PHIL 679.1 L01 — "Gödel's Incompleteness Theorem"
Winter Term 2017

Course Outline

Lectures: TuTh 5–6:15, Science B 105

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Course Description

This course will focus on two famous theorems of symbolic logic due to Kurt Gödel: The Incompleteness Theorems. The first of these states, roughly, that every formal mathematical theory, provided it is sufficiently expressive and free from contradictions, is incomplete in the sense that there are always statements (in fact, true statements) in the language of the theory which the theory can't prove.

In order to prove the Incompleteness Theorem, we will study the expressive power of formal languages and axiomatic theories—this is an important and exciting area in itself. This investigation will lead us naturally to computability. We'll approach computability not via Turing machines, but via the notion of a recursive function. (We will prove that both notions coincide.)

Prerequisites

Logic II (PHIL 379) is a prerequisite for this course.

Course Learning Outcomes

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

1. define complicated computable functions using primitive recursion and minimizations, apply such definitions to specific cases, understand the scope of computable functions and computable sets, and be able to prove basic results about them;

2. articulate and explain the incompleteness theorems, its assumptions, and its consequences; appreciate the scope of these theorems; and understand and explain at least in outline how these theorems are proved;

3. make connections between incompleteness and undecidability of theories, between computability and representability in theories, and between computability in various models of computation, informally and using arithmetization;

4. explain the structure of non-standard models of arithmetic understand and work through proofs of advanced metamathematical results, and and apply the studied proof methods yourself in intermediate problems;

5. Research metalogical results, their proofs, and their application and philosophical significance independently, and present them in clear, well-structured prose as well as orally.

Required Text

Readings will be made available electronically via D2L.

Course Assessment

Your grade will be determined on the basis of four problem sets (40%, 10% each) and a final project and presentation (60%, of which 5% is for an outline and bibliography, 10% for the presentation, and 35% for the final product).

There will be no exams. You must submit all four assignments and the final project to pass the course. The quality (correctness, concision, clarity) of your writing is a factor in the evaluation of your work.

The final project will consist in a paper (at least 3,000 and not more than 5,000 words) on a topic of your choice related to the material covered in the course. You will give an oral presentation on your paper towards the end of term. Possible projects include: working out a proof in detail, researching a logical topic related to the course, or writing a philosophical paper on the importance of Gödel's theorems. The amount and quality of independent research on your part (or lack thereof) will be taken into account in assigning a grade.

For each 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 (A = 4, B = 3, C = 2, D = 1, F = 0, with +/− adding/subtracting 0.3), and averaged according to the weights given above. The final mark is the letter grade corresponding to this average plus a margin of 0.1 (i.e., an average of 3.9 earns an A, an average of 3.6 an A−, etc.).

Assignments and Policies

Tentative due dates. Problem sets will be due on Thursday of the 3rd, 5th, 7th, and 9th week of class (Jan 26, Feb 9, March 2, March 16. The draft of the final project is due April 4 and the final project is due April 17.

Submitting assignments. You may submit problem sets in class or in the Phil 479 dropbox in the corridor outside SS 1253 in the Philosophy Department.

Late work. You may turn in one problem set or the final project 48 hours past the deadline without penalty, but you must tell me by email before the deadline. Late submissions beyond this one late assignment will be penalized by the equivalent of one grade point per calendar day or part thereof (unless you can document an illness or other emergency which prevented you from completing or submitting the assignment).

Collaboration. Collaboration on problem sets is encouraged. However, you must write up your own solutions, and obviously you must not simply copy someone else's solutions. You are also required to list the names of the students with whom you've collaborated on the problem set. **If you collaborate without following these instructions**, **it constitutes cheating**.

Plagiarism. You might think that it's only plagiarism if you copy a term paper off the internet. However, you can also plagiarize in a logic course, e.g., by copying a proof verbatim from the textbook or the internet (and only making the necessary changes to apply it to the assigned problem.) The point of logic problems which are similar to the proofs in the text is to make you work through those proofs, understand them, and then prove a similar result on the problem sets. Hence, all solutions must be in your own words; copying or paraphrasing closely from the text or elsewhere constitues plagiarism, which must be reported to the Dean's office by university policy. It may result in a failing grade or worse penalties.

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 Non-Disciplinary Academic Appeals"). In particular, term work will only be reappraised within 15 calendar 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 D2L) and compare them with the graded work returned to you.

IMPORTANT DEPARTMENTAL, FACULTY AND UNIVERSITY INFORMATION

Academic Honesty

Cheating or plagiarism on any assignment or examination is regarded as an extremely serious academic office, the penalty for which may be an F on the assignment, an F in the course, academic probation, or requirement to withdraw from the University. See the relevant sections on 'Academic Misconduct' in the current University Calendar. 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 correct referencing, consult your instructor.

Academic Accommodation

Student's seeking an accommodation based on disability or medical concerns should contact Student Accessibility Services. SAS will process the request and issue letters of accommodation to instructors. For more information on support services and accommodations for students with disabilities, visit http://www.ucalgary.ca/access/ Students who require accommodation in relation to their coursework based on a protected ground other than disability should communicate this need in writing to their instructor. The full policy on student accommodations is available at http://www.ucalgary.ca/policies/files/policies/student-accommodation-policy_0.pdf

D2L Help

Desire2Learn is UCalgary's online learning management system. Important information and communications about this course may be posted on D2L. Go to http://www.ucalgary.ca/it/services/d2l for help.

Protection of Privacy

The University of Calgary is under the jurisdiction of the provincial Freedom of Information and Protection of Privacy (FOIP) Act. The Department of Philosophy ensures the student's right to privacy by requiring all graded assignments be returned to the student directly from the instructor or teaching assistant.

Internet and Electronic Communication Devices

The instructor reserves the right to establish course policies regarding the use of devices such as laptops, tablets, and smartbooks. If allowed, these devices must be used exclusively for instructional purposes and must not cause disruption to the instructor or to fellow students. Cell phones and paging devices should be set to silent mode during lectures. Audio or video recording of lectures is not permitted without the written permission of the instructor. Students violating this policy are subject to discipline under the University of Calgary's Non-Academic Misconduct policy

Emergency Evacuation:

In case of an emergency evacuation during class, students must gather at the designated assembly point nearest to the classroom. The list of assembly points is found at http://www.ucalgary.ca/emergencyplan/assemblypoints . Please check this website and note the nearest assembly point for this course.

Other Helpful Contacts

- Safewalk and Campus Security: 403-220-5333.