

PHIL 5202: Symbolic Logic II (Spring 2017, 4 units)

January 2, 2017

Instructor: Prof. Samuel C. Fletcher (scfletch@umn.edu)

Lectures: Tu/Th 9:45–11:00 in Blegen 430

Office Hours: Tu/Th 11:15–12:15 in Heller 754, and by appointment

Teaching Assistant: Dongwoo Kim (kimx4262@umn.edu)

Discussion Sections: M/W 11:15–12:05 in Humphrey 15

Office Hours: M 12:15–1:15 in Heller 775, and by appointment

Course Website: <https://ay16.moodle.umn.edu/course/view.php?id=9998>

Required Text: George S. Boolos, John P. Burgess, and Richard C. Jeffrey. *Computability and Logic*, 5th ed. New York: Cambridge University Press, 2007. Available at the campus bookstore and on reserve at Wilson library.

Other Required Materials: Please bring to every lecture and discussion section paper and either a pencil or a pen in blue or black ink.

Description and Objectives

This second course in first-order logic concerns metatheoretic results about the limitations of that system, and the profoundly influential theory of computability that made them possible. These limitations concern incompleteness (Gödel), undecidability (Church), and undefinability (Tarski), while the path to them treads through recursion theory, providing a formalization of the concept of an algorithm or effective procedure by means of various (e.g., abacus, register, Turing) abstract machines. As time permits, we will study applications in computer science (e.g., computational complexity), mathematics (e.g., theories of arithmetic), and logic (e.g., normal forms).

PHIL 5201: Symbolic Logic I, an equivalent course in first-order logic at the level of Enderton's *Mathematical Introduction to Logic*, or instructor permission is a prerequisite for this course. Discussion sections will focus on review of and practice with new concepts and methods introduced.

Grading

Basis for Evaluation

Exams (40%) There will be two open-book exams, on March 7th and May 11th, worth 15% and 25% of your grade, respectively. Although they will not be cumulative, understanding much of the material in the later parts of the course depends on mastering that of the earlier parts. The second exam, scheduled for 1:30–3:30 p.m. (as it is during the finals period), will take place in our usual classroom.

Homework (60%) There will be *thirteen* homework assignments due at the beginning of class, of which the twelve with the best scores are each worth 5% of your grade. (See the class schedule at the end of this syllabus for specific due dates.) You may discuss the homework problems with your classmates but the document you turn in should be your own. Late homeworks will be accepted up to 24 hours after they're due at your TA's office, but with a multiplier of 75% (i.e., the final score on a late homework will be 75% of the regular score). After 24 hours, late homework will not be accepted. Except at the end of semester, your homework will be returned only during your discussion section the week after the homework due date, or by appointment.

Extra Credit For each typo in the textbook, not recorded in the official or supplementary errata, that you find and report to me, you will receive 0.1% extra credit on your grade.

Understanding Your Letter Grade

How to Compute Your Letter Grade												
	90 >	B+ ≥	87	80 >	C+ ≥	77	70 >	D+ ≥	67			
A ≥	93	87 >	B ≥	83	77 >	C ≥	73	67 >	D ≥	63	F <	60
93 >	A- ≥	90	83 >	B- ≥	80	73 >	C- ≥	70	63 >	D- ≥	60	

Grades in the following ranges represent the following corresponding levels of achievement relative to the level necessary to meet course requirements:

A: Outstanding.

B: Significantly above.

C: Adequate in every respect.

D: Worthy of credit despite not fully meeting course requirements.

F: Not meeting enough course requirements to be deserving of credit.

Students taking this course “pass/fail” will receive an “S,” representing satisfactory achievement, for any standard final letter grade of “C-” or higher that he or she would have been assigned. Such students will receive an “N,” representing unsatisfactory achievement, for any standard final letter grade of “D+” or lower that he or she would have been assigned.

For additional information about University policies about grading and transcripts, please refer to: <http://policy.umn.edu/education/gradingtranscripts>.

Policies

Student Conduct Code

The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.

As a student at the University you are expected adhere to Board of Regents Policy: Student Conduct Code. To review the Student Conduct Code, please see: http://regents.umn.edu/sites/regents.umn.edu/files/policies/Student_Conduct_Code.pdf.

Note that the conduct code specifically addresses disruptive classroom conduct, which means “engaging in behavior that substantially or repeatedly interrupts either the instructor’s ability to teach or student learning. The classroom extends to any setting where a student is engaged in work toward academic credit or satisfaction of program-based requirements or related activities.”

Use of Personal Electronic Devices in the Classroom

Using personal electronic devices in the classroom setting can hinder instruction and learning, not only for the student using the device but also for other students in the class. To this end, the University establishes the right of each faculty member to determine if and how personal electronic devices are allowed to be used in the classroom. (For complete information, please reference: <http://policy.umn.edu/education/studentresp>.)

In this class, the use of laptops, tablets, and other electronic devices is permitted as long as it would not reasonably be a distraction to others. Reasonable distractions include movies and social media. Students violating this policy will be asked to put their offending device away for the rest of the class session, and may also lose participation credit for that day.

Scholastic Dishonesty

You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. (Student Conduct Code: http://regents.umn.edu/sites/regents.umn.edu/files/policies/Student_Conduct_Code.pdf) If it is determined that a student has cheated, he or she may be given an “F” or an “N” for the course, and may face additional sanctions from the University. For additional information, please see: <http://policy.umn.edu/education/instructorresp>.

The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: <http://www1.umn.edu/oscai/integrity/student/index.html>. If you have additional specific questions regarding what would constitute scholastic dishonesty in the context of this class, please ask.

Makeup Work for Legitimate Absences

Students will not be penalized for absence during the semester due to unavoidable or legitimate circumstances. Such circumstances include verified illness, participation in intercollegiate athletic events, subpoenas, jury duty, military service, bereavement, and religious observances. Such circumstances do not include voting in local, state, or national elections. For complete information, please see: <http://policy.umn.edu/education/makeupwork>.

Under such legitimate circumstances leading a student to be absent for any exam, that student must contact me at least two weeks in advance of the exam, or as soon as possible if the circumstances are known later, to schedule a make-up exam.

Appropriate Student Use of Class Notes and Course Materials

Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community. For additional information, please see: <http://policy.umn.edu/education/studentresp>.

Sexual Harassment

“Sexual harassment” means unwelcome sexual advances, requests for sexual favors, and/or other verbal or physical conduct of a sexual nature. Such conduct has the purpose or effect of unreasonably interfering with an individual’s work or academic performance or creating an intimidating, hostile, or offensive working or academic environment in any University activity or program. Such behavior is not acceptable in the University setting. For additional information, please consult the Board of Regents’ policy on the matter: <http://regents.umn.edu/sites/regents.umn.edu/files/policies/SexHarassment.pdf>.

Equity, Diversity, Equal Opportunity, and Affirmative Action

The University provides equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression. To this effect, please notify me if you have a preferred name or pronoun not indicated in your official enrollment data. For more information, please consult the Board of Regents’ policy on the matter: http://regents.umn.edu/sites/regents.umn.edu/files/policies/Equity_Diversity_EO_AA.pdf.

Disability Accommodations

The University of Minnesota is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center (DRC) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations. If you have, or think you may have, a disability (e.g., mental health, attentional, learning, chronic health, sensory, or physical), please contact the DRC at 612-626-1333 to arrange a confidential discussion regarding equitable access and reasonable accommodations. If you are registered with the DRC and have a current letter requesting reasonable accommodations, please contact me as early in the semester as possible to discuss how the accommodations will be applied in the course. For more information, please see the DRC website, <https://diversity.umn.edu/disability/>.

Mental Health and Stress Management

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University of Minnesota services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website: <http://www.mentalhealth.umn.edu>.

Academic Freedom and Responsibility

Academic freedom is a cornerstone of the University. Within the scope and content of the course as I have defined it, this includes the freedom to discuss relevant matters in the classroom. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study, but they are responsible for learning the content of any course of study for which they are enrolled. Reports of concerns about academic freedom are taken seriously, and there are individuals and offices available for help, including me, the Philosophy Department Chair Prof. Valerie Tiberius (tiberius@umn.edu), your adviser, or College of Liberal Arts Associate Dean Ana Paula Ferreira (apferrei@umn.edu).

Tentative Course Schedule

As the section title indicates, the course schedule is open to (reasonable) modification in light of the class's progress. Unless otherwise indicated, all readings are from *Computability and Logic*; you are advised to have the reading assigned for a particular day done before that day's lecture. Homework will be posted on the course Moodle site at least one week before it is due.

Date	Topic	Reading	Notes
Tu 1/17	Enumerability	Ch. 1	
Th 1/19	Diagonalization	Ch. 2	
Tu 1/24	Turing Computability I	Ch. 3	HW #1 due
Th 1/26	Turing Computability II	Ch. 3	
Tu 1/31	The Halting Problem	Ch. 4.1	
Th 2/2	Abacus Computability I	Ch. 5.1–5.2	HW #2 due
Tu 2/7	Abacus Computability II	Ch. 5.2–5.3	
Th 2/9	Recursive Functions I	Ch. 6.1	HW #3 due
Tu 2/14	Recursive Functions II	Ch. 6.2	
Th 2/16	Recursive Relations	Ch. 7.1	HW #4 due
Tu 2/21	Semirecursive Relations	Ch. 7.2	
Th 2/23	Equivalent Definitions of Computability I	Ch. 8.1	HW #5 due
Tu 2/28	Equivalent Definitions of Computability II	Ch. 8.2–8.3	
Th 3/2	Computational Complexity	Handout/TBA	HW #6 due
Tu 3/7			Exam 1
Th 3/9	Logic and Turing Machines	Ch. 11.1	
Tu 3/14			Spring Break
Th 3/16			Spring Break
Tu 3/21	Logic and Primitive Recursive Functions	Ch. 11.2	
Th 3/23	Cardinality and Equivalence of Models	Ch. 12.1–12.2	HW #7 due
Tu 3/28	Löwenheim-Skolem and Compactness Theorems	Ch. 12.3, 13.5	
Th 3/30	Arithmetization of Syntax	Ch. 15.1	HW #8 due
Tu 4/4	Gödel Numbering	Ch. 15.2–15.3	
Th 4/6	Representability of Recursive Functions I	Ch. 16.1	HW #9 due
Tu 4/11	Representability of Recursive Functions II	Ch. 16.2–16.3	
Th 4/13	Indefinability, Undecidability, Incompleteness I	Ch. 17.1–17.2	HW #10 due
Tu 4/18	Indefinability, Undecidability, Incompleteness II	Ch. 17.3	
Th 4/20	The Unprovability of Consistency	Ch. 18	HW #11 due
Tu 4/25	Normal Forms I	Ch. 19.1–19.2	
Th 4/27	Normal Forms II	Ch. 19.3–19.4	
Tu 5/2	Craig's and Robinson's Theorems	Ch. 20.1–20.2	HW #12 due
Th 5/4	Beth's Definability Theorem	Ch. 20.3	
Tu 5/9			HW #13 due
Th 5/11			Exam 2, 1:30–3:30 p.m.