



**UNIVERSITY OF CALGARY**  
FACULTY OF ARTS  
Department of Philosophy

## **PHIL 679.6 Lec 01**

### **Topics in Logic: Proof Theory**

**Fall Term 2022**  
**Time and room TBA**

#### **Course Outline**

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**Office Hours:** by appointment

#### **Course Description**

Formal proofs in logic and mathematical systems play an important role in several areas of analytic philosophy, including the philosophy of logic and the philosophy of mathematics. The study of formal proofs is the subject of proof theory. It investigates the structure, length, and complexity of formal proofs, operations on formal proofs, relationships between formal proofs in various different proof systems such as sequent calculus and natural deduction, and special forms formal proofs can have. Formal proofs of theorems in mathematical systems have been used to account for the meaning and truth of these theorems. Proof theoretic results such as consistency proofs have been used for philosophical aims such as to account for the security of mathematical knowledge or to argue for or against various positions in the philosophy of mathematics such as instrumentalism or the so-called indispensability arguments.

In this course we will study some of the basic methods and results in proof theory. This will include a study of the sequent calculus and the cut-elimination theorem, of natural deduction systems and normal form theorems, and formalizations of mathematics and consistency proofs. The ap-

proach will be in part historical: we will study the pioneering work of Gerhard Gentzen in the 1930s and its context in the development of logic and metamathematics.

Proof theory also has important applications outside of philosophy: in mathematics, computer science, and linguistics. We will touch on some of these applications, depending on student interest.

### **Prerequisites**

Consent of the department.

### **Course Objectives**

By the end of the course, you should be able to ...

1. Understand, construct, and formulate simple mathematical proofs in which you apply definitions, identify hypotheses, and correctly and appropriately use informal patterns of mathematical reasoning.
2. Understand systems and results of proof theory.
3. Understand the mathematical and philosophical significance of proof theory.
4. Be able to research proof theoretical literature.
5. Compose a research paper on proof theory.

### **Readings**

Mancosu, Paolo, Sergio Galvan, and Richard Zach. 2021. *An Introduction to Proof Theory: Normalization, Cut-Elimination, and Consistency Proofs*. Oxford: Oxford University Press. [doi.org/10.1093/oso/9780192895936.001.0001](https://doi.org/10.1093/oso/9780192895936.001.0001).

Additional readings will be made available electronically.

### **Requirements and Evaluation**

*Course Requirements.* The following assessment components are required to pass the course:

2 problem sets	$2 \times 10\%$	Oct 7, 2022 Nov 4, 2022
3 presentations	$3 \times 5\%$	TBA (Sept–Nov 2022)
final project	65%	Dec 7, 2022

**There will be no exams.**

*Final Project.* The final project will be due on **Wednesday, December 7, 2022**. A project will consist in either a worked out presentation of an advanced topic (e.g., a proof of a proof-theoretic result, a survey article on some application of proof theory in mathematics, computer science, or linguistics), or a philosophical paper on a topic related to proof theory. A technical project should run about 10–15 pages; a more philosophical paper 15–20 pages.

The evaluation of your final paper will take into account the difficulty of the chosen topic, the amount and quality of research evident in it, and the quality, clarity, and precision of your exposition. **Your writing and the grading thereof is a factor in the evaluation of your work for this course.**

*Evaluation and Grades.* For each question on a problem set and for the final project components, you will receive a letter grade (possibly with +’s or –’s) reflecting the level of mastery of the material shown by the work you submit. The overall grading rubric is given below:

**A** Excellent—superior performance, showing comprehensive understanding of subject matter.

Your work shows comprehensive understanding of the subject matter. Your solutions to problems are correct, clear, and elegant. Your final project presents a well-researched, non-trivial topic in a correct, clear, well-organized, self-contained, and accessible paper.

**B** Good—clearly above average performance with knowledge of subject matter generally complete.

Your work shows a complete understanding of most topics covered in the course. Your solutions to problems are mostly correct, with only minor errors or oversights, and reasonably clear. Your final project presents a relevant topic in a well-organized paper with coverage of the topic reasonably complete and no significant errors or areas of unclarity.

**C** Satisfactory—basic understanding of the subject matter.

Your work shows only a basic understanding of the topics covered in the course. You can only complete simple problems correctly but proofs contain major errors. Your final project is relevant and contains some interesting a correct contributions but may be insubstantial, unclear, disorganized, or contain major errors.

**D Minimal pass—marginal performance.**

You complete most assignments but your solutions are unclear, incorrect, or incomplete. You have trouble completing even simple problems. Your final project is badly organized, unclear, incorrect, or superficial.

**F Fail—Unsatisfactory performance.**

In computing your final grade, your marks will be converted to grade points and averaged according to the weights given above. The correspondence of letter grades with grade points is defined in the *Calendar* (A = 4, B = 3, C = 2, D = 1, F = 0). “Slash” grades receive 0.5 below the value of the higher grade (e.g., A/B = 3.5).

The final grade will be the letter grade corresponding to the weighted average of your assignments, paper, presentation, and participation plus a margin of 0.1. For the final grade, +’s and –’s are possible, too; as defined in the *Calendar*, +/- adds/subtracts 0.3 grade points. In other words, a course average of 3.9 or higher receives an A; at least 3.6 and less than 3.9, an A–; at least 3.2 and less than 3.6, a B+; at least 2.9 and less than 3.2, a B; and so on. There is no D– grade; to earn a D you require a course average of at least 0.9. The A+ grade is reserved for “truly outstanding” performance.

**Assignments and Policies**

*Late work and extensions.* Assignments handed in late without prior arrangement will be penalized by the equivalent of one grade point per calendar day, unless you can provide a medical or other valid reason for why your assignment is late.

*Plagiarism.* You will find the University policy on plagiarism at the end of this outline. Plagiarism is a very serious academic offense. It is *not limited* to copying papers wholesale from the Internet; close paraphrase of the texts, of the lectures, or of anyone (other than you) without attribution constitutes plagiarism. Your assignments should only contain your own formulations. When in doubt, consult with the instructor. **Plagiarism will result in a failing grade on the assignment or in the course and a report to the Dean’s office.**

*Checking your grades and reappraisals of work.* University policies for reappraisal of term work and final grades apply (see the *Calendar* section “Reappraisal of Grades and Academic Appeals”). In particular, term work will only be reappraised within 15 days of the date you are advised of your marks. Please keep track of your assignments (make sure to pick them up in lecture

or in office hours) and your marks (check them on the website) and compare them with the graded work returned to you.

### **Important departmental, faculty, and university information**

*Academic accommodations.* It is the student's responsibility to request academic accommodations according to the University policies and procedures. The student accommodation policy can be found at: [ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf](https://ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf)

Students seeking an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: [ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities-Procedure.pdf](https://ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities-Procedure.pdf)

Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to their instructor.

*Absence or missed course assessments.* Students who are absent from class assessments (tests, participation activities, or other assignments) should inform their instructors as soon as possible. Instructors may request that evidence in the form of documentation be provided. If the reason provided for the absence is acceptable, instructors may decide that any arrangements made can take forms other than make-up tests or assignments. For example, the weight of a missed grade may be added to another assignment or test.

*Student support and resources.* Full details and information about the following resources can be found at [ucalgary.ca/current-students/student-services](https://ucalgary.ca/current-students/student-services)

- Wellness and Mental Health Resources
- Student Success Centre
- Student Ombuds Office
- Student Union (SU) Information
- Graduate Students' Association (GSA) Information
- Emergency Evacuation/Assembly Points
- Safewalk

*Academic Advising.* If you are a student in the Faculty of Arts, you can speak to an academic advisor in the Arts Students' Centre about course planning, course selection, registration, program progression and more. Visit the Faculty of Arts website at [arts.ucalgary.ca/current-students/undergraduate/academic-advising](https://arts.ucalgary.ca/current-students/undergraduate/academic-advising) for contact details and information regarding common academic concerns.

For questions specific to the philosophy program, please visit [phil.ucalgary.ca](https://phil.ucalgary.ca). Further academic guidance is available by contacting Mark Migotti (Undergraduate Program Director, [migotti@ucalgary.ca](mailto:migotti@ucalgary.ca)) or Megan delehanty (Honours Advisor, [mdelehan@ucalgary.ca](mailto:mdelehan@ucalgary.ca)).

*Writing assessment and support.* The assessment of all written assignments—and, to a lesser extent, written exam responses—is based in part on writing skills. This includes correctness (grammar, punctuation, sentence structure, etc.), as well as general clarity and organization. Research papers must include a thorough and accurate citation of sources. Students are also encouraged to use Writing Support Services for assistance (one-on-one appointments, drop-in support and writing workshops). For more information, and other services offered by the Student Success Centre, please visit [ucalgary.ca/student-services/student-success](https://ucalgary.ca/student-services/student-success).

*Required technology.* In order to successfully engage in their learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security, and malware updates;
- A current and updated web browser;
- Webcam (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Broadband internet connection.

Most current laptops will have a built-in webcam, speaker and microphone.

*Responsible Use of D2L.* Important information and communication about this course will be posted on D2L (Desire2Learn), UCalgary's online learning

management system. Visit [ucalgary.service-now.com/it](https://ucalgary.service-now.com/it) for how-to information and technical assistance. All users of D2L are bound by the guidelines on the responsible use of D2L posted here: [elearn.ucalgary.ca/commitment-to-the-responsible-use-of-d2l/](https://elearn.ucalgary.ca/commitment-to-the-responsible-use-of-d2l/). The instructor may establish additional specific course policies for D2L, Zoom, and any other technologies used to support remote learning. Instructional materials, including audio or video recordings of lectures, may not be posted outside of the course D2L site. Students violating this policy are subject to discipline under the University of Calgary's Non-Academic Misconduct policy.

*Media Recording.* Please refer to the following statement on media recording of students: [elearn.ucalgary.ca/wp-content/uploads/2020/05/Media-Recording-in-Learning-Environments-OSP\\_FINAL.pdf](https://elearn.ucalgary.ca/wp-content/uploads/2020/05/Media-Recording-in-Learning-Environments-OSP_FINAL.pdf)

*Academic misconduct/honesty.* Cheating or plagiarism on any assignment or examination is as an extremely serious academic offense, the penalty for which will be an F on the assignment or an F in the course, and possibly a disciplinary sanction such as probation, suspension, or expulsion. For information on academic misconduct and its consequences, please see the University of Calgary Calendar at: [ucalgary.ca/pubs/calendar/current/k.html](https://ucalgary.ca/pubs/calendar/current/k.html)

Intellectual honesty requires that your work include adequate referencing to sources. Plagiarism occurs when you do not acknowledge or correctly reference your sources. If you have questions about referencing, please consult your instructor.

*University policies.* The Instructor Intellectual Property Policy is available at: [ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Intellectual-Property-Policy.pdf](https://ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Intellectual-Property-Policy.pdf) Course materials created by professor(s) (including course outlines, presentations, assignments, and exams) remain the intellectual property of the professor(s). These materials may *not* be reproduced, redistributed or copied without the explicit consent of the professor. The posting of course materials to third party websites such as note-sharing sites without permission is prohibited. Sharing of extracts of these course materials with other students enrolled in the course at the same time may be allowed under fair dealing.

The University of Calgary is under the jurisdiction of the provincial Freedom of Information and Protection of Privacy (FOIP) Act, as outlined at

[ucalgary.ca/legal-services/access-information-privacy](http://ucalgary.ca/legal-services/access-information-privacy). The instructor (or TA) must return graded assignments *directly* to the student UNLESS written permission to do otherwise has been provided.

All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright ([ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Acceptable-Use-of-Material-Protected-by-Copyright-Policy.pdf](http://ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Acceptable-Use-of-Material-Protected-by-Copyright-Policy.pdf)) and requirements of the copyright act ([laws-lois.justice.gc.ca/eng/acts/C-42/index.html](http://laws-lois.justice.gc.ca/eng/acts/C-42/index.html)).