

Mar. 24, 26 First Order Theories. Completeness and Compactness of such Theories. Löwenheim-Skolem Theorems. [Hunter, sections 44-46].

WEEK ELEVEN

Mar. 31 **Homework #4 due.** Completeness of QS=. [Hunter, sections 47-49].

Apr. 2 Completeness of QS= (cont').

Part III: The Limits of Formalism

WEEK TWELVE

Apr. 7 **Exam #2 due.** Turing Machines. Church-Turing Thesis. [*Boolos et al., ch. 3].

Apr. 9 The Halting Problem. [*Boolos et al., section 4.1].

WEEK THIRTEEN

Apr. 14, 16 Hints at the Undecidability of Arithmetic. Arithmetization. Generalized Gödel Theorem. [Nagel & Newman, pp. 57-91; Hunter, sections 51, 52].

WEEK FOURTEEN

Apr. 21, 23 **Homework #5 due.** Recursive Functions. Representability. A Formal System of Arithmetic: H. [Hunter, sections 53-55].

WEEK FIFTEEN

Apr. 28, 30 Undecidability of H, QS, and QS=. [Hunter, sections 56, 57].

WEEK SIXTEEN

May 5

Gödel's Incompleteness Theorems. Tarski's Indefinability Theorem.
[Nagel & Newman, pp. 92–108; Hunter, 59; *Boolos et al., section 17.1].

Exam #3 due on **May 12th** at **12:05pm** in my office, Major Williams 221.

Additional Texts:

Barwise, Jon & John Etchemendy (2008). *Language, Proof, and Logic*. CSLI Publications.

Bergmann, Merrie, James Moor & Jack Nelson (2014). *The Logic Book*, 6th edition. McGraw-Hill.

Boolos, George, Richard Jeffrey & John Burgess (2007). *Computability and Logic*, 5th edition. Cambridge UP.

Papineau, David (2012). *Philosophical Devices*. Oxford UP.

Half of the articles for the presentations are in the following:

Benacerraf, Paul & Hilary Putnam (eds.) (1983). *Philosophy of Mathematics: Selected Readings*, second edition. Cambridge UP.