Syllabus
History of Mathematics. Math 3010. Fall 2021

Andrej Cherkaev

Preamble

Course Number and Title: M 3010 History of Mathematics
Semester and Year: Fall 2021
Dates and time: Mo We Fr 11:50 am-12:40 pm.
Location: LCB 225
Final exam: Tuesday, December 14, 2021
Instructor: Andrej Cherkaev
Email: cherk@math.utah.edu
Office hour: JWB 225. Monday 2-3 pm and by appointment

Text: Victor J. Katz. A History of Mathematics (3rd Edition) Pearson 2009.

Description

The theme From the beginning of recorded history, mathematics has been a hallmark of every society. Its complexity reflects a civilization's ability to handle logic, quantities, shapes, processes, arrangements, etc. Today, mathematics is all around us in computers, engineering, architecture, medicine, transportation, art, money, and even sports. The course offers a journey through the four millennia of mathematical research. We track the history of algebra, geometry, discrete mathematics, calculus, statistics. We look at ancient societies' contributions and recent developments observing the graduate rise of sophistication and level of abstraction of concepts; learn about great mathematicians and their ideas. We review some central problems of the times and practice their solutions.

The expected learning outcomes At the end of the course, the students should understand the tendencies and reasons for the development of mathematics, the methods of ancient mathematicians, and the ideas behind modern mathematical branches. The students should learn the landmark problems that lead to breakthroughs in mathematical practices; learn about the works of great mathematicians in the past and present. Finally, students should polish their skills in writing essays.

The course M3010 satisfies the General Education requirements; it addresses the following Essential Learning Outcomes: Critical Thinking, Written Communication, Foundations and Skills for Lifelong Learning.

Course Design The course consists of lectures, discussions, homework, essay writing, peer reviews, and consultations with the instructor.

I expect that the students will read the assigned material before class and be ready for the discussion. A part of the grade assesses the in-class activity (questions and discussion).

Assignments, Assessment, and Grading The homework will be assigned every week or two. The midterm and final essays serve as midterm and final exams.

The grade is based on:
- Homework problems - 40%.
- Participation in class discussions and presentation - 10%.
- Peer reviewer - 10%
- Midterm Essay on Math before 19th century - 20%
- Final Essay on development of a mathematical concept - 20%.

Policies

COVID-19 Considerations: Students must self-report if they test positive for COVID-19 via coronavirus.utah.edu.

Checking grades Please check the accuracy of the homework, online assignments, and exam grades. Keep a record of all your graded assignments. If you see any error in Canvas's grades, reach out to the instructor quickly.

Late Assignments and Regrading I will be flexible where possible/appropriate. Please remember, however, that grading late assignments is a pain. You may ask for regrading provided you have a good reason.

Incompletes According to university policy, to be considered Incomplete, a student must have 20% or less of the course work remaining and be passing the course with a C or better. You must request an incomplete grade, and I will consider giving that grade under exceptional circumstances.

Content Accommodations Consistent with principles of academic freedom, the faculty, individually and collectively, has the responsibility for determining the content of the curriculum. Students are expected to take courses that will challenge them intellectually and personally. Students must understand and articulate the ideas and theories that are important to the discourse within and among academic disciplines. A personal disagreement with these ideas and theories or their implications is not sufficient grounds for requesting the accommodation (see
https://regulations.utah.edu/academics/6-100.php).

Plagiarism Plagiarism is unacceptable and results in **F** - grade. I use plagiarism detection service.

Syllabus topics

Anchient Mathematics Prehistory: math is originated in the cradles of civilization: Sumer-Babylon, Egypt, The Indus Valley, China, England, etc. Almost all available documents come from Babylon and Egypt.

Bronze Age: Sumer-Babylon, and Egypt: Base 60, multiplication and division, a geometrical solution of quadratic equations. Approximation of Pi, Pythagorean triples, the iterative algorithms for square roots, binary system, Egyptian fractions.

Greek Math: Pythagoras and this society, Archimedes and beginning of calculus, Euclid - geometry and number theory, Ptolemy - a model of the Solar system.

Chinese, Indian, and Islam math: the story of zero, trigonometry, algorithms, etc

Europe in the 16th century: Discovery (Napier) of logarithms. Solution of the cubic equations and introduction of complex numbers (Tartaglia, Cardano, Bombelli). Works of Copernicus, Galileo, Kepler.

Modern Mathematics The 17th-century mathematics: Works of Newton, Leibnitz, Fermat, Pascal, Descartes, Huygens: Calculus, functions, coordinates, differential equations, probability

The 18th-century mathematics Bernoulli family, Euler, Lagrange, Calculus of variations, series, algebraic notations, modeling of nature, topology. complex-valued functions

History after 1800

Analysis, Fourier series, stability, complex analysis, divergent series.

Algebra: Solvability of equations, group theory. Boolean logic.

Differential equations, vectors, and matrices.

Formalization of gravity, heat transfer, elasticity, electromagnetism, fluid dynamics.

Non-Euclidean geometry, curved spaces, differential geometry.

Probability.

Generalization of functions, set theory, paradoxes

Faces and dramas behind theorems: Lagrange, Laplace, Sophie Germain, Fourier, Cauchy, Abel, Galois, Gauss, Lobachevsky, Riemann, Weierstrass, Chebyshev, Agrand, Hamilton, Moebius, Maxwell, Cayley, Sylvester, Heaviside, Kelvin

Women in modern mathematics Maria Agnesi, Sophie Germain, Sofya Kovalevskaya, Emmy Noether, Olga Ladyzhenskaya, Maryam Mirzakhani, Karen Uhlenbeck, and others.

Glance into contemporary mathematics (20-21 centuries) Possible topics:

Foundations: Cantor - Continuum hypothesis, Goedel theorem.

Analysis: Hilbert space, distributions, measures, and integration.

Geometry: Fractals, Penrose tiling, graphs. Computer-aided proofs.

Representation theory. Algebraic geometry. Number theory.

Diff. Equations: Nonlinear phenomena, bifurcations, and blow-up solutions, etc.

Probability and Statistics. Aggregation: chaos and homogenization.

Math modeling. Optimization, game theory, engineering math, financial math. Transport problem, metamaterials.

Big Data. Numerics, machine learning, and computer-aided proofs.

What's next?

Table 1: 3010. Preliminary schedule - Fall 2021

No	Date	Subject	Text
		Antique Mathematics	
1	Aug 23 - 27	Introduction. Structure and roots of modern math. Prehistoric math, Numeral system	Notes
2	Aug 30 - Sept 3	Mathematics in Bronze Age: 2nd millennium BCE. Mesopotamia, Egypt	Ch. 1
3	Sept 8 - 10	Early Greek math/ Thales, Pyphagores, Euclid.	Ch 2-3
4	Sept 13 - 17	Math in China, India, Mediavistic Muslim world and Europe	Review Ch 7-11
		Origins of Modern math. 16-18th centuries	
6	Sept 27 - Oct 1	Arabic-Hindu notations. Cubic equation and complex numbers. Logarithms.	Ch.12-13
7	Oct 4 - 7	Works of Fermat, Pascal, Descartes: Number theory, Probability, Analytic geometry	Ch. 14
8	Oct 11 - 14	Newton and Leibniz: Function, Calculus and Differential Equations, first computer	Ch. 16
9	Oct 18 - 21	Bernoulli, Euler: Calculus of Variations, Series, Beginning of Topology	Ch. 17
		Some branches of modern math. 19th century	
10	Oct 25 - 28	Complex Analysis, Differential equations in mechanics and physics, Functional spaces	Ch. 18
11	Nov 1 - 5	Algebra: vectors, matrices, Boolean logic, number theory	Ch. 22
12	Nov 8 - 12	Differential and non-Euclidean geometry	Ch. 24
		20th-21st century	
13	Nov 15 - 19	Continuum hypothesis, Goedel theorem. Fermat theorem, Penrose tiling, Kepler?s conjecture,	Ch. 25,
14	Nov 22, 24	Limits: Hilbert space, Distributions, Measures in PDEs, Fractals, Chaos, Homogenization.	Ch. 25
15	Nov 29, Dec 3	Math modeling. Optimization, Game theory, Transport problem, Metamaterials.	Internet
16	Dec 5, 8	Probability and Statistics. Big Data. Numerics, Machine learning and computer-aided proofs.	Internet

The schedule may be changed This syllabus is meant to serve as an outline and guide for our course. I may modify the plan to respond to the needs of our class.

Essays: Important dates
October 18. Submit the project of the midterm essay for approval.
October 25. Submit the draft of the essay for peer review.
November 1. Submit the peer reviews
November 8. Submit the midterm essay

November 15. Submit the project of the final essay for approval.
November 22. Submit the draft of the essay for peer review.
November 29. Submit the peer reviews
December 8. Submit the final essay