# Philosophy 1630
# Deductive Logic

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## Course Structure and Requirements

The course will meet Monday, Wednesday, and Friday at 10am, in Gerard House 119. Class meetings will consist primarily of lectures.

The text for the course is *Fundamentals of Mathematical Logic*, by Peter Hinman. Copies are available at the Brown bookstore. Students should plan to read the relevant material from the book before each lecture. Lectures will not cover all material for which students will be responsible. There will be a mid-term examination on 14 October and a final examination during the final examination period. There will also be nine problem sets.

Final grades will be determined by a variety of factors.

- The first and most important factor is that *all of the problem sets must be completed and submitted for marking*. I'll let you off once, if you do miss one. Failure to submit all (but one) of the problem sets will *automatically* lead to a grade of NC. It is, quite simply, impossible to learn this material without doing a lot of problems, and students should actually plan to do a lot more problems than are actually assigned.
  Please note that the requirement is that the problem sets should be "completed", and by that I mean that one has given them a proper effort. Simply turning in a piece of paper with a few random jottings does not count as completing a problem set.
- If you do all of the problem sets, then it is impossible to do worse in this class than you do on the final exam. That is: If you get an A on the final (and have turned in all the problem sets), you will get an A for the course; if you get a B on the final, you cannot get worse than a B for the course, though you might get an A.
- It is impossible to fail the class if you have given it what I regard as a proper effort.
- A presumptive grade will be determined by performance on the two exams, with somewhat greater weight being given to the final. Borderline cases will be decided by performance on the problem sets. Exceptionally good or bad performance on the problem sets may move a grade up or down.

Problem sets are due in class on the day specified below. *I will not accept late problem sets*. On the other hand, you will find that I am quite prepared to grant extensions, so long as they are requested in advance, that is, *at least twenty-four hours prior to the class in which the problem set is due*. Extensions will not be granted after that time except in very unusual and unfortunate circumstancess. Please note: Because I am so willing to grant extensions, exploitation of my reasonableness will be taken badly.

Let me emphasize again something said above. As with any mathematical subject-matter, it is impossible to learn this material without doing a lot of exercises. The book contains many more than are assigned, and students are encourage to do additional exercises to improve their understanding of the material. Students are also encouraged to work on the problems together—though, of course, submitted material should be a student's own work.

## Prerequisites

There are no formal prerequisites for this course. In particular, the course presupposes no particular college-level mathematical knowledge, not even calculus. However, as has already been said, the course is mathematical in content. It is essential that students should be familiar with and comfortable with mathematical argument, that is, with the presentation and conduct of proofs. Anyone uncertain of their background in this area is encouraged to speak with the instructor. Students seeking an introduction to logic who do not have the preparation for this course are encouraged to enroll in Philosophy 0540, which is also being taught this semester.

Let me emphasize that this course is very cumulative: What we do later always depends heavily on what we've done earlier. If you get behind, it can be very difficult to catch up.

## Syllabus

The syllabus for the course is available online at http://frege.brown.edu/phil1630/, as are the problem sets.

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| 7 September | Introductory Meeting |
| 9–16 September | Section 1.1 |

End of material covered by Problem Set #1: Due 23 September

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| 19–21 September | Section 1.3 |

End of material covered by Problem Set #2: Due 28 September

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| 23–28 September | Section 1.4 |
| 30 September | Section 1.5 |

End of material covered by Problem Set #3: Due 5 October

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| 3 October | Introduction to Quantification Theory |
| 5–7 October | Section 2.1, pp. 83-90 |

End of material covered by Mid-term Examination

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| 10 October | *No Class*: Columbus Day Holiday |
| 12 October | Review Session |
| 14 October | **Mid-term Examination** |
| 17–19 October | Section 2.1, pp. 90-94 |

End of material covered by Problem Set #4: Due 26 October

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| 21–26 October | Section 2.2, pp. 96-105 |
| 28–31 October | Section 2.2, pp. 105-12 |

End of material covered by Problem Set #5: Due 7 November

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| 2–7 November | Section 2.3, pp. 114-29 |

End of material covered by Problem Set #6: Due 14 November

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| 9–11 November | Section 3.1, pp. 194-200 |
| 14–18 November | Section 3.2 |

End of material covered by Problem Set #7: Due 28 November

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| 21 November | Natural Deduction (Handout) |
| 23–25 November | *No Class*: Thanksgiving Holiday |
| 28 November | Natural Deduction (Handout) |

End of material covered by Problem Set #8: Due 5 December

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| 30 Nov.–2 December | Section 1.6, pp. 63–67 |
| 2–7 December | Section 3.3, pp. 216–24 |

End of material covered by Problem Set #9: Due 15 December

## Problem Sets

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| Problem Set 1 | Exercises 1.1.10, 11, and 13; Extra Problem 1 |
| Problem Set 2 | Exercises 1.3.15, one of 1.3.17-19, one of 1.3.20-21, 1.3.22, and *1.3.24; Extra Problems 2 and 3 |
| Problem Set 3 | Exercises 1.4.32, 33, 35, 41, 43, *48; 1.5.23, 25, *28 |
| Problem Set 4 | Exercises 2.1.31-33; Extra Problem 4 |
| Problem Set 5 | Exercises 2.2.44, 45; Extra Problem 5; Exercises 2.2.40, 43, 46, 49, *50 |
| Problem Set 6 | Exercises 2.3.65, 67, 70, 72 |
| Problem Set 7 | Exercises 3.1.22, 23; 3.2.27-30 |
| Problem Set 8 | Extra Problems 6 and 7 |
| Problem Set 9 | Exercises 1.6.20, 21; 3.3.31, *32 |

## Extra Problems

Note: Many of these problems are taken from Warren Goldfarb's textbook *Deductive Logic*, which is what we use in Philosophy 0540.

## For Problem Set 1

**1.** Using your answer to exercise 1.1.10, prove that every formulae contains an even number of parentheses.

## For Problem Set 2

**2**. Use truth-tables to determine the validity of the following formulae:

$$(p \vee q \to r) \to (p \to r)$$
$$(p \wedge q \to r) \to (p \to r)$$

**3.** Use truth-tables to determine whether the first formula implies the second:

$$p \vee r \equiv q \vee r \qquad p \equiv q$$
$$(p \wedge \neg q) \vee (\neg q \wedge r) \qquad (p \equiv q) \equiv r$$

## For Problem Set 4

**4**. For each of the following formulae, find a structure that makes it true and another that makes it false.

$$\exists x \forall y (Fyx \to Fyy)$$
$$\forall x \forall y (Fxy \to \exists z (Fxz \wedge Fyz))$$
$$\forall x [\forall y (Fyx \to Fxy) \to \forall y (Fxy \to Fyx)]$$

## For Problem Set 5

**5**. Give careful proofs of five logical equivalences or consequences from the list on p. 99.

## For Problem Set 8

**6**. Show by natural deduction that:

(i) Any transitive and symmetric relation is reflexive.

(ii) The formulae

$$\forall x \forall y (Gxy \to Gxx \wedge Gyy)$$
$$\forall x [\exists z (Gxz) \vee \exists z (Gzx) \to Gxx]$$

are equivalent.

**7.** The two formulae $\forall x \forall y (Gxy \to Gyx)$ and $\forall x (Hx \equiv \exists y (Gyx))$ together imply one of (a) and (b) below, but not the other. Find which is implied and show the implication by natural deduction. Show the lack of implication in the other case by supplying a suitable structure.

$$\forall x (Hx) \to \exists x \forall y (Gxy) \quad \text{(a)}$$
$$\exists x \forall y (Gxy) \to \forall x (Hx) \quad \text{(b)}$$