Math E-320:
Teaching Mathematics with a Historical Perspective
Oliver Knill,   Harvard Extension School, Spring 2012

Key information:

- **URL:** http://www.math.harvard.edu/~knill/teaching/mathe320_2012/index.html

- **Class:** Monday, 4:30-6:30 PM, 1 Story Street, Room 303

- **Distance learning:** The lectures will be available online for distance learners.

- **First Class:** Monday, January 23, 2012

- **Instructor:** Oliver Knill, 432 Science Center, knill@math.harvard.edu

- **Office hours:** Before and after the lecture and by appointment.

- **Text:** The Britannica Guide to The History of Mathematics, Edited by Erik Gregersen, 2011

Abstract:

The difficulty of both learning and teaching mathematics is evident in its history. The struggle of early research mathematicians who developed and formalized a topic parallels the struggle of students and teachers in the modern classroom. Students learning about the concept of limits and series undergo a similar process as the pioneers of a subject did when they developed the subject. This struggle goes on today, as new flavors of calculus are developed and studied. Each week, this course considers a different mathematical subject and pinpoints a moment when something interesting happened. This moment or moments is condensed into specific and concrete mathematical problems.

Prerequisites:

While we try to keep the presentation on a level accessible to a more general public, a good pre-calculus background is of advantage, an open mind is even more important. We believe that also interesting mathematics can be presented on a high school level.

Methodology:

We use the "case method" methodology and cover in every lecture a different part of mathematics. The range of mathematical topics will therefore be rather broad. The main goal is to stimulate interest in some topic rather than cover a lot of ground. After a general overview of Mathematics in the first lecture, we will work each week with a specific branch of mathematics and see its development in a historical context. The **case method** is diametrically opposed to an **encyclopedic approach**. The advantage of the method is that one can get more involved if a concrete example is used. As a balance, the class reads a text which is a bit more encyclopedic. A specific story is more engaging and each "case" can serve as a crystallization point for an entire subject. In a time when knowledge explodes fast and a plethora of possibilities are offered online, teaching requires both to be broad as well as care for details. The dilemma of combining these two can be achieved with a "short story approach" and also by mixing different teaching elements (presentation, discussion and work on problems). The case method is well established and was used especially at the Harvard business school, where "discussions focused on real-world situations" is considered a good way to prepare students. In our case, the "real word situations" are "historical highlights". Participants can adapt such models for their own teaching. Besides the material, the pedagogy will play an important role. While all of the lectures could be adapted to lectures for to high school students, we will discuss also pedagogical issues and think about it. We will notice a general principle: difficulties for the pioneers developing a topic, reverberate today in the classroom when students are taught the subject.

Text:

We have used different books in the past for this course but since the lectures are independent from any text, we keep the reading light. This year, we use "The Britannica Guide to the History of Mathematics", ISBN-13: 978-1615301270, which is affordable, is available also in ebook form, summarizes major developments quite well on 300 pages and can be read in reasonable time. Today, the web is a great source to get more information on particular topics so that our text book choice will suffice. Of course, other book sources will be mentioned. We live in a great time, where many wonderful books are available.
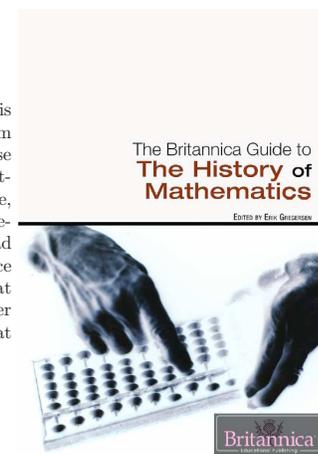
Grades:

The course grade is based on three parts:
1. Quizzes after each lecture 40 percent
2. A final project with details to be announced. 40 percent
3. General participation in discussion 20 percent

Day to Day Syllabus:

The lecture sequence has worked very well in the past. We use part of the lecture to get an overview over the topic in a lecture using slides and multimedia. Due to the distance learning option, we structure the worksheets now more into the lecture. Additionally, we work on a particular problem. We always end the lecture with a short quiz. This quiz is always very closely related to the lecture. If you have seen the lecture, the quiz should not be a problem. You can use all notes from the lecture while taking the quiz. Keep notes therefore during the presentation part. For distance learners, the quiz has to be completed until the next day.

Lecture	Topic	Presentation
January 23, 2012	Mathematics	What is mathematics?
January 30, 2012	Arithmetics	Representing Numbers
February 6, 2012	Geometry	Shapes and Symmetries
February 13, 2012	Number theory	Primes and Diophantine Equations
February 20, 2012	Presidents day	No class
February 27, 2012	Algebra	Symmetries and Games
March 5, 2012	Calculus	Summation and Differences
March 11 -March 18	Spring break	
March 19 , 2012	Set theory	Sets, Infinities, Incompleteness
March 26, 2012	Probability	Chance and Processes
April 2, 2012	Topology	Polyhedra and Invariants
April 9, 2012	Analysis	Fractals and Dimension
April 16, 2012	Cryptology	Codes and Cyphers
April 23, 2012	Dynamics	Chaos and Predictability
April 30, 2012	Computer science	Artificial Intelligence
May 11, 2012	Project due	

Special dates:

Feb 20:	Presidents day
May 7-11:	Exam period
Mar 11-Mar 18:	Spring break