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 online. 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:

<table>
<thead>
<tr>
<th>Class</th>
<th>Date</th>
<th>Topic Name</th>
<th>Homework to do before the next class meets</th>
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<tbody>
<tr>
<td>1</td>
<td>Friday</td>
<td>Arguments; Validity and Soundness</td>
<td>§1.1: I.1, 3, 7, 14, 20, 27</td>
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<td></td>
<td>August 27</td>
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<td>§1.4: I.1, 3, 7, 8, 10</td>
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<td>§1.2: VI.1, 2, 4, 7, 9</td>
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<tr>
<td>2</td>
<td>Monday</td>
<td>Translation using Propositional Logic; Wffs</td>
<td>§6.1: I.1-11, 13-16, 21-23, 29, 30, 38, 39, 41-43</td>
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<td></td>
<td>August 30</td>
<td></td>
<td>Homework Handout #1: Translating from Propositional Logic</td>
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<td>§6.1: III.1-10</td>
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<td>§6.2: I.1-4, 9, 10</td>
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<tr>
<td>3</td>
<td>Wednesday</td>
<td>Truth Functions</td>
<td>Read Goodman, “The Problem of Counterfactual Conditionals.”</td>
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<td>September 1</td>
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<tr>
<td>4</td>
<td>Friday</td>
<td>Philosophy Friday #1: Conditionals</td>
<td>§6.1: I.34-37, 45, 47, 48, 50</td>
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<td></td>
<td>September 3</td>
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<td>§6.2: III.1-3, 6-11, 12, 21, 22, 24</td>
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<td>§6.2: II.1-3, 13, 15</td>
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<td>§6.2: IV.1-5, 11, 12</td>
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<tr>
<td>5</td>
<td>Monday</td>
<td>Truth Tables for Propositions</td>
<td>§6.3: I.1-4, 11, 14</td>
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<td></td>
<td>September 6</td>
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<td>§6.3: II.1, 3, 6, 11</td>
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<td></td>
<td>§6.3: III.1, 9, 10</td>
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<tr>
<td>6</td>
<td>Wednesday</td>
<td>Truth Tables for Arguments</td>
<td>Read Searle, “Can Computers Think?”</td>
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<td></td>
<td>September 8</td>
<td></td>
<td>Read Frege, Preface to <em>Begriffsschrift.</em></td>
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<tr>
<td>7</td>
<td>Friday</td>
<td>Philosophy Friday #2: Syntax and Semantics</td>
<td>§6.4: II.2, 5, 10, 17, 19</td>
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<td></td>
<td>September 10</td>
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<td>§6.4: I.1, 3, 5, 10</td>
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<td>8</td>
<td>Monday</td>
<td>Invalidity and Inconsistency: Indirect Truth Tables</td>
<td>§6.5: I.3, 6, 12, 13, 15</td>
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<td></td>
<td>September 13</td>
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<td>§6.5: II.2, 5, 9</td>
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<td>9</td>
<td>Wednesday</td>
<td>Rules of Implication I</td>
<td>Prepare for Test #1.</td>
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<td>September 15</td>
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<tr>
<td>10</td>
<td>Friday</td>
<td>Test #1: Chapters 1 and 6</td>
<td>§7.1: III.1-3, 5, 7, 8, 14, 21, 22</td>
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<td>September 17</td>
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<td>§7.1: IV.1, 3, 8</td>
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<tr>
<td>11</td>
<td>Monday</td>
<td>Rules of Implication II</td>
<td>Homework Handout #2: Rules of Implication</td>
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<td>September 20</td>
<td></td>
<td>§7.2: III.2, 4, 8, 12, 16, 22</td>
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<td>§7.2: IV.1, 2, 6, 8</td>
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<tr>
<td>12</td>
<td>Wednesday</td>
<td>Rules of Replacement I</td>
<td>Read Quine, “Grammar.”</td>
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<td>September 22</td>
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<td>13</td>
<td>Friday</td>
<td>Philosophy Friday #3: Adequate Sets of Connectives</td>
<td>§7.3: III.6-12, 14, 18, 19, 22, 26, 32</td>
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<td>September 24</td>
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<td>§7.3: IV.4, 9</td>
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<td>14</td>
<td>Monday</td>
<td>Rules of Replacement II</td>
<td>§7.4: III.2-5, 8, 10, 21, 24, 36, 38, 45</td>
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<td></td>
<td>September 27</td>
<td></td>
<td>§7.4: IV.6, 8</td>
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<td>Homework to do before the next class meets</td>
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<td>15</td>
<td>Wednesday, September 29</td>
<td>Practice with Proofs</td>
<td>Prepare for Test #2.</td>
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<td>16</td>
<td>Friday, October 1</td>
<td>Test #2: Derivations</td>
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</table>
| 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 |  |
| 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 |
| 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 |
<table>
<thead>
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<th>Homework to do before the next class meets</th>
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<tr>
<td>29</td>
<td>Wednesday November 3</td>
<td>Semantics for Predicate Logic</td>
<td>Read Quine, “On What There Is.”</td>
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<td>30</td>
<td>Friday November 5</td>
<td>Philosophy Friday #6: Quantification and Ontological Commitment</td>
<td>Practice Problems for Test #5.I</td>
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<td>31</td>
<td>Monday November 8</td>
<td>Invalidity in Predicate Logic</td>
<td>§8.5: II.1, 2, 6, 10 §8.5: III.2, 4 (Use only the finite universe method.)</td>
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<td>32</td>
<td>Wednesday November 10</td>
<td>Translation Using Relational Predicates I</td>
<td>Prepare for Test #5. Practice Problems for Test #5.II</td>
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<td>33</td>
<td>Friday November 12</td>
<td>Test #5: Predicate Logic Derivations and Invalidity</td>
<td>§8.6: I.1-4, 7-10, 13, 14, 17, 19, 20</td>
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<td>34</td>
<td>Monday November 15</td>
<td>Translation Using Relational Predicates II</td>
<td>§8.6: I.5, 6, 11, 12, 23, 24, 27, 30 Homework Handout #5: Translating from Relations</td>
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<td>36</td>
<td>Friday November 19</td>
<td>Philosophy Friday #7: Color Incompatibility</td>
<td>§8.6: II.2, 3, 4, 7, 9, 13, 14, 19 §8.6: III.1, 4, 8</td>
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<td>Thanksgiving Break</td>
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<td>37</td>
<td>Monday November 29</td>
<td>Translation Using Identity I</td>
<td>§8.7: I. 2, 3, 6, 9, 10, 13, 14, 15, 17, 18, 22, 23, 24, 25</td>
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<td>39</td>
<td>Friday December 3</td>
<td>Derivations Using Identity I Papers are due.</td>
<td>§8.7: II.2, 3, 5, 6, 9, 11, 12, 19 §8.7: III.2, 3, 7, 8, 10, 12</td>
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<td>40</td>
<td>Monday December 6</td>
<td>Derivations Using Identity II</td>
<td>§8.7: II.7, 10, 14, 15, 17 §8.7: III.5, 13, 15</td>
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<td>41</td>
<td>Wednesday December 8</td>
<td>Functions</td>
<td>Homework Handout #6: Functions</td>
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<td>42</td>
<td>Friday December 10</td>
<td>Second-Order Logic</td>
<td>Homework Handout #7: Second-Order Quantifiers Practice Problems for Test #6</td>
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<td></td>
<td>Thursday December 16</td>
<td>Test #6 (Final): Relations, Identity Theory, Functions, and Second-Order Logic</td>
<td>Plus, Compensatory Material</td>
</tr>
</tbody>
</table>

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)**
\[
\alpha \supset \beta \\
\alpha \\
\beta
\]

**Modus Tollens (MT)**
\[
\alpha \supset \beta \\
\sim \beta \\
\sim \alpha
\]

**Disjunctive Syllogism (DS)**
\[
\alpha \lor \beta \\
\sim \alpha \\
\beta
\]

**Hypothetical Syllogism (HS)**
\[
\alpha \supset \beta \\
\beta \supset \gamma \\
\alpha \supset \gamma
\]

**Conjunction (Conj)**
\[
\alpha \\
\beta \\
\alpha \cdot \beta
\]

**Addition (Add)**
\[
\alpha \\
\alpha \lor \beta
\]

**Simplification (Simp)**
\[
\alpha \cdot \beta \\
\alpha
\]

**Constructive Dilemma (CD)**
\[
(\alpha \supset \beta) \cdot (\gamma \supset \delta) \\
\alpha \lor \gamma \\
\beta \lor \delta
\]

Rules of Replacement

**DeMorgan’s Laws (DM)**
\[
\sim (\alpha \cdot \beta) :: \sim \alpha \lor \sim \beta \\
\sim (\alpha \lor \beta) :: \sim \alpha \cdot \sim \beta
\]

**Associativity (Assoc)**
\[
\alpha \lor (\beta \lor \gamma) :: (\alpha \lor \beta) \lor \gamma \\
\alpha \cdot (\beta \cdot \gamma) :: (\alpha \cdot \beta) \cdot \gamma
\]

**Distributivity (Dist)**
\[
\alpha \cdot (\beta \lor \gamma) :: (\alpha \cdot \beta) \lor (\alpha \cdot \gamma) \\
\alpha \lor (\beta \cdot \gamma) :: (\alpha \lor \beta) \cdot (\alpha \lor \gamma)
\]

**Commutativity (Com)**
\[
\alpha \lor \beta :: \beta \lor \alpha \\
\alpha \cdot \beta :: \beta \cdot \alpha
\]

**Double Negation (DN)**
\[
\alpha :: \sim \sim \alpha
\]

**Transposition (Trans)**
\[
\alpha \supset \beta :: \sim \beta \supset \sim \alpha
\]

**Material Implication (Impl)**
\[
\alpha \supset \beta :: \sim \alpha \lor \beta
\]

**Material Equivalence (Equiv)**
\[
\alpha \equiv \beta :: (\alpha \supset \beta) \cdot (\beta \supset \alpha) \\
\alpha \equiv \beta :: (\alpha \cdot \beta) \lor (\sim \alpha \cdot \sim \beta)
\]

**Exportation (Exp)**
\[
\alpha \supset (\beta \supset \gamma) :: (\alpha \cdot \beta) \supset \gamma
\]

**Tautology (Taut)**
\[
\alpha :: \alpha \cdot \alpha \\
\alpha :: \alpha \lor \alpha
\]
Rules for Quantifier Instantiation and Generalization

Universal Instantiation (UI)

\[
\frac{(\alpha)\mathcal{F}\alpha}{\mathcal{F}\beta}
\]
for any variable \(\alpha\), any predicate \(\mathcal{F}\), and any variable or constant \(\beta\)

Universal Generalization (UG)

\[
\frac{\mathcal{F}\beta}{(\alpha)\mathcal{F}\alpha}
\]
for any variable \(\beta\), any predicate \(\mathcal{F}\), and
\[
\frac{\alpha}{\mathcal{F}\alpha}
\]
for any variable \(\alpha\)

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 \(\beta\), any predicate \(\mathcal{F}\), and
\[
\frac{(\exists\alpha)\mathcal{F}\alpha}{\mathcal{F}\beta}
\]
for any variable \(\alpha\)

Existential Instantiation (EI)

\[
\frac{(\exists\alpha)\mathcal{F}\alpha}{\mathcal{F}\beta}
\]
for any variable \(\alpha\), any predicate \(\mathcal{F}\), and
\[
\frac{\alpha}{\mathcal{F}\alpha}
\]
any new constant \(\beta\)

Rules Governing the Identity Particle (ID)

ID Rule #1. Reflexivity: \(\alpha=\alpha\)

ID Rule #2. Symmetry: \(\alpha=\beta::\beta=\alpha\)

ID Rule #3. Indiscernibility of Identicals

\[
\frac{\mathcal{F}\alpha}{\alpha=\beta/\mathcal{F}\beta}
\]