

University of Waterloo
Department of Philosophy
PHIL 257: Philosophy of Mathematics
Fall 2019

Tuesdays and Thursdays 2:30-3:50 AL 105

UNOFFICIAL VERSION -- TO GET THE OFFICIAL VERSION COME TO CLASS

Territorial Acknowledgement

We acknowledge that we are living and working on the traditional territory of the Attawandaron (also known as Neutral), Anishinaabe and Haudenosaunee peoples. The University of Waterloo is situated on the Haldimand Tract, the land promised to the Six Nations that includes six miles on each side of the Grand River.

Instructor Information

Instructor: Patricia Marino
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Course Description

The philosophy of mathematics is concerned with conceptual, methodological, foundational, and practical questions about mathematics and its practice, such as:

- Do mathematical objects, such as numbers and sets, exist?
- If mathematical objects exist, how would we know about them, given that they do not seem to be encountered through experience?
- If mathematical objects do not exist, what makes mathematical statements true? Or are mathematical statements not true after all?
- Is mathematics reducible to logic? Is it just the study of what follows from what?
- What is the right logic for mathematical practice?
- Is mathematics fictional, like a made-up story?
- What should we infer about mathematical existence and truth from the role that mathematics plays in science?
- How should we understand the "unreasonable effectiveness" of mathematics in natural science?
- What is randomness?
- What is the "black swan" problem in statistical reasoning?
- How does the use of algorithms become sexist, racist, and discriminatory in other ways?
- What is ethnomathematics and what is its role in pedagogy?

This course does not endorse any particular conclusion about these matters; rather, the idea is for you to both understand what others have had to say, and to develop, possibly change, and learn how to intelligently defend, your own opinions.

You should read the texts listed for a given date before class and be ready to discuss them. I will post study questions on LEARN ahead of time for each reading and you should come to class having given some thought to these. Course announcements and information will be on the LEARN page so please check it daily. There is more information about this course on the "Further Course Information" document posted on LEARN. Be sure to read it. If you experience difficulties of any kind during the term, please come talk to me. Also, information about contacting mental health resources is included below. If you have questions about the syllabus, the course, the requirements, the assignments, or anything else to do with this course, please do not hesitate to ask!

Course Objectives

This course should help you be able to:

- appreciate the surprising range of disputed issues in mathematical practice;
- analyze and critically evaluate divergent views in mathematical foundations and practice;
- understand connections between foundational issues and mathematical practice;
- develop your own ideas concerning disputed issues in mathematical practice;
- develop your own ideas about the role mathematics plays in science and society;
- effectively communicate your ideas orally and in written work.

Readings

One book is required: Frege's *Foundations of Arithmetic*. All other readings will be posted on LEARN as pdfs you can download.

Course Requirements and Assessment

- Paper 1, due Thursday Oct 3, 20%
- In-class test, Thursday Oct 10, 25%
- Paper 2, due Thursday Nov 14, 25%
- In class test, Tuesday Dec 3, 25%
- Attendance and participation, 5%

Papers

Both papers should be 900-1200 words and topics will be handed out. For the first paper, you have the option of handing in a rewrite based on my comments. If you choose to do this your new paper grade will be an average of the original and the rewrite; your grade will not go down if the new draft is worse, but improved grades require significant changes and not just small edits. For the second paper, I will write fewer comments; if you would like more feedback, don't hesitate to ask. Paper assignments will ask you to write about your own ideas about a philosophical problem while engaging the texts and ideas we've encountered in class. The focus is on presenting an original argument. Of course, this means the ideas in your papers must be your own; we will talk more in class about how to ensure that the ideas you present as your own really are, and how to cite any outside sources you do use appropriately. If you have any questions at any time about academic honesty and what it requires, do not hesitate to ask. Just raise your hand or approach me after class. For help with writing, check out [The Writing Centre](#).

Tests

Tests will be a mix of multiple choice, short answer and short essay. Test 1 covers the first half of the course and test 2 the second half.

Attendance and Participation

Attendance is required and everyone should participate in class discussion. There are several ways to participate in this class: you can participate in class discussion, or by contributing to the discussion on LEARN, or by emailing or speaking with me personally. If you have to miss class, you are responsible for finding out what content you missed. If you come to class regularly without participating, your attendance and participation grade will be 70 percent (you may miss up to two classes for any reason with no penalty). If you participate regularly that will increase your participation grade; if you attend less frequently that will lower it. Contributing several questions and comments during each week will earn a grade at least in the 80s range. I will post attendance and participation grades on LEARN at the end of term; if you don't agree with yours please email me and we can discuss it. If for some reason coming to class is a problem for you, let me know and we can discuss.

Course Outline

Introduction

Sept 5: no reading

Kant and Frege on what numbers are

Sept 10: Selection from Gottlob Frege, *Foundations of Arithmetic*. Read pages i-xi and 1-24 (Introduction and sections 1-17).

Sept 12: Selection from Gottlob Frege, *Foundations of Arithmetic*. Read pages 46 to 91 (sections 35 to 77).

Frege's logicism, basic set theory, and the effect of Russell's paradox

Sept 17: Selection from Gottlob Frege, *Foundations of Arithmetic*. Read pages 91-119, sections 78-109.

Sept 19: Selection from Andrew Irvine, "Russell's Paradox" at the *Stanford Encyclopedia of Philosophy*. Read the section "[History of the Paradox](#)."

Classical formalism

Sept 25: David Hilbert, "On the Infinite," from Benacerraf and Putnam, *Philosophy of Mathematics, Selected Readings*, 2nd edition (Cambridge University Press, 1984) pp. 183-200, this translates the originally published 1926 article "Über das Unendliche," *Mathematische Annalen*, 95: 161-90.

Sept 27: Solomon Feferman, "The Nature and Significance of Gödel's Incompleteness Theorems," [online](#).

Classical intuitionism

Oct 1: Arend Heyting "Disputation" reprinted in Benacerraf and Putnam, *Philosophy of Mathematics, Selected Readings*, 2nd edition (Cambridge University Press, 1984).

Oct 3: Arend Heyting, "The Intuitionistic Foundations of Mathematics," reprinted in Benacerraf and Putnam, *Philosophy of Mathematics, Selected Readings*, 2nd edition (Cambridge University Press, 1984). **First paper due.**

The essential problem of mathematical truth and existence

Oct 8: Paul Benacerraf, "Mathematical Truth," *The Journal of Philosophy*, 70 (1973), 661 - 679.

Oct 10

FIRST IN-CLASS TEST

Oct 14-18 reading week

Naturalism and the indispensability of mathematics in science

Oct 22: Penelope Maddy, "Indispensability and Practice," *The Journal of Philosophy*, 89 (1992), 275–289.

Oct 24: Mary Leng, "What's Wrong with Indispensability?" *Synthese* 131, no. 3 (2002): 395-417.

Fictionalism

Nov 13: Stephen Yablo, "The Myth of the Seven," *Fictionalism in Metaphysics* (Oxford University Press, 2005).

Nov 15: John Burgess, "Mathematics and Bleak House," *Philosophia Mathematica*, 12 (2004), 18-36.

The "unrealistic effectiveness" of mathematics in science

Nov 5: Eugene Wigner, "The Unreasonable Effectiveness of Mathematics in the Natural Sciences," Richard Courant Lecture in Mathematical Sciences delivered at New York University, May 11, 1959, *Communications on Pure and Applied Mathematics* 8 (1960).

Nov 7: Arezoo Islami, "A Match Not Made in Heaven: on the Applicability of Mathematics in Physics." *Synthese* 194, no. 12 (2017): 4839-4861.

Randomness and statistics

Nov 12 Bennett, Deborah. "Defining Randomness." In *Philosophy of Statistics*, pp. 633-639. North-Holland, 2011.

Nov 14 Nassim Taleb, "[The Fourth Quadrant: A Map of the Limits of Statistics](#)," *The Edge*, Sept 14, 2008, Aaron Brown (2007) "Strong Language on Black Swans," *The American Statistician*, 61:3, 195-197, Peter H Westfall & Joseph M Hilbe (2007) "The Black Swan," *The American Statistician*, 61:3, 193-194, Nassim Nicholas Taleb (2007) "Black Swans and the Domains of Statistics," *The American Statistician*, 61:3, 198-200.

Algorithms and discrimination

Nov 19: Selection from Cathy O'Neil, *Weapons of Math Destruction* (Crown Press, 2016). Read also Introduction and section 1 (pages 1 to 8) of the Kleinberg, Ludwig, Mullainathan and Sunstein paper listed below.

Nov 21: Jon Kleinberg, Jens Ludwig, Sendhil Mullainathan, and Cass R. Sunstein, "Discrimination in the Age of Algorithms." *Journal of Legal Analysis* 10 (2018).

Indigeneity, pedagogy, and ethnomathematics

Nov 26: TBA

Nov 28: TBA

Dec 3

second in-class test

Late work

Please submit your papers to LEARN before the deadline on the day they are due. Obviously, you should hand in your papers on time, but if you must be late, I will subtract three percentage points from your paper grade per day of lateness. If you experience unexpected difficulties like illness or personal difficulties, please let me know; if you expect to miss a deadline or test, please let me know by email as soon as possible and preferably beforehand.

Information on Plagiarism Detection

No formal or technological plagiarism detection mechanisms will be used in this class.

Electronic Device Policy

Laptops or mobile devices can support your learning in this class, but they can also be a source of distraction for you and other students around you. Please turn off all sound notifications before you enter the classroom. You are welcome to use your devices for course-related activities such as taking notes, researching lecture topics, collaborating on group projects, viewing documents in LEARN, and communicating with other students about the course material. You are not permitted to use these devices for any non-course-related activities. Students who wish to use laptops or mobile devices are asked to sit in the laptop-designated area of the class. During activities that do not require these devices, such as group discussions, you may be asked to close or put them away. Please ask the instructor if you wish to make an audio recording of class lecture material. If you have concerns or comments about how the use of laptops or mobile devices is affecting your learning during the course, please make an appointment to talk with the instructor.

Attendance Policy

Attendance is required. See "Attendance and participation" section above.

Cross-listed course (requirement for all Arts courses)

Please note that a cross-listed course will count in all respective averages no matter under which rubric it has been taken. For example, a PHIL/PSCI cross-list will count in a Philosophy major average, even if the course was taken under the Political Science rubric.

Academic Integrity

In order to maintain a culture of academic integrity, members of the University of Waterloo are expected to promote honesty, trust, fairness, respect and responsibility. Check the [Office of Academic Integrity website](#) for more information.

Discipline

A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. [Check [the Office of Academic Integrity](#) for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to [Policy 71, Student Discipline](#). For typical penalties, check [Guidelines for the Assessment of Penalties](#).

Grievance

A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read [Policy 70, Student Petitions and Grievances, Section 4](#). When in doubt, please be certain to contact the department’s administrative assistant who will provide further assistance.

Appeals

A decision made or penalty imposed under [Policy 70, Student Petitions and Grievances](#) (other than a petition) or [Policy 71, Student Discipline](#) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to [Policy 72, Student Appeals](#).

Accommodation for Students with Disabilities

Note for students with disabilities: [AccessAbility Services](#), located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with [AccessAbility Services](#) at the beginning of each academic term.

If you are using Turnitin® in your course

Turnitin.com and alternatives: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students’ submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit the alternate assignment.

Mental Health Support

All of us need a support system. The faculty and staff in Arts encourage students to seek out mental health support if they are needed.

On Campus

- Counselling Services: counselling.services@uwaterloo.ca / 519-888-4567 ext. 32655
- [MATES](#): one-to-one peer support program offered by Federation of Students (FEDS) and Counselling Services
- Health Services Emergency service: located across the creek from Student Life Centre

Off campus, 24/7

- [Good2Talk](#): Free confidential help line for post-secondary students. Phone: 1-866-925-5454
- Grand River Hospital: Emergency care for mental health crisis. Phone: 519-749-4300 ext. 6880
- [Here 24/7](#): Mental Health and Crisis Service Team. Phone: 1-844-437-3247
- [OK2BME](#): set of support services for lesbian, gay, bisexual, transgender or questioning teens in Waterloo. Phone: 519-884-0000 extension 213

Full details can be found online on the Faculty of Arts [website](#)

Download [UWaterloo and regional mental health resources \(PDF\)](#)

Download the [WatSafe app](#) to your phone to quickly access mental health support information

Academic freedom at the University of Waterloo

[Policy 33, Ethical Behaviour](#) states, as one of its general principles (Section 1), “The University supports academic freedom for all members of the University community. Academic freedom carries with it the duty to use that freedom in a manner consistent with the scholarly obligation to base teaching and research on an honest and ethical quest for knowledge. In the context of this policy, 'academic freedom' refers to academic activities, including teaching and scholarship, as is articulated in the principles set out in the Memorandum of Agreement between the FAUW and the University of Waterloo, 1998 (Article 6). The academic environment which fosters free debate may from time to time include the presentation or discussion of unpopular opinions or controversial material. Such material shall be dealt with as openly, respectfully and sensitively as possible.” This definition is repeated in Policies 70 and 71, and in the Memorandum of Agreement, Section 6.