Philosophy 240: Symbolic Logic Hamilton College
Fall 2010 Russell Marcus
Mondays, Wednesdays, Fridays: 9am - 9:50am Office: 210 College Hill Road, Room 201
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Syllabus

Course Description and Overview:

Philosophy has one technical tool: logic. Formal logic is the study of arguments and inferences, made in artificial languages designed to maximize precision. This course is a standard introduction to elementary formal logic, covering propositional logic and predicate logic, including identity theory, functions, and second-order quantification. The central goal of this course is to provide you with a technical method of deciding what follows from what.

The two main techniques we will study are translation and derivation. We will establish a formal definition of valid inference using logical operators and truth functions. We will translate sentences of English into the formal languages of propositional and predicate logic, and back. We will use a proof system to infer new claims from given ones, following prescribed rules of inference and proof strategies.

Thirty of the forty-two class meetings will be devoted to learning logical techniques. There will be seven Philosophy Fridays during which we will examine some philosophical questions about logic. Some of these questions concern the status of logic, and its relation to the rest of our knowledge. Some of these questions concern how best to construct logical systems. The remaining five classes, and the final exam period, will be used for tests. You will be asked to write one essay.

Texts

Patrick Hurley, *A Concise Introduction to Logic*, 10th edition, Wadsworth. The full text costs ~$130. I have ordered copies with just the sections we will use, and an appendix of interest to pre-law students. It will be available at the bookstore for $50.

Other readings and class notes will be available either on ereserve or on the course website. These will be especially important for the several topics not covered in Hurley.

On-Line Resources

The website for this course is:

www.thatmarcusfamily.org/philosophy/Course_Websites/Logic_F10/Course_Home.html

The course website includes an html syllabus and schedule, homework solutions, class notes, course bibliography, other readings and handouts, and links to websites specifically selected for this course. Limited material, other than your grades, will be available on the Blackboard course pages. The Blackboard page will contain a link to the course website.

Office Hours

My office hours for the Fall 2010, term are 10:30am - noon, Monday through Friday.

Assignments and Grading:

Your responsibilities this course include the following, with their contributions to your grade calculation in parentheses:

Attendance
Homework (8%)
Six Tests (72%, 12% each)
One four-to-six page paper (20%)

Attendance: Classes are for your edification. It will be useful for you to come to class, but there is no direct penalty for missing class. Some students pick up on the technical material quickly. If you do miss a class, you should arrange to drop off your homework, if you have homework due to be handed in.

Homework: Homework assignments and their due dates are listed on the schedule below. Some homework assignments are problem sets, mainly from the Hurley text; there are also seven homework handouts. Other homework assignments are readings in preparation for classes in which we will discuss the philosophy of logic.

All students will be expected to hand in the first six problem sets, those which are due before the first exam. If you receive less than an 85% on any exam, you must hand in all problem sets which are due before the next exam. If you receive an 85% or higher on the most recent exam, you may hand in your homework, if you wish, but it will not be required. When handing in homework, make it neat and presentable. There should be no ripped or crumpled pages. Problems should be clearly delimited. Questions need not be written out fully, but solutions must be.

Sample solutions to all homework problems are available on line. Acceptable solutions to most problems vary. We will begin most classes with time to review a few homework questions. You are expected to have completed the homework and looked at the solutions provided before the beginning of class. Come to class prepared to ask any questions about the homework that remain unanswered.

Use the text as a reference guide. The chapter sections include excellent examples, and solutions. Read on a need-to-know basis: when you have difficulty with specific problems, read the relevant sections of the chapter. My lecture notes should also be helpful, and contain additional exercises. The homework assignments on the schedule are minimal. If you are still struggling with the material, you should do more problems.

Tests: All six tests are mandatory. Dates for the tests are given on the schedule below. No make-ups will be allowed for missed tests. If you are unable to take a test, you must request an arrangement from me in advance. The final exam will be one more test of the same type as each of the first five tests. Be prepared: the final exam will cover the most difficult material in the course.

You will have an opportunity, at the time of the final, to take a compensatory version of up to two of the first five tests. I will average the grade on the re-take with your original grade. If you miss a test during the term, the re-take will be averaged with a 0. Practice problems for each test will be available on the course website.

Paper: Each student will write a short paper on a topic in logic, philosophy of logic, or the application of logic to philosophy. Seven class meetings will be devoted to such topics. All papers will require a small amount of research. Papers may be mainly expository, especially those covering technical topics. But, the best papers will philosophical, and will defend a thesis. I will suggest topics and readings through the term. **Papers are due on December 3**, though they may be submitted at any time during the course. More details about the papers will be distributed in class.

The Hamilton College Honor Code will be strictly enforced.

Schedule:

Class	Date	Topic Name	Homework to do before the next class meets
1	Friday August 27	Arguments; Validity and Soundness	**§1.1: I**.1, 3, 7, 14, 20, 27 **§1.4: I**.1, 3, 7, 8, 10 **§1.2: VI**.1, 2, 4, 7, 9
2	Monday August 30	Translation using Propositional Logic; Wffs	**§6.1: I**.1-11, 13-16, 21-23, 29, 30, 38, 39, 41-43 Homework Handout #1: Translating from Propositional Logic **§6.1: III**.1-10 **§6.2: I**.1-4, 9, 10
3	Wednesday September 1	Truth Functions	Read Goodman, "The Problem of Counterfactual Conditionals."
4	Friday September 3	**Philosophy Friday #1**: Conditionals	**§6.1: I**.34-37, 45, 47, 48, 50 **§6.2: III**.1-3, 6-11, 12, 21, 22, 24 **§6.2: II**.1-3, 13, 15 **§6.2: IV**.1-5, 11, 12
5	Monday September 6	Truth Tables for Propositions	**§6.3: I**.1-4, 11, 14 **§6.3: II**.1, 3, 6, 11 **§6.3: III**.1, 9, 10
6	Wednesday September 8	Truth Tables for Arguments	Read Searle, "Can Computers Think?" Read Frege, Preface to *Begriffsschrift*.
7	Friday September 10	**Philosophy Friday #2**: Syntax and Semantics	**§6.4: II**.2, 5, 10, 17, 19 **§6.4: I**.1, 3, 5, 10
8	Monday September 13	Invalidity and Inconsistency: Indirect Truth Tables	**§6.5: I**.3, 6, 12, 13, 15 **§6.5: II**.2, 5, 9
9	Wednesday September 15	Rules of Implication I	Prepare for Test #1.
10	Friday September 17	**Test #1**: Chapters 1 and 6	**§7.1: III**.1-3, 5, 7, 8, 14, 21, 22 **§7.1: IV**.1, 3, 8
11	Monday September 20	Rules of Implication II	Homework Handout #2: Rules of Implication **§7.2: III**.2, 4, 8, 12, 16, 22 **§7.2: IV**.1, 2, 6, 8
12	Wednesday September 22	Rules of Replacement I	Read Quine, "Grammar."
13	Friday September 24	**Philosophy Friday #3**: Adequate Sets of Connectives	**§7.3: III**.6-12, 14, 18, 19, 22, 26, 32 **§7.3: IV**.4, 9
14	Monday September 27	Rules of Replacement II	**§7.4: III**.2-5, 8, 10, 21, 24, 36, 38, 45 **§7.4: IV**.6, 8

Class	Date	Topic Name	Homework to do before the next class meets
15	Wednesday September 29	Practice with Proofs	Prepare for Test #2.
16	Friday October 1	**Test #2**: Derivations	
17	Monday October 4	Conditional Proof	**§7.5: I**.3, 7, 9, 11, 14, 18, 20 **§7.5: II**.3, 5 Note: You need not try each problem without conditional proof, though trying a few may be edifying. **§7.7:** 1, 3, 5
18	Wednesday October 6	Indirect Proof	Read Aristotle, *De Interpretatione*, §9. Read Quine, "Deviant Logics."
19	Friday October 8	**Philosophy Friday #4**: Three-Valued Logics	**§7.6: I**.1, 2, 4, 6, 13, 15, 17 **§7.6: II**.2, 4 Note: You need not try each problem without indirect or conditional proof, though trying a few may be edifying. **§7.7:** 2, 9, 13, 16, 18
20	Monday October 11	More on Proofs	**§7.6: I**.7, 8, 11, 16, 19 **§7.7:** 6, 10, 14, 17, 19 Homework Handout #3: Practice Problems for Test #3
21	Wednesday October 13	**Test #3**: Conditional and Indirect Methods	
	October 15	**Fall Break**	
22	Monday October 18	Predicate Logic, Translation I	**§8.1**: 2-4, 6-11, 14-19, 23-28, 35-37
23	Wednesday October 20	Predicate Logic, Translation II	**§8.1**: 21, 31-33, 38-40, 42, 44-6, 50-55, 58, 60 Homework Handout #4: Translating from Pred. Logic
24	Friday October 22	Derivations in Predicate Logic	Prepare for Test #4.
25	Monday October 25	**Test #4**: Predicate Logic Translation	**§8.2: I**.1-3, 7-9 **§8.2: II**.1, 3, 4, 6
26	Wednesday October 27	More Derivations and Changing Quantifiers	Read Tarski, "The Semantic Conception of Truth and the Foundations of Semantics."
27	Friday October 29	**Philosophy Friday #5**: Truth and Liars	**§8.2: I**.4, 5, 10, 12, 13**; §8.2: II**.5, 7, 9, 10 **§8.3: I**.1, 3, 7, 8, 10, 14; **§8.3: II**.3, 5, 9
28	Monday November 1	Conditional and Indirect Proof, Predicate Versions	**§8.4: I**.1-4, 10, 12, 19, 21 **§8.4: II**.4, 6, 9

Class	Date	Topic Name	Homework to do before the next class meets
29	Wednesday November 3	Semantics for Predicate Logic	Read Quine, "On What There Is."
30	Friday November 5	**Philosophy Friday #6**: Quantification and Ontological Commitment	Practice Problems for Test #5.I
31	Monday November 8	Invalidity in Predicate Logic	**§8.5: II**.1, 2, 6, 10 **§8.5: III**.2, 4 (Use only the finite universe method.)
32	Wednesday November 10	Translation Using Relational Predicates I	Prepare for Test #5. Practice Problems for Test #5.II
33	Friday November 12	**Test #5**: Predicate Logic Derivations and Invalidity	**§8.6: I**.1-4, 7-10, 13, 14, 17, 19, 20
34	Monday November 15	Translation Using Relational Predicates II	**§8.6: I**.5, 6, 11, 12, 23, 24, 27, 30 Homework Handout #5: Translating from Relations
35	Wednesday November 17	Derivations Using Relational Predicates	Read Katz, "The Problem in Twentieth-Century Philosophy."
36	Friday November 19	**Philosophy Friday #7**: Color Incompatibility	**§8.6: II**.2, 3, 4, 7, 9, 13, 14, 19 **§8.6: III**.1, 4, 8
	Thanksgiving	**Break**	
37	Monday November 29	Translation Using Identity I	**§8.7: I**. 2, 3, 6, 9, 10, 13, 14, 15, 17, 18, 22, 23, 24, 25
38	Wednesday December 1	Translation Using Identity II	**§8.7: I**. 28, 31, 34, 35, 37-39, 40, 42, 43, 45, 46, 47,50 Complete paper.
39	Friday December 3	Derivations Using Identity I **Papers are due**.	**§8.7: II**.2, 3, 5, 6, 9, 11, 12, 19 **§8.7: III**.2, 3, 7, 8, 10, 12
40	Monday December 6	Derivations Using Identity II	**§8.7: II**.7, 10, 14, 15, 17 **§8.7: III**.5, 13, 15
41	Wednesday December 8	Functions	Homework Handout #6: Functions
42	Friday December 10	Second-Order Logic	Homework Handout #7: Second-Order Quantifiers Practice Problems for Test #6
	Thursday December 16 2pm - 5pm	**Test #6 (Final)**: Relations, Identity Theory, Functions, and Second-Order Logic	Plus, Compensatory Material

Note: See the Course Bibliography for full citations of all readings above.

Names of Languages

PL: Propositional Logic
M: Monadic (First-Order) Predicate Logic
F: Full (First-Order) Predicate Logic
FF: Full (First-Order) Predicate Logic with functors
S: Second-Order Predicate Logic

Rules of Inference

Modus Ponens (MP)
$\alpha \supset \beta$
$\alpha \quad / \beta$

Modus Tollens (MT)
$\alpha \supset \beta$
$\sim\beta \quad / \sim\alpha$

Disjunctive Syllogism (DS)
$\alpha \vee \beta$
$\sim\alpha \quad / \beta$

Hypothetical Syllogism (HS)
$\alpha \supset \beta$
$\beta \supset \gamma \quad / \alpha \supset \gamma$

Conjunction (Conj)
α
$\beta \quad / \alpha \cdot \beta$

Addition (Add)
$\alpha \quad / \alpha \vee \beta$

Simplification (Simp)
$\alpha \cdot \beta \quad / \alpha$

Constructive Dilemma (CD)
$(\alpha \supset \beta) \cdot (\gamma \supset \delta)$
$\alpha \vee \gamma \quad / \beta \vee \delta$

Rules of Replacement

DeMorgan's Laws (DM)
$\sim(\alpha \cdot \beta) :: \sim\alpha \vee \sim\beta$
$\sim(\alpha \vee \beta) :: \sim\alpha \cdot \sim\beta$

Associativity (Assoc)
$\alpha \vee (\beta \vee \gamma) :: (\alpha \vee \beta) \vee \gamma$
$\alpha \cdot (\beta \cdot \gamma) :: (\alpha \cdot \beta) \cdot \gamma$

Distributivity (Dist)
$\alpha \cdot (\beta \vee \gamma) :: (\alpha \cdot \beta) \vee (\alpha \cdot \gamma)$
$\alpha \vee (\beta \cdot \gamma) :: (\alpha \vee \beta) \cdot (\alpha \vee \gamma)$

Commutativity (Com)
$\alpha \vee \beta :: \beta \vee \alpha$
$\alpha \cdot \beta :: \beta \cdot \alpha$

Double Negation (DN)
$\alpha :: \sim\sim\alpha$

Transposition (Trans)
$\alpha \supset \beta :: \sim\beta \supset \sim\alpha$

Material Implication (Impl)
$\alpha \supset \beta :: \sim\alpha \vee \beta$

Material Equivalence (Equiv)
$\alpha \equiv \beta :: (\alpha \supset \beta) \cdot (\beta \supset \alpha)$
$\alpha \equiv \beta :: (\alpha \cdot \beta) \vee (\sim\alpha \cdot \sim\beta)$

Exportation (Exp)
$\alpha \supset (\beta \supset \gamma) :: (\alpha \cdot \beta) \supset \gamma$

Tautology (Taut)
$\alpha :: \alpha \cdot \alpha$
$\alpha :: \alpha \vee \alpha$

Rules for Quantifier Instantiation and Generalization

Universal Instantiation (UI)

$$\frac{(\alpha).\mathcal{F}\alpha}{\mathcal{F}\beta}$$

for any variable α, any predicate $\mathcal{F}$, and any variable or constant β

Universal Generalization (UG)

$$\frac{\mathcal{F}\beta}{(\alpha).\mathcal{F}\alpha}$$

for any variable β, any predicate $\mathcal{F}$, and for any variable α

But, never UG within the scope of an assumption for conditional or indirect proof on a variable that is free in the first line of the assumption.

And, never UG on a variable when there is a constant present, and the variable was free when the constant was introduced.

Existential Generalization (EG)

$$\frac{\mathcal{F}\beta}{(\exists\alpha).\mathcal{F}\alpha}$$

for any constant or variable β, any predicate $\mathcal{F}$, and for any variable α

Existential Instantiation (EI)

$$\frac{(\exists\alpha).\mathcal{F}\alpha}{\mathcal{F}\beta}$$

for any variable α, any predicate $\mathcal{F}$, and any *new* constant β

Rules Governing the Identity Particle (ID)

ID Rule #1. Reflexivity: α=α

ID Rule #2. Symmetry: α=β :: β=α

ID Rule #3. Indiscernibility of Identicals

$$\begin{array}{l}\mathcal{F}\alpha \\ \alpha=\beta \quad / \mathcal{F}\beta\end{array}$$