MATH FOR LIFE in Fall 2019 (MA1005B)

Course Code	MA1005B	**Professor(s)**	Michel Broue
Prerequisites	None	**Office Number**	
Class Schedule	TWF: 09:00-10:20 in PL-1	**Office Hours**	
Credits	4	**Email**	mbroue@aup.edu
Semester	Fall 2019	**Office Tel. Ext.**	

Course Description

We shall examine questions and concepts from various areas in Mathematics, many of them taken from number theory or Geometry, in a way that any student can understand — the challenge being to be both not technical and not superficial. It will be a kind of random walk through the world of mathematics (the world of ideas, and the world itself), from historical, philosophical, aesthetic, and scientific points of views.

One of the aims of the course is to show the audience that Mathematics take their problems from real world, that they often put order into chaos, that they sometimes strongly shake common sense, that they can produce magnificent objets as well as unique way to understand some aspects of the world (from Music to gravitation)… and also that they provide the most extraordinary dreams of human history.

We shall introduce the course by showing some surprising mathematical facts, such as : various cuttings of a Möbius band, the stunning growth of the exponential, the presence of many irrational numbers in everyday life, as well as some apparent paradoxes coming from simple computations. We shall also list some misconceptions about mathematics that the course will constantly address.

The class will be illustrated, or, rather, interrupted in order to relax the audience, by somehow unexpected or weird mathematical curiosities such as the « audio-active sequence », the « (3n+1)-sequence, stories about the number 666, numerology, curious or beautiful geometrical objects, etc.

All along the way, stories about some great mathematicians, their work, pride and passion (Kepler, Archimedes, Galois, Hipatia, Ramanujan, Al Khawarizimi, Euler, Sophie Germain, Bourbaki, etc.), will be told.

Course Learning Outcomes

Develop a positive approach to mathematics.
Appreciate the use of mathematics in modeling the world.
Reason with quantitative information – in words, numbers and graphs.
Clearly communicate quantitative information in words, numbers and with graphs.
Develop strategies for solving problems.

General Education

Is this a General math elective course?

Yes, this **course is designed to fulfill the University mathematics general education requirement.**

Course Outline

Intended Learning Outcomes

- Improve relationship with some mathematical concepts.
- Improve openness with some mathematical approaches.
- Discover that mathematics can greatly improve knowledge of reality.
- Develop the practice of rigorous skepticism.
- Is the parallel postulate true ? Develop reflection about truth.

More detailed information

Here is a list of the mains topics which the course will cover, at least in part.

1) Natural integers and the induction argument (triangle numbers, Pascal triangle, Fibonacci numbers), the ``alarm clock numbers'' and some of their applications (Chinese Remainder Theorem, dodecaphonic music, as well as various computations), prime numbers (they are the bricks of arithmetic, Sieve of Eratosthenes, their distribution — chaos and order —, Goldbach and twin numbers conjectures).

2) Irrational numbers : Pythagorus and the story of the square root of 2, the Golden Ratio and its many occurrences in art and nature, the strange and marvelous number p, the *Vesica Piscis*, mathematics in arts and religious decorations.

3) What is the meaning of « infinite decimal expansions » of most numbers ? Connection with « Achilles and the Tortoise paradox », and reflection on various conventions to write numbers through history and nowadays. Continued fractions and how to put order in chaos again. Euclidean algorithm everywhere. What are “infinite sums” ?

4) Some old questions in Number Theory (sums 2, 3, or 4 squares, sums of cubes, sums of 4th powers) from Antiquity to 21st century. Key functions on integers : Euler function phi, Möbius function, and some applications to cryptography.

5) Other numbers : Gauß integers, initiation to complex numbers, discussion on the term « imaginary numbers », introduction to Julia sets and fractals though the film “Dimension”. « Counting numbers » : how many integers versus how many real numbers (Cantor’s “diagonal argument”).

6) More on pi, from a spectacular conjecture about its decimal expansion to Buffon needle, history from Egypt to nowadays, the way to express it as various sums of beautiful series, its occurrence almost everywhere. Its computations using polygons.

7) Constructible numbers, squaring the circle (from Kheops to the proof of impossibility), trisecting the angle. Ramanujan’s trick to fake-square the circle. Fermat numbers, constructible polygons.

8) From regular polygons (dimension 2) to regular polyhedra (dimension 3). Platonic solids and their symbolic importance from Plato to Kepler, semi-regular polyhedra. Euler-Poincaré formula : Application to semi-regular polyhedra and the football balls, as well as the question of the maximal numbers of pieces in a cake.

9) Dimensions : « Flatland » and dimension 3, as an introduction to dimension 4. A few words on general relativity, geometry and gravity, and … paintings of Max Ernst or Marcel Duchamp.

10) An introduction to non-Euclidean geometry through Poincaré finite-infinite universe for the hyperbolic geometry, and through spherical geometry. Sum of the angles of a triangle on a sphere. The parallel axiom revisited, discussion about « the truth ».

11) Games, more “paradoxes”, and different mathematics : Tower of Hanoi, Josephus problem, Monty Hall paradox, Peg solitaire, Cards Shuffling, Bridges of Königsberg and graph theory. Curves in coffee cups (caustics), a few examples of billards : and introduction to “envelopes”. Ruled surfaces (and Man Ray’s photographs).

12) Introduction to permutations and groups through some card shuffling and mathematical magic. Description of some simple multiplication tables. The group of the square (dihedral group of order 8, construction and analysis of its multiplication table.

13) Anthropology and Mathematics : a few words about the revolutions in arts and sciences at the beginning of the last century. Structuralism. André Weil and Claude Levi-Strauss meet in New-York : mathematical description of the marriage laws of an aboriginal tribe governed by the

dihedral group of order 8, and applications.

Through these examples and others we wish to show how and why Mathematics is a “subversive” intellectual activity, relying on passion, imagination, beauty as much as on logic and rigorous argumentation.

Textbooks

This course doesn't have any textbook.

Attendance Policy

Students studying at The American University of Paris are expected to attend ALL scheduled classes, and in case of absence, should contact their professors to explain the situation. It is the student’s responsibility to be aware of any specific attendance policy that a faculty member might have set in the course syllabus. The French Department, for example, has its own attendance policy, and students are responsible for compliance. Academic Affairs will excuse an absence for students’ participation in study trips related to their courses.

Attendance at all exams is mandatory.

IN ALL CASES OF MISSED COURSE MEETINGS, THE RESPONSIBILITY FOR COMMUNICATION WITH THE PROFESSOR, AND FOR ARRANGING TO MAKE UP MISSED WORK, RESTS SOLELY WITH THE STUDENT.

Whether an absence is excused or not is ALWAYS up to the discretion of the professor or the department. Unexcused absences can result in a low or failing participation grade. In the case of excessive absences, it is up to the professor or the department to decide if the student will receive an “F” for the course. An instructor may recommend that a student withdraw, if absences have made it impossible to continue in the course at a satisfactory level.

Students must be mindful of this policy when making their travel arrangements, and especially during the Drop/Add and Exam Periods.

Grading Policy

Teaching and Learning Methodologies

This will be essentially a classical course — using blackboard of course, but also much of “Keynote type” animation, pictures, movies, internet —, completed by collective exercises led in small groups.

Every class will be opened by at least one lecture presented by one or two students on a topic they have chosen and discussed with the Professor.

The students will be asked to write up three papers on various mathematical questions, which require no preliminary knowledge, but real work to phrase convincing explanations. They must write in such a way that any other student in AUP may understand their paper.

Grade Scale

Class Participation 15%

Lectures 30%

Paper 1 15%

Paper 2 15%

Paper 3 25%

Note =

« Class participation » grade includes :

—> regular attendance,

—> attention to what is taught or discussed,

—> participation to discussions, resolutions of questions, etc.

Schedule of Papers

Paper	**Length**	**Due**	**Returned**
1	5 pages	Sept. 24	Oct. 1
2	5 pages	Oct. 22	Oct. 29

3	8 pages	Dec. 3	Dec 10
TOTAL	18 pages		

Other

Cell phones and Laptops The use of cell phones and laptops (unless we work on statistics) is strictly forbidden in this course.