Math E-320:
Teaching Mathematics with a Historical Perspective
Oliver Knill,   Harvard Extension School, Spring 2010

Key information:

- **URL:** http://my.harvard.edu/icb/icb.do?keyword=k65496

- **Class:** Monday, 4:30-6-30 PM, SC 216

- **First Class:** Monday, Jan. 25, 2010

- **Instructor:** Oliver Knill, 434 Science Center, knill@math.harvard.edu

- **Office hours:** By appointment

- **Text:** Howard Eves: Great Moments in Mathematics, Volume I and II, AMS, 1983

Abstract:

The difficulty of both learning and teaching math 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 challenge to do new mathematics 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 is condensed into one or a few specific and concrete mathematical problems.

Prerequisites:

How much mathematics is needed for this course? While we try to keep our presentation on a level accessible to a more general public, a good pre-calculus background is required to appreciate the lectures. We believe that even interesting mathematics can be presented on a high school level. For participants interested in more background, we will make background resources available.

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. 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. A specific story is more engaging. 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 on-line, teaching requires both to be broad as well as some care for details. The dilemma of combining these two extremes can be achieved with a "short story approach". It is well established and was used especially at the Harvard business school, where "discussions focused on real-world situations" was 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, **pedagogy** will play an important role. While all of the

lectures could be adapted to lectures for high school students, we will discuss also pedagogy and think about it.

Text:

To get an other perspective beside the lectures, we will do some reading. We can not cover the entire book but select some of the stories.

Howard Eves: Great Moments in Mathematics, Before 1650, AMS, 1983
Howard Eves: Great Moments in Mathematics, After 1650, AMS, 1983

We chose the book not only because of its content, but because it follows the same "case method" principle. The two books feature 39 lectures, which can be read independently.

Day to Day Syllabus:

Here is the plan for each lecture: The topics of the presentation can still change but the topics are fixed.

Lecture	Topic	Presentation
Jan 25	Mathematics	Overview over all mathematical areas
Feb 1	Arithmetics	From the origin of numbers to new number systems
Feb 8	Geometry	From planimetry to differential geometry
Feb 22	Number theory	From Diophantine equations to complex analysis
Mar 1	Algebra	From group theory to algebras
Mar 8	Calculus	From infinitesimals to quantum mechanics
Mar 22	Set theory	From paradoxes to undecidability
Mar 29	Probability	From combinatorics to stochastic processes
Apr 5	Topology	From curves and surfaces to invariants
Apr 12	Analysis	From calculus of variations to fractals
Apr 19	Cryptology	From codes to cryptography
Apr 26	Dynamics	From astronomy to differential equations
Mai 3	Computer science	From algorithms to artificial intelligence

Special dates:

Feb 15: Presidents day , May 10-14: Exam period, Mar 14-Mar 21: Spring break