Introduction to Symbolic Logic

(ABRIDGED) COURSE OUTLINE

Detailed Course Description.

This course is meant to serve as an introduction to modern deductive logic, including propositional and first-order predicate logic. Deductive logic is a form of reasoning which relies on a notion of validity—when the truth of an argument's conclusion is guaranteed from the truth of its premises.

In the first part of the course, we will introduce several concepts central to deductive reasoning, including validity, logical equivalence, tautology, and contradiction. We will begin by showing how language can be represented symbolically; specifically, we will focus on the logical components of sentences, which give rise to the truth-functional operators: 'and', 'or', 'not', 'if…then' and 'if and only if'.

In the second part of the course, we will examine a system of natural deduction that allows us to determine the entailment relations between propositions. In this case, our formal language will be grounded in atomic propositions that are symbolised by letters—e.g., P, Q. However, we shall see that characterising propositions by complete symbols limits the expressive capacities of our system of logic. In the final part of the course, we will introduce predicates ($P(\ldots)$, $Q(\ldots)$), constants (a, b, c), variables (x, y, z), and quantifiers ($\exists$, $\forall$) into our system, which gives rise to first-order logic (FOL). At this level, we can symbolise internal logical relations between objects—e.g., "a is taller than b".

Utilising formal symbolic languages allows us to abstract away from the actual content of specific arguments in order to determine their value by means of their form alone. Overall, this course will benefit students in any discipline that uses, or purports to use, logical reasoning; you will gain the formal tools to, e.g., evaluate whether you must accept some conclusion an author draws or if this conclusion requires more argumentation. Moreover, the formal approach we take will be of particular interest to students in mathematics, computer science, philosophy, and more. In setting up our formal language we will cover tools used in computer programming and mathematical proof as well as touch on concepts such as 'truth' and 'meaning' of interest to many philosophers.

Learning outcomes.

Upon successful completion of this course, students should be able to:

- Represent the structure of statements and arguments using a formal logical framework;
- Assess formalised arguments for validity using truth tables and deductive methods;
- Display knowledge of and facility with symbolic logic under assessment conditions;
- Apply these formal methods to clarify and assess real-world arguments;

Required Readings

We will be using the following textbook throughout this course:

> *Forall x (Calgary Remix): An Introduction to Formal Logic.* (Fall 2018) P. D. Magnus and Tim Button; with additions by J. Robert Loftis; remixed and revised by Aaron Thomas-Bolduc and Richard Zach.

Full .pdf files of the text can be downloaded here: http://forallx.openlogicproject.org. A hard copy can be purchased as well.

Additional resources will be posted on the course webpage.

In the detailed course schedule below, all of the chapters refer to this text.

Grading Details

The final grade for this course will consist in short, weekly problem sets in addition to four short in-class examinations. The best way to learn logic is by doing it. As such, when an assignment is graded and returned, you will have one opportunity to correct your mistakes and resubmit the assignment for a higher grade. After one week has passed, the answer key for that assignment will be posted on the course webpage, so no further resubmissions will be accepted. The exams are 'non-cumulative' in one sense. Namely, the first midterm will focus on the first part of the course, the second midterm will focus the second part, etc. However, each of these topics builds on the previous topics, and so the midterms are not self-contained.

You are encouraged to discuss the problem sets amongst yourselves, but the work that you submit must be your own. For reference, please note the following:

- Working with colleagues to figure out a problem ***is not*** cheating.
- Having a more knowledgeable person teach you how to solve a few problems ***is not*** cheating (Provided the work you submit is your own).
- Having someone else write up the answers and putting your name on it ***is*** cheating.
- Blindly copying someone else's answers without understanding the steps ***is*** cheating.

Grading Overview.

The grading for this course is broken down as follows:

Weekly Problem Sets	40 %
Midterm 1	15 %
Midterm 2	15 %
Midterm 3	15 %
Midterm 4	15 %
TOTAL	**100 %**

Detailed Course Schedule

	PART I: Key Notions of Logic
Week 1	**Course Introduction**
Req. Reading	*Course Syllabus*
	Chapter 1: Arguments
	Chapter 2: Valid Arguments
Week 2	**Truth-Functional Connectives**
Req. Reading	Chapter 4: Symbolisation
	Chapter 5: Connectives
	Chapter 6: Sentences of TFL
Week 3	**Truth Tables**
Req. Reading	Chapter 8: Characteristic Truth Tables
	Chapter 9: Truth-Functional Connectives
	Chapter 10: Complete Truth Tables
	Chapter 11: Semantic Concepts
	PART II: Natural Deduction for TFL
Week 4	**Introduction to Natural Deduction**
Req. Reading	Chapter 14: The Idea of Natural Deduction
	Chapter 15: Basic Rules of TFL
	First Midterm, In Class Covers: Ch. 1 - Ch. 11 (Weeks 1 - 3)
Week 5	**Deductive Rules and Proofs (I)**
Req. Reading	Chapter 16: Additional Rules for TFL
	Chapter 17: Proof-Theoretic Concepts

Week 6	**Deductive Rules and Proofs (II)**
Req. Reading	Chapter 18: Proof Strategies
	Chapter 19: Derived Rules

PART III: First-Order Logic

Week 7	**Introduction to First-Order Logic (FOL)**
Req. Reading	Chapter 21: Building Blocks of FOL
	Chapter 22: Sentences with One Quantifier
	Chapter 23: Multiple Generality

Second Midterm, In Class
Covers: Ch. 14 - Ch. 19
(Weeks 4 - 6)

Week 8	**Identity and Extensionality**
Req. Reading	Chapter 24: Identity
	Chapter 25: Definite Descriptions
	Chapter 26: Sentences of FOL
	Chapter 27: Extensionality
Week 9	**Interpretations**
Req. Reading	Chapter 28: Truth in FOL
	Chapter 29: Semantic Concepts
	Chapter 30: Using Interpretations
	Chapter 31: Reasoning About Interpretations

PART IV: First-Order Logic

Week 10	**Natural Deduction for FOL**
Req. Reading	Chapter 32: Basic Rules of FOL
	Chapter 33: Conversion of Quantifiers

Third Midterm, In Class
Covers: Ch. 21 - Ch. 31
(Weeks 7 - 9)

Week 11	**Identity and Derived Rules for FOL**
Req. Reading	Chapter 35: Rules for Identity
	Chapter 36: Derived Rules
Week 12	**Normal Forms**
Req. Reading	Chapter 37: Normal Forms
Week 13	**Review**
Req. Reading	N/A

Final Examination, In Class
Covers: Ch. 32 - Ch 37
(Weeks 10 - 12)