Math 108: History of Mathematics Syllabus Fall 2013

Prof. J. Grabiner
Office phone: 73160; Secretary: 621-8218;
email jgrabiner@pitzer.edu (I may well email you sometime – read your email!)
Office Fletcher 224 (stairs to 2d floor Fletcher are in Scott or Avery)
Office hours (tentative): Monday 12 – 1:10, Thursday 2-4, & by appointment

Prerequisite: At least one year of university-level calculus (yes, you really do need this background)

What's on this syllabus?

The Four Required Books

1. Victor J. Katz, A History of Mathematics: Brief Edition (Pearson/Addison-Wesley), 2004.
   A "brief" – 528 pages! – revision and updating of Katz's longer book. This "brief" edition makes a better course textbook than the longer version, A History of Mathematics: An Introduction, whose 3d edition was published by Addison-Wesley in 2009.
   The longer version, though, is the best one-volume history in existence – you can buy the longer version for yourself and use it if you prefer since the problems and questions are the same.
   Either edition is very much worth keeping permanently.

   Note especially in the required text:
   the **pronunciation guide** in the index at the end of Katz's book; this is empowering.
   the g**eneral bibliography** on p. 542
   what I call the "**Guide to Decent Websites**" on p. 543. Add the website "Convergence" (http://mathdl.maa.org/mathDL/46/), [The Mathematical Association of America's online magazine on the history of mathematics and its uses in the classroom.]
   the **historical timeline** pp. 529-35 linking the history of mathematics to general history
   the material on pages 521-528 with **suggestions on using history of mathematics in the teaching of mathematics**.

2. Plato, Meno (Bobbs-Merrill pb but any edition will do)

3. René Descartes, Discourse on Method (Bobbs-Merrill pb or any other edition)

4. Jacques Hadamard, Psychology of Invention in the Mathematical Field (Dover pb)

Lectures will focus on specific topics, and will reflect the instructor's view of what is most important; Katz will provide an excellent overview of each topic and a wealth of examples.

There will be discussions on the books numbered 2, 3, and 4. Of course questions in lecture are welcome, as consistent with the size of the class.

Written assignments:

"Intelligent Sentences" Assignment: Read the week's reading **before** each Monday's class. Hand in two intelligent sentences on the reading for the coming week, covering **different parts of the reading**.
These will be handed in at the START of class, peer-graded during the last 5 minutes of class, **then collected by the instructor**. I'll briefly review them and hand them back on the following Wednesday.
Sample good sentences and not-so-good ones (two of each, you should be able to tell which is which)::

1. Leibniz, inventor of the calculus, lived in Germany.
2. Leibniz's major contribution to calculus was really his mathematically suggestive notation, since conceptually Newton's calculus would have been good enough.
3. Euclid was an important predecessor of Archimedes, who drew on the work of Euclid who lived earlier.
4. Although both Euclid and Archimedes gave logical proofs in geometry, Archimedes was willing to use less rigorous methods to discover the non-obvious results he later proved.

Random peer grading: Assign each "sentence" a letter grade, and write a brief comment explaining your grading. Samples:

1. A grade. You've explained clearly how proof and problem-solving interact in the work of Archimedes.
2. B grade. Deals with substantive issues but not clearly enough worded – not clear what you mean by "the way Archimedes approaches mathematics"?
2. C grade. These are just individual facts that one could look up.
3. D grade. You don't address the actual reading, but just rephrase the title of the first section of the chapter.
3. F This is a blank piece of paper.

These "sentences" will constitute **15% of your course grade**, and doing them will help you be an intelligent discussant and lecture listener. Try to enlighten your peer grader.
NOTE: **This is a pass/fail assignment; peer grades are for your information**.

Problems and Essays: Each week, due at the start of class on **Wednesday** (except the first week), **50% of the course grade.** For both (a) and (b), GIVE THE PAGE AND QUESTION NUMBER!

(a) Every **Wednesday** at the start of class (except for the first week and the 13th and 15th weeks), hand in:

> the solution of **three problems** from the current week's reading from Katz (your choice; it's most valuable if you pick the hardest ones you can reasonably do; *Do not "share" this assignment with another student; work on your own*): **2/3 of this** component (1/3 of course grade). Grader graded.

(b) **Every other** Wednesday (last name A-M the even-numbered weeks, last name N-Z the odd-numbered weeks), at the start of class:

> your answer to **one** of the **discussion questions** in the **previous two weeks' reading** from Katz (again, your choice; pick something that interests you. *Do not "share" this assignment with another student; work on your own*). "Discussion questions" are at the end of the problems; it should be clear which is which. **One to two double-spaced pages** usually is appropriate. **1/3 of this component** (1/6 of course grade). **These questions are like what you'll find on the final examination. Graded by the professor.**

You must type (b). As for (a), if you don't know how to use TeX, at least make (a) as legible as possible.
The grader will hand your problem back ungraded if it is too hard to read.

(ii) Women in Mathematics brief assignment. This will happen on Monday, December 2.
Guidelines will be handed out.

(iii) Final Examination
The final will combine short answers and essays. There will be some choice. Study questions will be provided ahead of time.

Grade algorithm: Problems & essays 50%, Women in Math 5%, Intelligent Sentences 15%, Final 30%.

Tentative Calendar:

Dates Topic and Assignments (My "Recommended" books are for your personal further education)

Week I (9/4): **Introduction to the course.**
READ THE SYLLABUS (it's a contract between us), look at pp. 521-543 of Katz.

Week 2 (9/9 and 9/11):
Mathematics in ancient Egypt
Read Katz, 1 – 9,
Babylonian mathematics
Katz, 10 – 25, 29 - 36
Recommended: H. Frankfort, Before Philosophy; O Neugebauer, Exact Sciences in Antiquity
M. Ascher, Ethnomathematics;; A. Aaboe, Episodes from Early Mathematics.
Super-highly Recommended: Victor J. Katz, ed., The Mathematics of Egypt, Mesopotamia, China, India, and Islam: A Sourcebook (Princeton, 2007), Chapter I, Annette Imhausen, "Egyptian Mathematics," Chapter II, Eleanor Robson, "Mesopotamian Mathematics.".

Week 3(9/16 and 9/18)**:**
Early Greek mathematics from Pythagoras to Euclid; Greek mathematics and philosophy; Introduction to Euclid
Plato, Meno (all) for Monday. Monday's class will be a discussion
Katz, 36-62.
Recommended: David Fowler, The Mathematics of Plato's Academy, Wilbur Knorr, The Evolution of the Euclidean Elements. The Elements of Euclid are on line and well worth looking at (try his proof of the Pythagorean Theorem, Book I, Proposition 47). Full table of contents of this is at
http://aleph0.clarku.edu/~djoyce/java/elements/toc.html

Week 4(9/23 and 9/25) **More on Euclid; Archimedes**
Review Katz, 36 – 62. Katz, 67 - 75
Recommended: Same books as last week, and also T. L. Heath, ed., The Works of Archimedes; E. J. Dijksterhuis, Archimedes (2d ed. is better because it has an updated bibliography); Reviel Netz & William Noel, The Archimedes Codex

Week 5(9/30 and 10/2): **Apollonius, Ptolemy, Hellenistic Mathematics, Greek Astronomy, Diophantus, Pappus, and Hypatia**
Katz, 67-99, 104 – 113.
Recommended: Thomas S. Kuhn, The Copernican Revolution; T. L. Heath, ed., Diophantus of Alexandria, Michael Deakin, Hypatia of Alexandria: Mathematician and Martyr, **:** Jacob Klein, Greek Mathematical Thought and the Origin of Algebra. Glen van Brummelen, The Mathematics of the Heavens and the Earth: The Early History of Trigonometry.

Week 6(10/7 and 10/9): **China and India**
Katz, 116 – 134, 138 – 156.
Recommended: George Gheverghese Joseph, The Crest of the Peacock: NonEuropean Roots of Mathematics; Frank J. Swetz and T. Kao, Was Pythagoras Chinese? Right Triangle Theory in China; Kim Pfloker, Mathematics in India, Jean-Claude Martzloff, A History of Chinese Mathematics.
Very highly recommended: Victor J. Katz, ed., The Mathematics of Egypt, Mesopotamia, China, India, and Islam: A Sourcebook, Chapter III, Joseph Dauben, "Chinese Mathematics," Chapter IV, Kim Pfloker, "Mathematics in India."

Week 7 (10/14 and 10/16) **Mathematics in the Islamic World**
Monday: Katz, 161-188. (Recommended reading on next page)

Recommended: J. L. Berggren, Episodes in the Mathematics of Medieval Islam, N. L. Rabinovitz, Probability and Statistical Inference in Ancient and Medieval Jewish Literature, Victor J. Katz, ed., The Mathematics of Egypt, Mesopotamia, China, India, and Islam: A Sourcebook, Chapter 5, Mathematics in Medieval Islam. Van Brummelen, The Mathematics of the Heavens and the Earth: The Early History of Trigonometry.

Mathematics in the Latin Middle Ages

Wednesday: Katz, 192 – 210.

Recommended: M. Mahoney, "Mathematics," and J. Murdoch and Edith Sylla, "The Science of Motion," in D. Lindberg, ed., Science in the Middle Ages. Edward Grant, ed., A Source Book in Medieval Science.

Week 8 (10/21 is fall break)

The Renaissance

Wednesday, 10/23: Katz, 213-242; 242-251.

Recommended: O. Ore, Cardan: The Gambling Scholar; J. Klein, Greek Mathematical Thought and the Origin of Algebra; Judith Grabiner, "Mathematics," in P. F. Grendler, ed.,Encyclopedia of the Renaissance (6 vols., 1999), vol. 4, 66-72.

Week 9 (10/28 and 10/30)

Mathematics in the Scientific Revolution; **Analytic Geometry: Fermat and Descartes**

Monday: Katz 242-251; Wednesday, Katz 257-278.

Recommended: A. Rupert Hall, The Scientific Revolution. I. Bernard Cohen, The Newtonian Revolution.. M. Mahoney, The Mathematical Career of Pierre de Fermat. Carl Boyer, History of Analytic Geometry

Week 10 (11/4 and 11/6) Descartes' philosophy and **17th-century mathematics before the calculus**

Read Descartes, Discourse on Method, all, for class discussion on Monday November 4

Katz, 282-303.

Recommended: I. Hacking, The Emergence of Probability; Edith Sylla, ed., The *Ars Conjectandi* of Jacob Bernoulli, Carl Boyer, History of the Calculus (covers antiquity-19th c.), Margaret Baron, Origins of the Infinitesimal Calculus (focuses on 17th century), Robin Wilson and John Watkins, eds., Combinatorics: Ancient and Modern (just published, September 2013

Week 11(11/11 and 11/13): **Newton and Leibniz invent the Calculus; 18th-century analysis**

Katz, 303 - 323; 329 – 359.

Recommended: Boyer and Baron from Week 10. D. J. Struik, A Source Book in Mathematics, excerpts from Leibniz's papers on calculus; D. T. Whiteside, ed., The Mathematical Works of Isaac Newton, vol. I, contains Newton's published work on calculus

A. R. Hall, Philosophers at War: The Newton-Leibniz Controversy

T. L. Hankins, Science and the Enlightenment; William Dunham, The Calculus Gallery: Masterpieces from Newton to Lebesgue; William Dunham, Euler: The Master of Us All

Week 12(11/18 and 11/20): **More on 18th-century analysis; Rigorization of the calculus.**

Review Katz, 329 – 359. Read Katz, 430-459. Read the handouts: translations from Cauchy.

Recommended: Books from Week 11. J. V. Grabiner, The Origins of Cauchy's Rigorous Calculus (Dover, 2005). *Cauchy's Cours d'analyse*, translated Rob Bradley and Ed Sandifer (Springer, 2009).

Week 13(11/25): **Mathematical creation**

For class discussion on Monday: Read Jacques Hadamard, Psychology of Invention in the Mathematical Field

Class will not meet on Wednesday Nov. 27. Use the time to prepare for Dec. 2 discussion.

Week 14(12/2 and 12/4): **Women in Mathematics: Class discussion on Dec. 2.**

Handout and **brief** written assignment, 5% of your total grade; more details forthcoming. Your instructor was on the committee of the Mathematical Association of America which published a "Women in Mathematics" poster and readings, from which part of the assignment will be taken. It's in the hall upstairs in Fletcher, between Fletcher & Scott.

Recommended: J.Alexanderson & D. Albers, Mathematical People; More Mathematical People;
Claudia Henrion, Women in Mathematics (her bibliography is especially worth consulting);
C. C. Gillispie, ed., Dictionary of Scientific Biography, 16 vols., **the** place to start for reliable biographies of any deceased scientific figure;
Ann H. Koblitz, Sofia Kovalevskaya: Scientist, Writer, Revolutionary; Constance Reid, Julia Robinson.
Biographies of women mathematicians: http://www.agnesscott.edu/Lriddle/women/women.html

Wednesday **Topics in 18th- and 19th-century mathematics**

Choose **one** of these chapters in Katz's book:

13: Probability & Statistics in the 18th century
14: Algebra and Number Theory in the 18th century
15:Geometry in the 18th century
Recommended: Jacqueline Stedall, From Cardano to Lagrange. Also see Katz's suggestions in each chapter.

Week 15 (12/9 and 12/11):

Monday: Choose one of these chapters in Katz's book:

16: 19th-century Algebra
17: 19th-century Statistics
18: 19th-century Geometry
Recommended: Theodore Porter, The Rise of Statistical Thinking; Jeremy Gray, Ideas of Space: Euclidean, NonEuclidean, and Relativistic. Also, see Katz's suggestions in each chapter.

Wednesday: **20th-century mathematics and some philosophical questions**

Skim Katz, chapter 20.
Recommended: T. Hawkins, Lebesgue's Theory of Integration; Joseph Dauben, Georg Cantor, J. L. Richards, Mathematical Visions: Non-Euclidean Geometry in Britain; G. Moore, Zermelo's Axiom of Choice; Constance Reid, Hilbert, Sylvia Nasar, A Beautiful Mind (life of John Nash); John Dawson, Logical Dilemmas: The Life and Work of Kurt Gödel; J. R. Newman and E. Nagel, Gödel's Proof

Final Examination: Thursday, December 19, 2 PM

Late work (without compelling reason) docked 10% per CALENDAR day.

Policies on electronics:

1. I identify with those who prefer to take class notes using a computer, and will begin the semester by allowing you to do this. But please do not text, email, or use the Web during class, and make sure you turn off the sound on your computer (and cell phone, Skype, and other devices and software).

2. Papers need to be handed in on paper. I can't print out 47 separate assignments each week, or give you any kind of feedback without a pencil and paper.

Student Learning Objectives:

Students who have completed this course successfully should be able to do these things:

Ask and answer significant questions about the history of mathematics. More precisely:
Describe the major mathematical developments over time in the cultures of Egypt, Babylonia, Greece, Medieval China, Medieval India, the Medieval Islamic world, the European Middle Ages, the Renaissance, and the seventeenth, eighteenth, nineteenth, and twentieth centuries in Europe and the Americas;
Be able to describe the development of number systems, geometry, proof, algebra, analytic geometry, the calculus, and the foundations of mathematics, across cultural and national lines;
Be able to explain the relationship between the development of mathematics and social, philosophical, religious, and scientific developments;
Be able to solve a range of mathematical problems, from calculus and from more advanced types of mathematics, from the societies whose mathematical history is covered in the course.