m3h0.tex Week 0

M3H HISTORY OF MATHEMATICS

Professor N. H. BINGHAM, Spring Term 2017

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Tue 1-2, Clore; Fri 9-11, 658

Course website: My homepage, link to M3H.

This full-unit course consists of 3 lectures (10 weeks, 3 hours per week).
Syllabus and Division of Time
Week 1, 17-20 Jan. Pre-history to Greek history
L1. Timeline; Prehistory
L2. Egypt; Mesopotamia
L3. The Greeks: History
Week 2, 24-27 Jan. Greeks: Thales to Euclid
L4. Thales to Anaxagoras
L5. Anaxagoras to Plato
L6. Eudoxus to Euclid
Week 3, 31 Jan - 3 Feb. Greeks: Archimedes to Pappus
L7. Archimedes
L8. Apollonius to Menelaus
L9. Ptolemy to Pappus
Week 4, 7-10 Feb. Greeks (end); Romans; India and China; The Arabs
L10. Greeks: Assessment
L11. Romans; India
L12. China; The Arabs
Week 5, 14-17 Feb. From the Arabs to Galileo
L13. From the Arabs to early Europe
L14. The Renaissance to Copernicus
L15. Viète to Galileo
Week 6, 21-24 Feb. 17th C.: Descartes to Newton and Leibniz
L16. Descartes to Fermat
L17. Huygens to Newton
L18. Newton to Leibniz

Week 7, 28 Feb - 3 Mar.   18th C.: Bernoullis and Euler to Lagrange
L19. Bernoullis to Taylor
L20. Euler to Lambert
L21. Lambert to Lagrange
Week 8, 7-10 Mar.   19th C.: Laplace, Gauss, Abel, Galois, Klein
L22. Laplace to Gauss
L23. Gauss to Abel
L24. Galois to Klein (Geometry: non-Euclidean, projective, group-theoretic)
Week 9, 14-17 Mar.   From the 19th C. to the 20th C.
L25. Bolzano to Cantor (Analysis)
L26. Cantor to Clausius (Set theory to Applied Maths and Physics)
L27. Stokes to Hilbert (Applied; Poincaré and Hilbert)
Week 10, 21-24 Mar.   20th C. (early)
L28. Borel to Landau (Analysis)
L29. Hardy and Littlewood to Baker and Hodge (Pure)
L30. Quantum Theory to Mathematical Genetics (Applied)
Week 11, Fri 24 March only.   20th C. (late) [for info and interest only]
L31. Bourbaki to Group Theory
L32. Grothendieck to Control Theory
L33. Computers to Chaos Theory

Texts

[B] C. B. BOYER, *A history of mathematics*, 1968, Wiley (2nd ed., with U. C. Merzbach, 1989, 762p)
Morris KLINE, *Mathematical thought from ancient to modern times*, OUP, 1972, 1238p
Nicholas BOURBAKI, *Elements of the history of mathematics*, Springer, 1994, 301p

We have not followed any text particularly closely. The course is based on my old notes of 1990-95, augmented by what I have learned since and what I have gleaned from Wikipedia [W] and the Internet. My notes from the 90s were based mainly on Boyer, followed roughly a chapter per lecture. Boyer is shorter than Kline, and more chronological. I recommend Boyer as a book of first resort, Kline as a reference.

Delivery

I will use the "belt and braces" method – give out hard copy *and* use the screen. Once the numbers have settled down, I will give out the text in ten handouts, Weeks 1-10 above, in the first lecture of every week, and talk through the text at a rate of about 4 pages per lecture (Week 11 – Fri 24

March only – not examinable).

Exam

The exam will consist of two sections: Section A (do 5 out of 10, 10 marks each – brief notes on a specific topic), and Section B (do 2 out of 4, 25 marks each – following some theme in its development over time). See the website for Exam + Solutions, Mock, 2013-14 and 2015-16.

References

At many places in the text, particularly in the second half or so, I have included specific references in the text. This is for interest and completeness, and to provide raw material for possible projects. Do *not* feel obliged to read anything, unless you have a specific interest in it. I possess many of the books I cite, and will lend them on request (if not in the College Library).

Dates etc.

You will meet a large number of names, and of dates (as you did in History at school). These are included for information and completeness (I now do this for all my courses, and books) – you are not expected to learn them all. The dates you really *must* know are 1687 (Newton's *Principia*) and c. 300 BC (Euclid's *Elements*); the names you really *must* know are Archimedes, Newton and Gauss. For the rest, a general idea is enough (again, compare school: 1066, 1914-18, 1939-45, and not much else).

Mathematical Content

In the beginning, you will find the mathematical content easy – it is being presented for historical rather than mathematical reasons. Towards the end, you will be well out of your comfort zone on a lot of the mathematics. If it's any comfort to you: so will I be, and any of my colleagues: there is so much Mathematics known that no one can have even a good grasp of all of it. But I don't want to let really important mathematics that you should all know pass us by. I shall put up on the Handouts section of the course website a number of brief modern presentations of the really key developments. Example: Newton, the Inverse Square Law of Gravity, and conical orbits.

Questions. I will ask you lots of questions in class. These are not rhetorical: I hope for answers! As we pass through two and a half millennia of mathematics, I want you to re-live your mathematical experiences to date.

Here are a few questions in advance (think of them as "Problems 0" – or "Problems 10" – Solutions at the end of the course):

Q1. Why do dust particles dance in sunbeams?

Q2. Why are there *two* tides a day?

Q3. Why does the Moon always show the same face to the Earth, rather

than revolve on its axis as the Earth does?
Q4. Why is the sky blue?
Q5. Why do we sweat?
Q6. Why does water freeze? Why does water boil?
Q7. What causes a rainbow?
Q8. What causes a double rainbow, and how does it differ from a single one?
Q9. What is a sonic boom, and what causes it?
Q10. What causes partial reflection of light at a mirror?

Why History of Mathematics?

1. Mathematics is a human creation. It has emerged over millennia, as a result of great labour by very many highly intelligent people. It is constantly evolving, and is not set in stone. Knowing something of the history of the subject helps to bring any individual course to life, and the undergraduate programme as a whole to life.
2. The evolution of mathematics spans a number of different historical periods, and a number of different cultures. Its study helps one to put one's own knowledge and environment in a broader context.
3. Mathematics is the common core of all science; science is the difference between the modern world and the Middle Ages. Without mathematics there is no science; without science (there is no Imperial College and) we're back in the Middle Ages burning witches.
4. The course will focus on what mathematics is used for as well as maths for its own sake. You will emerge with an enhanced awareness of science.
5. The course will enhance your historical sense generally. History is less a matter of lists of names and dates, more an overview of how human experience in different parts of the world and different time periods fits together.
6. The course will give you practice in writing English prose. You won't have done much of this since leaving school, and may be rusty (or even have fled into mathematics to avoid it!). But good document preparation – in undergraduate/MSc projects, PhD theses, professional life later – is a valuable skill. You will gain in ability to express yourself clearly in good English.
7. The course will teach you a lot you didn't previously know, but will also "re-live" your previous experience of mathematics – from childhood up to now. Most people find this emotionally as well as educationally satisfying (and it is excellent preparation for parenthood!).
8. For those of you intending to take mathematics further: by broadening your awareness of different areas, the course may help you to take a better informed decision on which area you want to work in. NHB