

PHILOSOPHY 115
INTRODUCTION TO FORMAL LOGIC II

BULLETIN INFORMATION

PHIL 115 – Introduction to Formal Logic II (3 credit hrs)

Course Description:

Intermediate topics in predicate logic, including second-order predicate logic; meta-theory, including soundness and completeness; introduction to non-classical logic.

SAMPLE COURSE OVERVIEW

Building on the material from PHIL 114, this course introduces new topics in logic and applies them to both propositional and first-order predicate logic. These topics include argument by induction, duality, compactness, and others. We will carefully prove important meta-logical results, including soundness and completeness for both propositional logic and first-order predicate logic. We will also learn a new system of proof, the Gentzen-calculus, and explore first-order predicate logic with functions and identity. Finally, we will discuss potential motivations for alternatives to classical logic, and examine how those motivations lead to the development of intuitionistic logic, including a formal system for intuitionistic logic, comparing the features of that formal system to those of classical first-order predicate logic.

ITEMIZED LEARNING OUTCOMES

Upon successful completion of PHIL 115, students will be able to:

1. Apply, as appropriate, principles of analytical reasoning, using as a foundation the knowledge of mathematical, logical, and algorithmic principles
2. Recognize and use connections among mathematical, logical, and algorithmic methods across disciplines
3. Identify and describe problems using formal symbolic methods and assess the appropriateness of these methods for the available data
4. Effectively communicate the results of such analytical reasoning and problem solving
5. Explain and apply important concepts from first-order logic, including duality, compactness, soundness, and completeness
6. Apply deductive techniques for the evaluation of arguments couched in the symbolism of first-order predicate logic, including functions and identity
7. Explain the motivation behind alternatives to classical logic and describe how intuitionistic logic pursues that motivation

SAMPLE REQUIRED TEXTS/SUGGESTED READINGS/MATERIALS

1. Bostock, David *Intermediate Logic* (Oxford University Press).
2. Kurtz, Stuart, "A Brief Introduction to the Intuitionistic Propositional Calculus" (available on Blackboard).

SAMPLE ASSIGNMENTS AND/OR EXAMS

- 1. 12 weekly homework assignments:** The following is a listing of all the homework assignments for the course. Please note that some weeks there are more homework problems required than others. Also, some assignments may take more time than it would appear from the number of problems, as many problems have multiple parts. All assignments refer to exercises in Bostock unless indicated otherwise.
 - a. 2.1.1, 2.2.1, 2.3.1, 2.4.1, 2.4.2
 - b. 2.5.1, 2.5.3, 2.6.1
 - c. 2.7.1, 2.8.1, 2.8.2
 - d. 2.9.1, 2.9.2, 2.10.1, 2.10.2
 - e. 2.11.1, 3.2.1, 3.3.1, 3.3.4, 3.5.1
 - f. 3.5.2, 3.6.1, 3.6.2, 3.7.1, 3.7.2
 - g. 4.1.2, 4.2.1, 4.2.2
 - h. 4.3.1, 4.4.1 (a), (e), and (k), 4.4.2(a), (b), and (c)
 - i. 4.5.1, 4.6.1, 4.6.2, 4.7.1, 4.8.2
 - j. 6.1.1, 6.1.2, 6.2.1, 6.2.3, 6.3.1, 6.3.2
 - k. 7.2.1, 7.3.1, 7.3.2, 7.6.1
 - l. 8.1.1, 8.2.1, 8.2.2, 8.3.1, 8.4.1, 8.5.1
 - m. [bonus assignment] "Questions about Intuitionism", posted on Blackboard
- 2. Mid-term exam,** in class.
- 3. Final exam,** cumulative, although with an emphasis on the material covered in class since the mid-term exam.

SAMPLE COURSE OUTLINE WITH TIMELINE OF TOPICS, READINGS/ ASSIGNMENTS, EXAMS/PROJECTS

- Week 1:** Topic: Truth Functions, Truth Functors, Semantics for Truth-functional languages
Reading: Bostock, 3-30
- Week 2:** Topic: Principles of entailment (cut, etc.), Normal forms (DNF, PNF, etc.)
Reading: Bostock, 30-45
Due: HW #1
- Week 3:** Topic: Expressive adequacy I, Proof by Induction
Reading: Bostock, 45-56
Due: HW #2
- Week 4:** Topic: Expressive adequacy II, Duality
Reading: Bostock, 56-65
Due: HW #3
- Week 5:** Topic: Truth-value analysis, The language of first order logic
Reading: Bostock, 65-81
Due: HW #4

- Week 6:** Topic: Model theory for first order logic, More principles of entailment
Reading: Bostock, 81-108
Due: HW #5
- Week 7:** Topic: Prenex normal form, Decision procedures for monadic predicate formulas, Proofs and Counterexamples
Reading: Bostock, 109-138
Due: HW #6
- Week 8:** Midterm Exam– Exam covers through chapter 3
Topic: Proofs with truth-functors, Proofs with quantifiers
Reading: Bostock, 141-165
Due: HW #7
- Week 9:** Topic: Soundness, Completeness
Reading: Bostock, 165-187
Due: HW #8
- Week 10:** Topic: Natural deduction I – truth-functors, Natural deduction II – quantifiers, Alternative proof styles
Reading: Bostock, 239-272
Due: HW #9
- Week 11:** Topic: Sequent Calculi I, Sequent Calculi II
Reading: Bostock, 273-319
Due: HW #10
- Week 12:** Topic: Identity, Functions, Descriptions, Emptiness and Extensionality
Reading: Bostock, 323-360
Due: HW #11
- Week 13:** Topic: Intuitionistic Logic – Motivation, Intuitionistic Logic – Semantics
Reading: Kurtz (all)
Due: HW #12
- Week 14:** Topic: Review for exam
Reading: none (see review questions posted on Blackboard)
Due: Bonus HW

Final Exam according to University Exam Schedule