Introduction to Symbolic Logic

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This is my model syllabus for Introduction to Symbolic Logic. In order to fit a particular schedule, it would need adjustments based on the number and length of course meetings.

Course Summary

To study logic is to study the nature of reasoning or argumentation, an activity important to every field of rational inquiry. An argument is a set of two or more statements of which at least one statement, i.e., the premise (or premises), is purported to provide support for another statement, i.e., the conclusion. Human discourse is typically filled with arguments—on news outlets, talk shows, in academia, in conversations between friends and between family members—though of course not everything communicated is an argument. Sometimes we report events, or explain facts, or tell stories; but other times, we argue for claims. An overarching aim of this course is to examine how to translate arguments conveyed by ordinary English sentences into symbolic logic form, and how to test these arguments for validity using a variety of methods.

In the first part of the course, on sentential or propositional logic, we will build up the requisite skills and concepts towards the aim of translating sets of sentences comprising arguments, and testing those arguments using truth-tables and the natural deduction method. In the second part of the course, we will take the same aim within predicate logic, which introduces quantifiers—in particular, the existential (∃) and universal (∀) quantifiers. By doing all of this, you will increase and refine your logical analysis skill, improve your ability to evaluate arguments, and enhance your overall reasoning capacity.

Brief Historical Note on Logic

Logic as a discipline has roots in the ancient Greek philosophers, most notably Aristotle (384-322 B.C.). Aristotle developed syllogistic logic, in which the fundamental elements are terms, and an argument is good or bad depending on how the terms are arranged; he also created modal logic, which involves concepts such as possibility and necessity. However, the methods we will cover in this course are relatively recent in origin, having roots in the ideas of mathematicians and logicians in the 19th and early 20th centuries. Gottlob Frege (1848-1925) invented the theory of quantification and laid the foundation for modern mathematical logic, a.k.a. symbolic logic. This work was continued by Alfred North Whitehead (1861-1947) and Bertrand Russell (1872-1970). In their *Principia Mathematica*, they tried to reduce all of pure mathematics to logic. Their work provides much of the symbolism that is used today in symbolic logic. The discoveries and techniques of symbolic logic formed the conceptual basis of the development of digital computing machinery, and continue to inform computer science, the theory of knowledge, artificial intelligence, and other fields of inquiry.[1]

[1] This brief note on the history of logic draws on the short history of logic presented in Patrick Hurley, *A Concise Introduction to Logic* (9th Edition, Wadsworth, 2006: pp. 5-7). For more on the history of logic, and

Meeting Activities
Lecture, Discussion, Homework Review, Quizzes, Exams

Materials
1. *Understanding Symbolic Logic*, 5/E, Virginia Klenk, Pearson, 2008.
2. Study Guides
3. Online Resources

Evaluation
1. *Fifteen Homework Assignments*
   We will review some homework in class; you will keep your homework file and turn it in with annotated corrections at the end of the term. (Homework is worth 15% of your total score.)
2. *Five Surprise Quizzes*
   Each of the quizzes will consist of two questions. The quizzes will tend to cover material that we have just studied and reviewed. Your lowest quiz score will be dropped; hence, you can miss one without it necessarily hurting your overall course grade. (Quizzes are worth 10% of your total score—each one is worth 2%.)
3. *Four Exams* (to include the Final Exam)
   The material covered by each exam necessarily builds on prior material. However, each exam will emphasize material covered since the previous exam, with the understanding that certain techniques, terminology, and rules will necessarily carry over. (The first exam is worth 15%, and all of the others are worth 20% each, of your total score.)

Schedule of Topics, Readings, Homework Assignments, and Exams [specific dates TBD]

Advice: Before reading each unit, read all of the Study Questions at the end of the unit (just before the exercises), and then after doing the reading, answer the questions before doing the assigned exercises.

All unit readings and homework assignments below refer to Klenk's *Understanding Symbolic Logic*. The page numbers listed for the homework assignments indicate the page on which the exercises begin. Please do the specific problems assigned. You are encouraged to do additional problems as you see fit.

<u>PART I: Sentential (or, Propositional) Logic</u>

Week 1:

Course Introduction: Scope and Expectations
Introduction to Logic (Unit 1)
Homework Assignment 1 Exercises (p. 18): 1a-o; 2(1)a-f, 2(2)a-f

The Structure of Sentential Logic (Unit 2)
Homework Assignment 2 Exercises (p. 31): 1a-o; 2a-l

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some discussion of various concepts in logic that go beyond the scope of this course, see the entries under the topic 'Logic' at the *Internet Encyclopedia of Philosophy* (http://www.iep.utm.edu/category/s-l-m/logic/).

Weeks 2/3:

Computing Truth Values (Unit 3)
Homework Assignment 3 Exercises (p. 49): 1a-k, 1q; 2a-e; 3a-c

Symbolizing English Sentences (Unit 4)
Homework Assignment 4 Exercises (p. 69): 1a-m; 2a-e; 3a-f; 4a-c, h-j; 5a-c; 6a-g

Weeks 4/5:

Truth Tables for Testing Validity (Unit 5)
Homework Assignment 5 Exercises (p. 92): 1a-f, h, i; 2a-c; 3a-c; 4a, b, e, h, & k

Exam 1 (covers material through Unit 4)

Further Applications of the Truth Table Method (Unit 6)
Homework Assignment 6 Exercises (p. 108): 1a-g; 2a-f; 3a-d; 4a & c; 5a & b; 6b; 7b, c; 8a

Weeks 6/7/8:

The Proof Method: Eight Basic Inference Rules (Unit 7)
Homework Assignment 7 Exercises (p. 139): 1(1) & (2); 2a-e, q-t; 3a-f, k & l; 4a; 5a; 6a, c; 7b, e; 8a-c, h, k; 9a, e; 10a, b, e

Replacement Rules (Unit 8)
Homework Assignment 8 Exercises (p. 168): 1a-e; 2a-c, m-p; 3a, c; 4a, e; 5a, c, e, g; 6a, c, g, j; 7c, d; 8a, d

Weeks 9/10:

Conditional Proof and Indirect Proof (Unit 9)
Homework Assignment 9 Exercises (p. 195): 1a-c; 2a, e, h; 3a-e; 4a, b, f; 5a, d, j; 6a, c, k; 7a; 8a, c, d; 9a-c

Exam 2 (covers material through Unit 8)

PART II: Monadic Predicate Logic

Week 11:

Singular Sentences (Unit 10)
Homework Assignment 10 Exercises (p. 209): 1a-j, n; 2a-g

Quantifiers (Unit 11)
Homework Assignment 11 Exercises (p. 222): 1a-e; 2a-e; 3a-k, q-s; 4a-d

Week 12:

Categorical Propositions (Unit 12)
Homework Assignment 12 Exercises (p. 245): 1a-f; 2a-g, m, n, r, s; 3a; 4a-f; 5a-d; 6a-h; 7a-c

Complex Subjects and Predicates (Unit 13)
Homework Assignment 13 Exercises (p. 258): 1a, b; 2a-g; 3 a, b, e; 4a-c; 5a-g; 6a, c, f; 7a-d

Exam 3 (covers material through Unit 12)

Week 13:

Quantifier Form and Truth-functional Compounds of Quantifier Statements (Unit 14)
Homework Assignment 14 Exercises (p. 269): 1a, b; 2a-f; 3a-e; a-c, g-i; 5a, e-g; 6a-e

Week 14:

Proofs in Predicate Logic (Unit 15)
Homework Assignment 15 Exercises (p. 295): a-j; 2a, b, k, l, o; 3a, b; 4a, c, e; 5a, c, d, f

Week 15:

Brief discussion of the completeness and soundness properties of logical systems
Additional topics/time for adjustments that may need to be made during the term

Exam 4/Final Exam (covers material through unit 15)

N.B.: The instructor reserves the right to make changes to this syllabus for the benefit of the class as a whole.