

Course Information Book
Department of Mathematics
Tufts University
Fall 2009

ZETA FUNCTIONS

for \mathbf{Q} :

$$\begin{aligned}\zeta(s) &= \sum_{n \geq 1} n^{-s} \\ &= \prod_p \frac{1}{1 - p^{-s}}\end{aligned}$$

for a number field K :

$$\begin{aligned}\zeta_K(s) &= \sum_{\mathfrak{a}} N_{K/\mathbf{Q}}(\mathfrak{a})^{-s} \\ &= \prod_{\mathfrak{p}} \frac{1}{1 - N_{K/\mathbf{Q}}(\mathfrak{p})^{-s}}\end{aligned}$$

sum over all non-0 ideals $\mathfrak{a} \subset \mathcal{O}_K$;
product over all non-0 prime ideals
 $\mathfrak{p} \subset \mathcal{O}_K$.

This booklet contains the complete schedule of courses offered by the Math Department in the Fall, 2009 as well as descriptions of all our upper-level courses (from Math 41 and up). For descriptions of lower-level courses, see the university catalog. If you have any questions about our courses, please feel free to contact one of the instructors.

A Guide for Current and Potential Math Majors and Minors can be found on the department's website.

The Study area on the third floor of Bromfield-Pearson is open to everyone all the time!

Math 41

Number Theory
Course Information

Fall 2009

BLOCK: F+, T Th, 12:00 – 1:15 PM

INSTRUCTOR: George McNinch

EMAIL: george.mcninch@tufts.edu

OFFICE: Bromfield-Pearson 112

OFFICE HOURS: (Spring 2009) T Th 2:30 – 3:30 pm, F 11:00 - 12:00 am

PHONE: 7-6210

PREREQUISITES: Math 12 or 17 or consent.

TEXT: *Elementary Number Theory and its applications* (4th edition) by Kenneth Rosen. Addison-Wesley Longman.

COURSE DESCRIPTION: Number theory studies the properties of particular types of numbers – in this course, mainly *integers*. In particular, we will study the language of *congruence* and its relationship to divisibility of numbers. We will learn about various related notions: *prime numbers*, *greatest common divisors*, and *Euclid's algorithm*. Using this language, we will see a number of fascinating mathematical results. For example, the “little theorem” of Fermat which says that if a is an integer not divisible by the prime number p , then a^p is congruent to a modulo p . Perhaps the most startling result in the class will be the law of *quadratic reciprocity*; if p and q are distinct prime numbers different from 2, this law gives a relatively simple criteria for deciding whether p is the square of some number modulo q .

We will also study some “enumerative” notions: for example, we study Euler’s phi-function ϕ : the value $\phi(n)$ counts the numbers $m \leq n$ whose only common divisor with n is 1.

Once upon a day, number theory was entirely a part of “pure mathematics”. However, many notions of number theory have power applications to cryptography. We will discuss some of these applications in the course.

Because it has relatively little dependency on other fields of mathematics, the study of number theory provides an excellent opportunity to develop the habits of mind necessary to write careful proofs in mathematics. Moreover, the mathematics it covers is fascinating and beautiful.

The course will have weekly homework, two midterm exams, and a final.

BLOCK: E+ Mon Wed 10:30 – 11:45
INSTRUCTOR: Chuck Hague
EMAIL: chuck.hague@tufts.edu
OFFICE: Bromfield-Pearson
OFFICE HOURS: (Spring 2009) TWF 2:00 – 3:00
PHONE: 7-2354

BLOCK: H+ Tues Thurs 1:30 – 2:45
INSTRUCTOR: George McNinch
EMAIL: george.mcninch@tufts.edu
OFFICE: Bromfield-Pearson 112
OFFICE HOURS: (Spring 2009) T Th 2:30 – 3:30 pm, F 11:00 - 12:00 am
PHONE: 7-6210

PREREQUISITES: Math 12 or 17 or consent.

TEXT: *Linear Algebra and its applications* (3rd edition) by David Lay. Pearson-Addison-Wesley.

COURSE DESCRIPTION: Math 46 is concerned with the study of systems of linear equations and matrix properties. “Linear” means that unknowns appear multiplied by known constants only, not as part of more complicated expressions — for instance, there are no products, ratios, or transcendental functions of unknowns. (You will learn a better definition of “linear” early in Math 46.) For example, $2x + 3y = 5$ is a linear equation in the unknowns x and y , whereas $xy = 1$ and $e^x = y$ are nonlinear. Systems of linear equations arise everywhere in mathematics and its applications. Even when the main focus is on nonlinear equations, as is often the case in real-world application, linear systems still play a central role, since the most common methods for studying nonlinear systems use linear approximations.

The study of systems of linear equations quickly leads to more abstract concepts — vector spaces, dimension (you will learn about four-, five-, and even infinite-dimensional spaces), linear transformations, eigenvalues, etc. These concepts prove central in understanding systems of linear equations, as well as other, more sophisticated problems which arise often in applications.

Mathematics majors and minors are required to take Math 46, and are urged to take it as early as possible, as it is a prerequisite for most upper-level mathematics courses. However, the course is also intended and useful for majors in computer science and engineering, as well as those in the natural and social sciences.

BLOCK: Block D+: Tuesday and Thursday 10:30-11:45

INSTRUCTOR: Mary Glaser

EMAIL: mary.glaser@tufts.edu

OFFICE: Bromfield-Pearson 004

OFFICE HOURS: (Spring 2009) Tues 3-4; Wed 11-12:30; Thurs: 1-1:30

PHONE: 7-5045

PREREQUISITES: Math 12 or 17 or consent.

TEXT: *Sheldon Axler, Linear Algebra Done Right, 2nd ed.*

COURSE DESCRIPTION:

This is the "honors" section of Math 46. We will stress the development of abstract concepts and the proofs of theorems. There will be much less emphasis on matrix computations. If you want to know the *why* as well as the *how* behind linear algebra, this is the course for you. There will be a strong emphasis on *proofs* rather than calculations. If you want to learn more about proofs and higher mathematics, this is the course for you. **The course is intended for majors or minors in mathematics, science and engineering.** While the emphasis of the course will be different, the material is still the material of Math 46 albeit done from a more abstract viewpoint.

Linear algebra is used in essentially all fields of mathematics, and in applications as diverse as imaging, operations research, and signal processing. You will use it again and again in your later math courses as well.

You will certainly learn to solve linear systems of equations using matrices in this course. However, this will be done in connection with how these systems arise in the abstract setting of linear transformations on vector spaces. The preliminary topics covered in the course include: vector spaces, subspaces, linear independence, bases, and dimension. The course then focuses on linear transformations and their associated matrices and properties such as rank, null space, trace, and determinant. Finally, eigenvalues/eigenvectors, diagonalizability, and invariant subspaces are covered. If time permits there are a number of other topics to choose from.

Math/Comp 128;
Math/Comp 250

Numerical Linear Algebra
Course Information

Fall 2009

BLOCK: Block G+, 1:30-2:45 Mon. and Wed.

INSTRUCTOR: Professor Misha Kilmer

EMAIL: misha.kilmer@tufts.edu

OFFICE HOURS: Office hours (Spring 2009): Tues. 3-4, Thurs. 11:30-12:30

PHONE: 7-2005

PREREQUISITES: For 128: Math 46 & Comp 11 or consent; For 250: Linear Algebra & Consent

TEXT: Numerical Linear Algebra, by L. N. Trefethen and D. Bau, III., SIAM Press, 1997 (can get in paperback.) Will be supplemented by lecture notes.

COURSE DESCRIPTION:

In this course, we will take the basic concepts (i.e. range, null space, vector subspaces) and tools (i.e. norms, matrix factorizations) from a standard linear algebra course and, paying attention to computer storage, operations counts and finite precision arithmetic, learn how they can be used to solve real-world problems.

In linear algebra and other math courses you learn techniques like Cramer's rule for solving linear systems or finding roots of characteristic polynomials to determine eigenvalues. These are great techniques for small scale homework problems but they aren't efficient on the large-scale problems that occur in practice. In this course, you will learn about the algorithms and underlying mathematics for solving linear systems of equations and least squares problems, two of the most common numerical problems that arise in physics and engineering applications. In-class examples and homework problems will feature some of these applications (e.g. circuit simulation, data mining and image processing). We will also survey standard techniques and state-of-the-art approaches for eigenvalue computation, an equally important topic in numerical linear algebra.

Homework problems will consist of written problems as well as computer programming assignments in Matlab. No previous programming experience in Matlab is assumed. In-class computer demonstrations will be given. The students enrolled in the course at the 200-level will find the assignments and exams more challenging and tailored to gaining independent insight into the thought process that is required of researchers in this field. Students enrolled at the 200-level will also be expected to attend* lectures 12-12:50 on most Mondays. (*Date & time subject to change, depending on enrollment).

One former student with interest in image-rendering and who went to work for Sony emailed me "I'm already seeing math128 [topics used] and I've been out of class for what, 3 weeks?" Another former student told me after attending a summer industrial math workshop "you can tell future students that they can use that stuff [tools from numerical linear algebra] a lot in industry!" Furthermore, the math is just plain cool and fun to learn, the algorithms are slick, and numerical linear algebra is my specialty. I anticipate at least one special-topics guest lecture.

Math 135

Real Analysis I
Course Information

Fall 2009

BLOCK: H+TR, Tue Thu 1:30-2:45 PM
INSTRUCTOR: Todd Quinto
EMAIL: todd.quinto@tufts.edu
OFFICE: Bromfield-Pearson 204
OFFICE HOURS: (Spring 2009) On leave.
Please e-mail me and we can meet.
PHONE: 7-3402

BLOCK: D+TR, Tue Thu 10:30-11:45 AM
INSTRUCTOR: Scott MacLachlan
EMAIL: scott.maclachlan@tufts.edu
OFFICE: Bromfield-Pearson 212
OFFICE HOURS: (Spring 2009) TWF 10:30-11:30
PHONE: 7-2356

PREREQUISITES: Math 13 or 18, and 46, or consent.

TEXT: *Elementary Classical Analysis, Second Edition* by Jerrold E. Marsden and Michael J. Hoffman, W. H. Freeman and Company, 1993, New York.

COURSE DESCRIPTION:

Real analysis is the rigorous study of real functions, their derivatives and integrals. It provides the theoretical underpinning of calculus and lays the foundation for higher mathematics, both pure and applied. Unlike Math 11, 12, and 13, where the emphasis is on intuition and computation, the emphasis in real analysis is on justification and proofs.

Is this rigor really necessary? This course will convince you that the answer is an unequivocal yes, because intuition not grounded in rigor often fails us or leads us astray. This is especially true when one deals with the infinitely large or the infinitesimally small. For example, it is not intuitively obvious that, although the set of rational numbers contains the set of integers as a proper subset, there is a one-to-one correspondence between them. These two sets, in this sense, are the same size! On the other hand, there is no such correspondence between the real numbers and the rational numbers, and therefore the set of real numbers is uncountably infinite.

In this course, we will study the topology of the real line and Euclidean space, compactness, connectedness, continuous mappings, and uniform convergence. The topics constitute essentially the first five chapters of the textbook. Along the way, we will encounter theorems of calculus, such as the intermediate-value theorem and the maximum-minimum theorem, but in a more general setting that enlarges their range of applicability. This is one of the exciting aspects of real analysis and of upper-level math in general; by studying fundamental ideas in a general setting, we understand what is really behind the ideas and gain a broader perspective and appreciation of the ideas. The course will end with the contraction mapping principle, a fundamental theorem that is used in many different areas, including the proof of the existence and uniqueness of solutions of certain differential equations.

In addition to introducing a core of basic concepts in analysis, a companion goal of the course is to hone your skills in distinguishing the true from the false and in reading and writing proofs.

Math 135 is required of all math majors. A math minor must take Math 135 or 145 (or both).

Math 145

Abstract Algebra I
Course Information

Fall 2009

BLOCK: E+ MW

INSTRUCTOR: Kim Ruane

EMAIL: kim.ruane@tufts.edu

OFFICE: 211

OFFICE HOURS: (Spring 2009) T 1:30 - 2:30 Th 9:30 - 10:30 F 10:30 - 11:30

PHONE: 7-2006

BLOCK: H+

INSTRUCTOR: Genevieve Walsh

EMAIL: genevieve.walsh@tufts.edu

OFFICE: 213

OFFICE HOURS: (Spring 2009) T W Th 10 - 11

PHONE: 7-4032

PREREQUISITES: Math 46 or consent of the instructor.

TEXT:

Beachy, J. A. and Blair, W. D. **Abstract Algebra**. Third edition, 2006.

COURSE DESCRIPTION: An introduction to algebraic structures, including groups, the structure of groups, and basic field theory. In particular we will study the elementary properties of finite groups, the basic isomorphism and Sylow theorems, and fields that arise from the study of polynomials.

BLOCK: C (TuWF 9:30–10:20)

INSTRUCTOR: Christoph Börgers

EMAIL: christoph.borgers@tufts.edu

OFFICE: 215 Bromfield-Pearson Hall

OFFICE HOURS: (Spring 2009) M 12–1:30, W 12–1:30

PHONE: 7-2366

PREREQUISITES: Math 38 or consent.

TEXT: Steven H. Strogatz, *Nonlinear Dynamics and Chaos*, Westview Press

COURSE DESCRIPTION: Math 150 is primarily a course on ordinary differential equations, with emphasis on qualitative, geometric aspects of the subject; however, there is also some material on iterated maps — that is, on dynamical systems in which time is thought of as ticking discretely, not flowing continuously. Applications in physics, biology, chemistry, and engineering will be discussed in detail.

We will discuss coupled systems of n differential equations describing n quantities $x_i(t)$, $i = 1, \dots, n$. (Here t is time and $x_i(t)$ is a real number.) Following the book, the course has three parts: $n = 1$, $n = 2$, and $n > 2$.

Even the case $n = 1$ has very interesting aspects. We will discuss bifurcations in a single differential equation for a single time-dependent unknown quantity, with applications to lasers, the motion of a bead on a rotating hoop immersed in molasses (we have to immerse it in molasses in part 1, otherwise $n = 2$ for this problem), insect outbreaks, and the simplest mathematical caricature of excitable (nerve and muscle) cells.

Systems with $n = 2$ allow oscillatory behavior. (Systems with $n = 1$ do not.) We will study the classification of fixed points, phase portraits, limit cycles (that is, persistent oscillations), and bifurcations in two dimensions. There is an abundance of applications of these subjects: the pendulum (first without drive, then the driven pendulum), predator and prey populations, oscillating chemical reactions, nerve cells, and the bead on the hoop without the molasses.

Systems with $n > 2$ allow “chaos”. We will study the famous Lorenz equations (one of the first systems of differential equations in which chaotic behavior was discovered), chaos in iterated one-dimensional maps, fractals, and strange attractors.

Math 150, Sec. 02

Knot Theory
Course Information

Fall 2009

BLOCK: J+, TR 3:00–4:15 PM

INSTRUCTOR: Dan Margalit

EMAIL: dan.margalit@tufts.edu

OFFICE: Bromfield-Pearson 209

OFFICE HOURS: (Spring 2009) By appointment

PHONE: 7-2678

PREREQUISITES: Math 145 or consent

TEXT: Knot Theory, by Charles Livingston

COURSE DESCRIPTION:

Take a rope, tangle it up, glue the ends together, and you have what mathematicians call a knot. Peter Tait studied knots formally in the late nineteenth century, motivated by new ideas about matter and the aether developed by Lord Kelvin and James Clerk Maxwell.

One of the basic questions about knots is: how can you tell when two knots are the same? Or, if someone hands you a knotted rope, how can you tell if it is possible to completely disentangle the rope so it looks like the letter "O"? You can explain this problem to a child, but it can be a very difficult problem to solve!

If your rope really is knotted, what is the minimum number of times would you have to pass it through itself in order to unknot it?

What is the smallest number of sticks needed to make a tinker toy model of a certain knot?

Is it possible to list all knots in such a way that you never repeat the same one twice?

How do you multiply knots? How can you factor a knot into prime knots?

What is the higher dimensional version of a knot?

Starting with the rigorous mathematical definition of a knot, we will develop increasingly more advanced combinatorial, algebraic, and topological techniques designed to answer these questions and many more.

Math 161

Probability
Course Information

Fall 2009

BLOCK: E+MF, MF, 10:30 -11:45 AM

INSTRUCTOR: Sabir Umarov

EMAIL: sabir.umarov@tufts.edu

OFFICE: Bromfield-Pearson 106

OFFICE HOURS: (Spring 2009) M 2:00 - 3:30 pm, F 1:00 - 2:30 pm

PHONE: 7-2357

PREREQUISITES: Math 13 or 18 or consent. (Most of the material learned in Math 11 and 12 will be used, as well as multiple integrals)

TEXT: Sheldon Ross, *A First Course in Probability*, 7th edition, Prentice Hall.

COURSE DESCRIPTION: Randomness appears everywhere in daily life, from the weather to the stock market or the lottery. Probability theory is the branch of mathematics which analyzes random events and quantities. It is both one of the major areas of pure mathematics and one of the most widely applied areas of mathematics. Probability is of fundamental importance in the natural and social sciences, computer science, medicine, engineering, finance, and many other fields. Math 161 is a course on probability theory. Math 162, which builds on Math 161, is a course on statistics. Completion of Math 161 and 162 provides excellent preparation for research in any area that involves randomness or data. The sequence also provides excellent preparation for the actuarial exams.

The goals of Math 161 are to gain a good understanding of the basic concepts of probability theory and to acquire familiarity with them through numerous fascinating examples and applications. The applications will be drawn from probability's roots in gambling as well as from a plethora of other applications. Basic topics of the course include sample spaces and events, basic combinatorics, conditional probability and independence, random variables (discrete and continuous) and their distributions, expectations and variances, jointly distributed random variables, distributions and expectations of functions of random variables, conditional expectations, Chebyshev's inequality, the weak and strong law of large numbers, moment generating functions, the central limit theorem, and Poisson processes. The culminating point of the course is the central limit theorem, one of the most remarkable and important results one can learn in any undergraduate mathematics class.

BLOCK: E+MW, 10:30 - 11:45 AM

INSTRUCTOR: Gill Barequet

EMAIL: barequet@cs.tufts.edu

NOTE: Prof. Barequet will be visiting Tufts in Fall 2009. In Spring 2009, Prof. Souvaine <dls@cs.tufts.edu> is available for inquiries regarding this course.

PREREQUISITES: Comp 160 or consent.

TEXT:

Mark de Berg, Marc van Kreveld, Mark Overmars, Otfried Schwarzkopf. *Computational Geometry: Algorithms and Applications*. Springer-Verlag. 2nd rev. ed., 2000. ISBN: 3540656200. Or 3rd ed., 2008. ISBN: 3540779736.

RECOMMENDED TEXT:

Joseph O'Rourke. *Computational Geometry in C*. Cambridge University Press. 2nd edition. 2000. ISBN: 0521649765.

COURSE DESCRIPTION:

Computational geometry is concerned with the design and analysis of algorithms for solving geometric problems and the analysis of the underlying complexity of the problems themselves. Applications can be found in such fields as VLSI design, computer graphics, robotics, computer-aided design, pattern recognition, and statistics. This course will study key problems in computational geometry and the design and analysis of algorithms for their solution. Topics include proof of lower bounds, convex hulls, range searching and point location, plane sweep and arrangements of lines, art-gallery guarding and polygon triangulation, linear programming, Voronoi diagrams, and Delaunay triangulations. Some topics of discrete geometry, e.g., the crossing number of a graph and its applications, are also covered. The ultimate aim will be to identify general paradigms and data structures of particular importance to solving computational geometry problems, and thereby provide the participants with a solid foundation in the field.

Course work includes written homework assignments, a midterm exam, a project, and a final exam.

Math 211

Analysis
Course Information

Fall 2009

BLOCK: E+MF, 10:30-11:45 AM

INSTRUCTOR: Marjorie Hahn

EMAIL: marjorie.hahn@tufts.edu

OFFICE: Bromfield-Pearson 202

OFFICE HOURS: (Spring 2009) On sabbatical, but in most Tuesdays and Thursdays

PHONE: 7-2363 (voice messages are not checked, send an e-mail instead)

PREREQUISITES: Math 135 or consent.

TEXT: To be determined

COURSE DESCRIPTION:

The focus of this course is graduate level real analysis, which is a beautiful, coherent subject. It is comprised of three main topics that provide essential foundations for all other areas of analysis, including functional analysis, measure-theoretic probability theory, ergodic theory, dynamical systems, differential equations, harmonic analysis, complex analysis, as well as for geometry and topology. The main topics are measure theory (measures, Lebesgue integration, convergence theorems, product measures), point set topology (topologies, metrics, compactness, completeness), and Banach spaces (norms, L^p spaces, Hilbert spaces, orthonormal sets and bases, linear forms, duality, Riesz representation theorems, signed measures). The course provides excellent preparation for the Ph.D. oral examinations in analysis. Most students feel well-prepared to take the exams in January, less than a month after completing the course.

Lectures will be blackboard style, providing motivation for the theory, emphasizing basic ideas of the proofs, and providing examples. Grades will be based on weekly homework as well as exams.

The topic of the second semester of the graduate analysis sequence varies from year to year. In Spring 2010, it will be measure theoretic probability, for which most of the material presented in Math 211 is essential.

Strong undergraduates who have done well in Math 135 and/or Math 136 are encouraged to consider taking the course, especially if they intend to apply to graduate school in mathematics.

Math 215

Algebra
Course Information

Fall 2009

D-BLOCK: M 9:30-10:20, TR 10:30 -11:20 AM

INSTRUCTOR: Richard Weiss

EMAIL: richard.weiss@tufts.edu

OFFICE: Bromfield-Pearson 116

OFFICE HOURS: On leave, Spring 2009

PHONE: 7-3802

PREREQUISITES: Math 145-146 or the equivalent

TEXT: *Abstract Algebra* by David Dummit and Richard Foote

COURSE DESCRIPTION: Math 215 covers the first portion of the graduate algebra syllabus. The course will begin with a thorough examination of group; among other things, we will study the class equation, Sylow's theorem, and the simplicity of the alternating groups.

The course will focus then on (mainly commutative) rings. Notions of particular importance include irreducibility and factorization of elements of a ring – for example, a ring of polynomials.

Many properties of rings are best expressed and studied using the language of ideals and of modules. An important theorem describes all finitely generated modules over a principal ideal domain; this result yields as a special case a description of all finitely generated commutative groups, and a description of the conjugacy classes of $n \times n$ matrices over a field.

A study of commutative rings provides essential tools in the study of fields; in the sequel course Math 216, the study of fields culminates in a proof of the main theorems of Galois theory.

Math 217

Geometry and Topology
Course Information

Fall 2009

BLOCK: L+, TTh, 4:30 - 5:45 PM
INSTRUCTOR: Fulton B. Gonzalez
EMAIL: fulton.gonzalez@tufts.edu
OFFICE: Bromfield-Pearson 203
OFFICE HOURS: (Spring 2009) MW 4:15 - 5:45 PM
PHONE: 7-2368

PREREQUISITES: Undergraduate real analysis (135, 136) and abstract algebra (145), some point-set topology

TEXT: Loring Tu, *An Introduction to Manifolds*, Springer 2008.

COURSE DESCRIPTION: Geometry and topology are concerned with the concepts of shapes and spaces. Geometric properties are, roughly speaking, based on length measurement, while topological properties are unchanged under continuous deformations. Our primary objects of study will be *manifolds*, which one should think of as higher-dimensional generalizations of smooth curves and surfaces. Higher-dimensional manifolds arise even if one is interested only in the three-dimensional space we inhabit. For example, the group of all rotations and translations in our three-dimensional space is a 6-dimensional manifold. We will generalize differential and integral calculus to manifolds and use it to study the geometry and topology of manifolds.

One of the purposes of this course is to present the topics in geometry and topology that, in the opinion of the Graduate Committee, every mathematician ought to know. We will therefore follow fairly closely the syllabus of the Geometry Core Examination for master's and Ph.D. candidates.

Math 250-02

Algebraic Geometry
Course Information

Fall 2009

BLOCK: D+, T, Th, 10.30-11.20

INSTRUCTOR: Montserrat Teixidor i Bigas

EMAIL: montserrat.teixidoribigas@tufts.edu

OFFICE: Bromfield-Pearson 115

OFFICE HOURS: (Spring 2009) M 9:30 - 10:20 a.m., T 10.30-11.20 a.m., F 12:00 - 2:00 pm

PHONE: 72358

PREREQUISITES: Math 146, 215 or consent.

TEXT: J.Harris, *Algebraic Geometry, a first course*, G.T.M 133, Springer Verlag 1992.

COURSE DESCRIPTION:

From high school and the beginning of calculus courses, you have been introduced to the real line, the real plane and 3-dimensional space. In the same way, you can define the n -dimensional complex space as the product of the complex numbers with itself n -times. An algebraic variety is defined as the set of n -uples of zeroes of a set of polynomials. For example, if $n = 2, 3$ and we take only one polynomial, we get a curve in the plane or a surface in space.

Algebraic Geometry is the study of algebraic varieties. Some of the most important properties of algebraic varieties are dimension, number of components (or pieces), degree and singularities. Most of these concepts are intuitively very clear. For example, a point has dimension zero, a curve has dimension one and a surface dimension two. Or as another example, the zero set of the polynomial $x^2 + y^2 - 1$ is a circle, so it has only one component while the zero set of $x^2 - y^2$ is a pair of lines and has two components. But sometimes intuition is not enough to decide what the answer to a question is. For example, how many components should we assign to the zero set of x^2 . It is clear that this set consists only of one line (the y -axis). But it is also clear that it is the limit of the family of pairs of lines $x^2 - ty^2 = 0$.

Situations like these arise often in Algebraic Geometry when intuitive ideas need to be supported with suitable tools that allow to make them precise and solve problems.

In this course we'll keep a balance between examples and techniques. We'll become familiar with many classical algebraic varieties and introduce concepts and invariants associated with these varieties that allow to identify them or distinguish among them.

Math 250-03

Dynamical systems
Course Information

Fall 2009

BLOCK: H+TR, TR 1:30–2:45 pm

INSTRUCTOR: Boris Hasselblatt

EMAIL: Boris.Hasselblatt@tufts.edu

OFFICE: Bromfield-Pearson 114

OFFICE HOURS: (Spring 2009) TRF 9:20 - 10:00 am

PHONE: 7-3419

PREREQUISITES: Measure theory, manifolds, some dynamical systems or probability theory, or consent.

TEXT: “Introduction to the Modern Theory of Dynamical Systems” (recommended), “Dynamics: A first course — with a panorama of recent developments” (recommended); both by Hasselblatt and Katok. Additional material will be distributed.

COURSE DESCRIPTION:

This course continues Mathematics 212 as taught in the Spring of 2009, but can be taken by students who are not taking Mathematics 212 this Spring.

Topics include ergodic theory of smooth dynamical systems, topics in the dynamics of uniformly and partially hyperbolic dynamical systems, and additional topics chosen by the instructor and the participants. Some material on dynamical zeta functions may be included.

An important theme in this course is the study of long-term behavior in deterministic dynamical systems that are so complex that probabilistic methods are a natural tool. This makes the course a natural complement to training in probability theory. The interplay between the smooth structure and the probabilistic point of view is intricate and interesting, and of great interest in both pure and applied mathematics.

Jobs and Careers

The Math Department encourages you go to discuss your career plans with your professors. All of us would be happy to try and answer any questions you might have. Professor Quinto has built up a collection of information on careers, summer opportunities, internships, and graduate schools and his web site (www.tufts.edu/~equinto) is also a good source.

Career Services in Dowling Hall has information about writing resumes and job-hunting in general. They also organize on-campus interviews. There are job fairs from time to time at various locations. Each January, for example, there is a fair organized by the Actuarial Society of Greater New York.

On occasion, the Math Department organizes career talks, usually by recent Tufts graduates. In the past we had talks on the careers in insurance, teaching, and accounting. Please let us know if you have any suggestions.

The Math Society

The Math Society is a student run organization that tries to involve mathematics beyond the classroom. The club seeks to present mathematics in a new and interesting light through discussions, presentations, and videos. The club is a resource for forming study groups and looking into career options. You do not need to be a math major to join! See any of us about the details.