Term Year – Course Number, Section

Introduction to Symbolic Logic

Class Number: ####, Delivery Method: In Person

Course Information

Course Times + Location	Exam Times + Location
Date and Time	Date and Time
Building and Room Number	Building and Room Number

Contact Information	Office Hours
Instructor: Travis LaCroix	Date and Time
✉ tlacroix@uci.edu	Building and Office Number

Contents

Calendar Description

An introduction to propositional and predicate logic; formalisation of arguments, truth tables, systems of deduction, elementary meta-results, and related topics.

Prerequisites

None

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;

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 ($P()$, $Q()$), 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.

Grading

Assignments	40%
Midterm 1	15%
Midterm 2	15%
Midterm 3	15%
Final Exam	15%

Assignments

The best way to learn logic is by doing it. As such, short assignments, which will consist primarily in a selection from the textbook exercises, will be distributed weekly.

When the assignment is graded and returned, you will have *one* opportunity to correct your mistakes and resubmit the assignment for a higher grade.

Midterm(s) and Final Exam

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.

Required Readings

1. 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.[1]

Note:
This text is available for free as a .pdf file **here**.
If you prefer, a hard copy can be purchased via Amazon or Indigo.

[1] Link for hard copy of syllabus: `http://forallx.openlogicproject.org/forallxyyc.pdf`

Additional Resources

Lecture slides will be posted on the course web page, for reference, after the lecture.

> **Note**:
> *If you are auditing or on the waitlist and do not have access to the course web-page, please email me.*

Kevin Klement has done up a prototype of his online natural deduction proof builder/checker that works with the natural deduction system of the Cambridge and Calgary versions of *forall x*. It is available **Here**.[2]

You are welcome to use this application to check your answers for your homework assignments.

Policies

For general university-wide policies, see here: [Insert Link to University Policies].

Policies specific to this course are detailed below.

Ground Rules for Discussions[3]

These ground rules form a set of expected behaviours for conduct in discussions and lectures. They are meant to foster an intellectual atmosphere where we work together to achieve knowledge. They are also meant to ensure that discussions are spirited without devolving into argumentation and to ensure that everyone has an opportunity to be heard.

- Respect yourself and others (share your viewpoint and allow others to share theirs).
- Show respect for others by learning and using their preferred names and pronouns.
- Give each other the benefit of the doubt. (Be charitable.)
- Be cautious of universal claims.
- Listen actively and attentively.
- Keep an open mind. (Expect to learn something new, or to have your views challenged by ideas, questions, and points of view different than your own.)
- Ask for clarification if you are confused.
- Do not interrupt one another—even when you are excited to respond.
- Challenge one another, but do so respectfully.

[2] For printed version of syllabus, the url is:
`openlogicproject.org/2017/02/27/proof-checker-for-forall-x-cambridge-and-calgary/`

[3] Adapted from Ambrose et al. (2010)

- Allow others (and yourself) to revise or clarify ideas and positions in light of new information.
- Critique ideas, not people.
- Do not offer opinions without supporting evidence.
- Try not to make assumptions; ask questions instead.
- Avoid put-downs.
- Take responsibility for the quality of the discussion.
- Build on one another's comments; work toward shared understanding.
- Always have your book or readings in front of you.
- Do not monopolise discussion.
- If you are offended by anything said during discussion, acknowledge it immediately.
- If you notice patterns that are troubling or might be impeding full engagement by others, please speak to me (or the T.A., when applicable) in office or via email. Such discussions should be understood as being strictly confidential. If it is not possible to speak to me, feel free to reach out to the department chair, and academic advisor, or a trusted mentor.

Use of Technology in Class

Laptops, tablets and phones are **not** allowed in class. This is a symbol-heavy course, so there is no need for a laptop during the lecture.

In case you miss something from the lecture, the slides for the day's lecture will be posted after the lecture on the course web page.

Missing or Late Assignments

I will accept late assignments up to one week after the initial due-date. However, late assignments will not be eligible for correction and re-submission.

If you miss an exam, with a **valid** and **documented** excuse, then the remaining exams will be weighted more heavily. No make-up exams will be given **unless** prior accommodations have been made with me.

If you have any concerns at any point throughout the course, I encourage you to email me or come to my office hours to discuss. In general, if a special condition or circumstance in your life may affect your performance, please let me know about it as soon as possible. It will be treated with the strictest confidence. *Do not wait until the condition or circumstance is impending or has already happened before telling me about its impact on you.*

If something unanticipated occurs, bring it to my attention and we will work out a way of dealing with it.

Academic Integrity

Any form of academic misconduct that is shown on an assignment or exam is sufficient for a failing grade on that assignment.

Demonstrable repetition of academic misconduct is sufficient for a failing grade in the course.

Depending on the severity of the misconduct, a letter recording the violation may be sent to the Dean.

[Refer to the university's policies concerning academic integrity.]

For the weekly assignments, please note the following:

- Working with friends 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.

Detailed Schedule

Part I: Key Notions of Logic

W1. **Introduction to Course**

Required Reading

Course Syllabus

Chapter 1: Arguments

Chapter 2: Valid Arguments

W2. **Truth-Functional Connectives**

Required Reading

Chapter 4: Symbolisation

Chapter 5: Connectives

Chapter 6: Sentences of TFL

W3. **Truth Tables**

Required 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

W4. **Introduction to Natural Deduction**

First Midterm, In Class
Covers: Ch. 1 – Ch. 11
(Weeks 1 – 3)

Required Reading

Chapter 14: The Idea of Natural Deduction

Chapter 15: Basic Rules for TFL

W5. **Deduction Rules and Proofs (I)**

Required Reading

Chapter 16: Additional Rules for TFL

Chapter 17: Proof-Theoretic Concepts

W6. **Deduction Rules and Proofs (II)**

Required Reading

Chapter 18: Proof Strategies

Chapter 19: Derived Rules

Part III: First Order Logic

W7. **Introduction to FOL**

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

Required Reading

Chapter 21: Building Blocks of FOL

Chapter 22: Sentences with One Quantifier

Chapter 23: Multiple Generality

W8. **Identity and Extensionality**

Required Reading

Chapter 24: Identity

Chapter 25: Definite Descriptions

Chapter 26: Sentences of FOL

Chapter 27: Extensionality

W9. **Interpretations**

Required Reading

Chapter 28: Truth in FOL

Chapter 29: Semantic Concepts

Chapter 30: Using Interpretations

Chapter 31: Reasoning About All Interpretations

Part IV: First Order Logic

W10. **Natural Deduction for FOL**

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

Required Reading

Chapter 32: Basic Rules of FOL

Chapter 33: Conversion of Quantifiers

W11. **Theme**

Required Reading

Chapter 35: Rules for Identity

Chapter 35: Derived Rules

W12. **Theme**

Required Reading

Chapter 37: Normal Forms

Review

W13. **Review**

Final Exam, In Class
Covers: Ch. 32 – Ch. 37
(Weeks 10 – 12)

Disclaimer

This document is meant to be binding; however, in the event of circumstances beyond my control, the course contents, evaluation scheme and other parts of this syllabus are subject to change.