

Intermediate Logic

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Malloy 411

Wednesday 12-3pm and by appointment

“Intermediate Logic” is the Department of Philosophy’s central course in logic. It is an appropriate course for students with no formal training in logic because it starts from the very beginning. It is also an appropriate course for students who are interested in studying advanced topics in mathematical logic or philosophical logic because it aims to leave one with a solid enough understanding of classical, first-order logic to build on immediately in several ways. The nature of logic is that it is possible to be both of these things in a single semester. Undergraduates and graduate students are welcome regardless of their major, department, or background, though the course is specifically designed as a cornerstone of the Philosophy Departments’ graduate curriculum.

1 Topics

This course covers the following topics:

1. logical validity and truth compared with formal validity
2. truth functionality
3. the syntax and semantics of classical, sentential logic
4. disjunctive normal form

5. expressive adequacy
6. axiomatic formal systems
7. Post's completeness theorem
8. logical independence
9. the syntax and semantics of monadic quantificational logic
10. decidability of monadic quantificational logic
11. the syntax and semantics of polyadic quantificational logic
12. prenex normal form
13. Herbrand's proof procedure for quantificational logic
14. Gödel's completeness theorem
15. the compactness theorem
16. Cantor's theorem
17. the Löwenheim-Skolem theorem
18. natural deduction
19. the sequent calculus
20. constructive completeness theorems
21. cut elimination
22. equality
23. expressible and inexpressible cardinality claims

2 Text

I will circulate notes periodically in place of a text. There are a few books with illustrative exercises that you might want to look at in a library. Two good, elementary ones are Warren Goldfarb's *Deductive Logic* and W. V. O. Quine's *Methods of Logic*, though the latter is notationally obscure. A more advanced book is Richard Grandy's *Advanced Logic for Applications*. I do not expect you to acquire any of these. Our lectures and discussions, and the periodic handouts (especially during the second half of the semester) of the central results and exercises, should suffice. My notes and lectures follow some of Quine's logic papers from the 1950s.

3 Format, aims

From a mathematical point of view, this course is highly redundant. We will have, for example, an excellent decision procedure for sentential logic up and running in no time, which is in no substantial way improved upon by the axiomatic systems that we will study later. We will become proficient with three different proof systems for quantificational logic, any one of which is sufficient. We even prove the main result, the completeness theorem, three times. The main idea behind this format is Quine's dictum: "Approaching logical structure thus from a plurality of angles conduce[s] to depth of understanding." All of our systems and techniques are suited to make some aspect of logic as clear and intuitive as possible:

- In addition to their semantic role, truth-tables are the best example of a decision procedure
- The axiomatic method, in addition to its historical importance, eases one into the discussion of logical dependence, comparisons of multiple systems, etc.
- Our first proof procedure for quantification theory is designed to make the completeness theorem as easy as possible to understand, our second one deepens our understanding of deductive validity and reasoning, and our third lends the greatest insight into the unique structural features of classical logic

- The three proofs of completeness highlight distinct aspects of the completeness phenomenon and have different sets of immediate applications

In addition to deepening one's understanding, we hope to get adequately exposed to the different main approaches to studying logic so that we can read important historical and philosophical manuscripts without any additional initiation.

4 Grading

You will get a grade in the course depending on your performance on several "take home" assignments. Some of these will be short; others will be long. you are free to think of them as tests or as homework or as problem sets. I will distribute these when the class as a whole feels ready for them, and I will allow ample time to complete them.

5 Note

Please be aware of the University's policies regarding academic honesty, anti-discrimination, and access to education for students with disabilities.

Here is the web-page of the office for students with disabilities:

<http://www.nd.edu/~osd/NEWHOME PAGE.htm>

Here is the Philosophy Department's web-page devoted to academic honesty, with links to information about plagiarism and the University's honor code:

<http://philosophy.nd.edu/undergraduate-program/honesty/>

In addition I am someone you can approach if you have concerns about discrimination or proper scholarly behavior, whether or not the concern is related to this course.

6 Important dates

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| September 30 | no class | Rosh HaShannah |
| October 9 | no class | Yom Kippur |
| October 14 | no class | Succos |