This booklet contains the complete schedule of courses offered by the Math Department in the Fall 2013 semester, as well as descriptions of our upper-level courses (from Math 61 [formally Math 22] and up). For descriptions of lower-level courses, see the University catalog.

If you have any questions about the courses, please feel free to contact one of the instructors.

Course renumbering
Course schedule
Math 61
Math 70
Math 72
Math 136
Math 146
Math 150-01
Math 150-02
Math 152
Math 158
Math 162
Math 212
Math 216
Math 218
Math 250-01
Math 250-02
Math 250-03
Math 250-04
Math 250-05
Mathematics Major Concentration Checklist
Applied Mathematics Major Concentration Checklist
Mathematics Minor Checklist
Jobs and Careers, Math Society, and SIAM
Block Schedule
**Course Renumbering**

Starting Fall, 2012, the lower level math courses will have new numbers. The matrix below gives the map between the current numbers and the new numbers. The course numbers on courses you take before Fall 2012 will not change, and the content of these courses will not change.

<table>
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<tr>
<th>Course Name</th>
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Course Information

Block: I+, Monday, Wednesday 3:00-4:15  
Instructor: Alberto Lopez  
Email: alberto.lopez@tufts.edu  
Office: Bromfield-Pearson 106  
Office hours: (Fall 2013) Monday, Wednesday 1:30-3:00  
Phone: 7-2357

Block: D+, Tuesday, Thursday 10:30-11:45  
Instructor: Richard Weiss  
Email: rweiss@tufts.edu  
Office: Bromfield-Pearson 116  
Office hours: (Fall 2013) Monday, Wednesday, Friday 1:30-2:30  
Phone: 7-3802


Course Description: This course is an introduction to discrete mathematics. In mathematics, ‘discrete’ is the opposite of ‘continuous’. In calculus, we study things that vary continuously, whereas in discrete mathematics, we focus on the combinatorics of things that can be counted and vary only in discrete steps. We will examine sets, counting problems, permutations, equivalence relations and properties of the integers and we will introduce some fundamental notions in graph theory. In short, we will open the door to some fascinating and fundamental topics in mathematics.

This course is intended as a bridge from the more computationally oriented courses like calculus to upper level courses in mathematics and computer science. We will spend a lot of time learning to read and write correct proofs of mathematical statements and we will practice these skills on a variety of problems.

This course, which is co-listed as CS 22, is required for computer science majors. It counts toward the math major and is, in fact, highly recommended for math majors (or possible math majors) who want a first glimpse of what higher mathematics is like.

Two sections of this course are being offered by the Math Department, one taught by Professor Lopez and one by Professor Weiss. A third section of this course is being taught by Professor Aloupis in the Computer Science Department. The three sections will vary slightly in their content according to the preferences of the instructors.
Math 70 Linear Algebra
Course Information

Spring 2014

Block: D+ (Tuesday, Thursday 10:30-11:45)
Instructor: Mary Glaser
Email: Mary.Glaser@tufts.edu
Office: Bromfield-Pearson 004
Office hours: (Fall 2013) Tues. 1:00 - 2:00, Thurs. 2:30 - 4:30
Phone: (617) 627-5045

Block: E+ (Wednesday, Friday 10:30-11:45)
Instructor: Hao Liang
Email: hao.liang@tufts.edu
Office: Bromfield-Pearson 109
Office hours: (Fall 2013) Wed. 2:30 - 4:30, Fri. 2:30 - 3:30
Phone: (617) 627-2678

Block: F+ (Tuesday, Thursday 12:00-1:15)
Instructor: Todd Quinto (course coordinator)
Email: todd.quinto@tufts.edu
Office: Bromfield-Pearson 204
Office hours: (Fall 2013) (just e-mail and we can talk (I'm on sabbatical))
Phone: (617) 627-3402

Block: H+ (Tuesday, Thursday 1:30-2:45)
Instructor: Jillian McLeod
Email: Jillian.mcleod@tufts.edu
Office: Bromfield-Pearson 114
Office hours: (Fall 2013) Tues. 10:30 - 11:30, 2:30 - 3:30, Thurs. 2:30 - 4:00
Phone: (617) 627-0359

Prerequisites: Math 34 or 39 or consent.


Course description: In Math 70 we start by studying systems of linear equations. For example, $2x + 3y = 5$ is a linear equation in the unknowns $x$ and $y$, whereas $e^x = y$ is
nonlinear. The study of linear equations quickly leads to beautiful deep concepts including
vector spaces, dimension (you will learn about four-, five-, and infinite-dimensional spaces!),
linear transformations, and eigenvalues. These abstract ideas will help you solve linear
equations efficiently, and more importantly, they fit together in a beautiful whole that will
give you a deeper understanding of these ideas.

Linear algebra arises everywhere in mathematics (you will use it in almost every upper
level math course) and in physics, chemistry, economics, biology, and a range of other fields.
Even when a problem involves nonlinear equations, as is often the case in applications, linear
systems still play a central role, since the most common methods for studying nonlinear
systems approximate them by linear systems.

This course introduces students to axiomatic mathematics and proofs as well as funda-
mental mathematical ideas. You will develop your logic skills and mathematical talents.
Mathematics majors and minors are required to take linear algebra (Math 70 or Math 72)
and are urged to take it as early as possible, as it is a prerequisite for most upper-level math-
ematics courses. The course is also useful to majors in computer science and engineering, as
well as those in the natural and social sciences.

There will be three exams in this course, two during the semester and one at the end,
and there will be daily assignments.
Course Information

Block: K+ (Monday, Wednesday 4:30-5:45)
Instructor: Kim Ruane
Email: kim.ruane@tufts.edu
Office: Robinson 155
Office hours: (Fall 2013) On Leave - contact me via email
Phone: (617) 627-4032

Prerequisites: Math 34 or 39 or consent.


Course description: Linear algebra is the study of vector spaces, matrices and linear transformations. Linear algebra provides a fundamental link between our geometric intuition of the world around us and the powerful tools of algebra.

The results and concepts of linear algebra are essential in virtually every branch of higher mathematics, from the most pure to the most applied. In fact, one could almost define higher mathematics as the study of ideas that are based on linear algebra, except that this definition would include most of physics as well!

This course is the honors version of Math 70. From the beginning, we will adopt a more sophisticated point of view. In particular, proofs and “theory” will play a greater role than in Math 70. We will present concepts in full generality, while emphasizing geometric examples.

This course is recommended for all those wanting to learn linear algebra who also enjoy a little extra challenge. Math 72 of course counts as a replacement for Math 70 wherever Math 70 is required as a prerequisite.

There will be three exams in this course, two during the semester and one at the end, and there will be daily assignments.
Math 136  
Real Analysis II  
Course Information  
Spring 2014

**Block:** D (Mondays 9:30 – 10:20 am, Tuesdays and Thursdays 10:30 – 11:20 am)  
**Instructor:** Fulton Gonzalez  
**Email:** fulton.gonzalez@tufts.edu  
**Office:** Bromfield-Pearson 203  
**Office hours:** (Fall 2013) Tuesdays 10:00 am - 1:00 pm  
**Phone:** (617) 627-2368

**Prerequisites:** Math 135 or consent.


**Course description:**

This course is a continuation of Math 135. In Math 135 we laid the foundation of real analysis by studying the topology of a metric space and the concept of continuity. Math 136 applies these tools to give a rigorous treatment of derivatives and integrals of real-valued and vector-valued functions on $\mathbb{R}^n$.

The derivative of a function $f : \mathbb{R}^n \to \mathbb{R}^m$ is defined to be a linear transformation, representable by a matrix of partial derivatives. Using this definition, we prove rules for differentiation (including the product rule and the chain rule), the mean-value theorem, Taylor’s theorem, and conditions for a real-valued function to have maxima and minima. All these are results you’ve encountered in calculus courses, but now you will know when and why they are true.

Two new results are the implicit function theorem, giving conditions under which an equation can be solved locally, and the inverse function theorem, giving conditions under which a function is locally invertible.

The second half of the course makes precise the notions of “area” and “volume” and develops the theory of Riemann integrals. As before, we prove some familiar theorems such as Fubini’s theorem and the change of variables formula.

If time permits, we will end the course with Fourier series, which has important applications to engineering and physics.

As in Math 135, apart from laying the theoretical foundation of calculus, a companion goal of the course is to hone your ability to formulate precisely mathematical ideas and to read and write proofs.
Math 146                Abstract Algebra II                Spring 2014
Course Information

Block: E+ (Wed and Fri 10:30 – 11:45)
Instructor: George McNinch
Email: george.mcninch@tufts.edu
Office: Bromfield-Pearson 112
Office hours: (Fall 2013) T 10:30 – 11:30 and 13:00 – 14:00, F 10:30 – 11:30
Phone: 7-6210

Prerequisites: Math 145 or consent.


Course description: This course continues the study begun in Math 145 of algebraic structures; the primary focus of this course is the structure of fields. A main goal of Math 146 is give a detailed description – using the language of modern algebra – of the beautiful connection found by E. Galois between the structure of groups and the solutions of polynomial equations.

Course requirements: weekly problem sets; 2 in-term exams; final exam
BLOCK: G+ (Monday, Wednesday 1:30 - 2:45)
INSTRUCTOR: Genevieve Walsh
EMAIL: genevieve.walsh@tufts.edu
OFFICE: Robinson 156
OFFICE HOURS: (Fall 2013) By Appointment
PHONE: (617) 627-4032

PREREQUISITES: Math 70 or 72. Some course in the mathematics department involving proofs. Willingness to present material in class!

TEXT: There is no text for this class. Copies of notes will be provided by the instructor, and will also be on Trunk. Students are requested not to look at other sources on point-set topology.

COURSE DESCRIPTION: The subject of point-set topology is extremely useful in many areas, particularly in analysis and topology. This class is a great way to prepare for math 135. We will start by covering cardinality and the axiom of choice and general topology, including creating our own topologies. We will describe what a basis of a topology is, the subspace topology, and the product topology. Then we will discuss various separation and covering properties, and investigate maps between topological spaces. Finally, we will discuss notions of connectivity of a topological space. Throughout, specific examples will be emphasized.

This course is designed to get you to think mathematically for yourself. To that end, there will be a running list of definitions and theorems and the goal of the class is to jointly work through proving the theorems. Everyday, students from the class will present problems and the class will discuss them and decide if they are ready to proceed. This method of instruction is called the modified Moore method, and it is a very fun and challenging way to deeply engage with the material.

There will be daily homework assignments, two in-class exams, and a final.
Math 150-02  Projective Geometry  Spring 2014

Course Information

Block: K+ (Mon Wed 4:30–5:45 p.m.)
Instructor: Alberto López Martín
Email: alberto.lopez@tufts.edu
Office: BP-106
Office hours: (Fall 2013) Mon Wed 1:30–3:00 p.m.
Phone: (617) 627-2357

Prerequisites: Either Math 70 or Math 72, or consent.

Text: No required text.

Course description: We are all familiar with Euclidean geometry. It is the geometry we use to describe our three-dimensional world, where the sides of objects have lengths, intersecting lines determine angles, and two lines are said to be parallel if they lie in the same plane and never meet. Moreover, all these properties are unchanged under translations or rotations.

Since Euclidean geometry describes our world so well, it is tempting to think that it is the only type of geometry — after all, the Greek word γεωμετρία means measurement of the earth. However, think of the drawing of a three-dimensional landscape on a two-dimensional canvas or the picture to the right. It becomes clear that Euclidean geometry is insufficient: in these cases, lengths and angles are no longer preserved, and parallel lines may intersect! Projective geometry provides the right framework for these situations and allow these pathologies by enriching our three-dimensional space with points at infinity.

In projective geometry, geometric transformations will now be allowed to move those extra points to traditional points, and vice versa. Of course, the drawback, as we will see, is that some measures may not be preserved — and among those are lengths, angles, and parallelism. Projective transformations, however, preserve type (points are still points after applying the transformation and likewise lines), incidence, and a new measure called the cross ratio.

In this course, we will study the differences among affine, Euclidean, and projective geometries, and apply our findings to the study of conics and quadrics. Linear algebra will be used throughout the semester on a daily basis.

Your grade will be based on two midterm exams and a final exam, as well as weekly assignments. These will constitute a significant part of your grade.
**Block:** H+ (Tuesday, Thursday 1:30–2:45)  
**Instructor:** Christoph Börgers  
**Email:** cborgers@tufts.edu  
**Office:** Bromfield-Pearson 215  
**Office hours:** (Fall 2013) Tuesday, Thursday 10:30–1:15  
**Phone:** (617) 627-2366

**Prerequisites:** Math 151 or consent.

**Text:** None. (Notes will be distributed electronically.)

**Course description:** We will begin the course with a review of the most fundamental linear partial differential equations (PDEs): The wave equation, the diffusion equation, and the Poisson equation, with emphasis on Fourier analysis and its use in understanding linear PDEs. In the process, we will give a more detailed treatment of Fourier series and the Fourier transform than time permitted in the fall.

We will then move on to examples of nonlinear PDEs, in particular Burgers’ equation and the Fisher-Kolmogorov equation. As in Math 151, strong emphasis will be put on understanding what these equations describe, and why. We will discuss the most fundamental numerical methods for solving these equations as well; their study supports conceptual understanding, and is practically important and mathematically interesting.

Burgers’ equation is the simplest example of a nonlinear first-order wave equation that allows the formation of shock waves, similar to the shock waves arising in supersonic flight. The same equation can also be derived from a model of traffic flow; the “shock waves” are then traffic jams forming spontaneously as a result of heavy traffic.

The Fisher-Kolmogorov equation describes the density of a population that grows logistically while diffusing in space. It is the simplest example of a reaction-diffusion equation. We will analyze its traveling wave solutions, i.e., waves describing the invasion of an uninhabited region in space by the population modeled by the equation.
Course Information

Block: B (Tue Th Fri 8:30-9:20)
Instructor: Mauricio Gutierrez
Email: mauricio.gutierrez@tufts.edu
Office: Bromfield-Pearson 111
Office Hours: TBD

Prerequisites: Math 42 or 44 or consent of the instructor.


Course Description: This course is an introduction to the theory of functions of one complex variable, a subject that has many important applications in physics, engineering, and elsewhere, and which is also fundamentally geometric in a way that is not always true for real variables. (The usefulness of complex analysis, and its harmony with other fields of mathematics, is ironic since it is founded on the “imaginary” or “impossible” number \( \sqrt{-1} \).)

In this course we will primarily explore the notion of an analytic function on a region in the complex plane. Quite simply, an analytic function is a complex-differentiable function, and yet this alone is enough to ensure that the function is completely determined by a very small sample of its values. This is an example of the rigidity phenomena at the heart of complex analysis.

The principal topics in our study of analytic functions include elementary functions (including Möbius transformations), contour integration, Cauchy’s theorem and integral formula, power series, residues, conformal mappings, and analytic continuation. We may touch on some of the many applications of complex analysis inside and outside of mathematics, such as two-dimensional potential theory, Fourier series, and hyperbolic geometry.

The course will be taught rigorously, with plenty of theorem-proving, but also with an emphasis on geometric intuition, as well as many computational examples and practical calculus-style problems. It is appropriate for mathematics, science, and engineering majors, and also as a view of more abstract mathematics for anyone hoping to glimpse the vista beyond calculus.
BLOCK: E+ (Monday, Wednesday 10:30-11:45)
INSTRUCTOR: Patricia Garmirian
Email: patricia.garmirian@tufts.edu
Office: Bromfield-Pearson 201
Office hours: (Spring 2014) Monday 3:00 - 4:30 and Wednesday 3:00-4:30
Phone: (617) 627-2682

Prerequisites: Math 161 or consent.


Course description: Suppose I claim that I make 75 percent of my basketball free throws. To test my claim, you ask me to shoot 40 free throws and I make only 24 of the 40. Do you believe my claim?

Statistics is the science of gaining information from numerical data. Our technological world generates data at an enormous rate. However, all too often the data is improperly obtained and/or improperly assessed. Important everyday decisions for individuals, corporations, societies, and governments hinge on a proper understanding and assessment of data. Every facet of industry, science, engineering, economics and business benefits from a solid knowledge of statistics.

Statistics uses the major ideas and concepts from probability. Only via the use of probability can a proper assessment be made of data collected for real-world problems. Math 162 provides opportunities to experience and learn the statistical thinking a functioning statistician must develop and use constantly. It also provides preparation for actuarial exams, graduate work in applied mathematics, and courses in physical/social sciences requiring statistical methodology. Topics to be covered include 1) estimating an unknown parameter of the underlying population, 2) turning data into evidence, as in testing a hypothesis, 3) determining existence and strength of a correlation between several variables, 4) making predictions, 5) testing models for goodness-of-fit, etc.
Course Information

Block: F+ (Tuesday, Thursday 12-1:20)
Instructor: Marjorie Hahn
Email: marjorie.hahn@tufts.edu
Office: Bromfield-Pearson 202
Office hours: (Fall 2013) Friday 9:30-10:30 or by appointment
Phone: (617) 627-2363
Prerequisites: Measure Theory (Math 211) or consent, no prior probability assumed.


Course description: This course teaches students how to think probabilistically and provides the essential background in probability for graduate students to do innovative research in probability/stochastic processes or to read, understand, and apply probabilistic thinking, theory, and methods to their own investigations in other areas of mathematics or in applications. It also provides practice in using the tools of analysis learned in Math 211.

Probability provides a way of thinking that can bring new insights to all areas of pure and applied mathematics. Measure theoretic probability theory combines the powerful tools of measure theory and special intuition provided by probabilistic thinking to provide realistic models for complicated phenomena together with enhanced methods for analyzing and answering questions about the models. Some advantages of probabilistic models include the facts that they:

- Include inherent ways for assessing error and risk, hence their wide use in statistics, financial mathematics, as well as the physical, social and medical sciences;

- Provide ways to initiate investigation of the behavior of unknown processes via assessment of their statistical properties;

- Augment knowledge of a process whose dynamics are specified by partial differential equations, often via a corresponding random process with the same dynamics, but from which much finer information about the nature of the process can be extracted.

Focus: The “Big Ideas” in Probability: Independence (including zero-one laws, random walks, laws of large numbers); Weak convergence (including central limit theory); Martingale theory (including the important technique of conditioning); Brownian motion (including the strong Markov property); Stochastic integration
Math 216  Groups and Fields  Spring 2014

Course Information

**Block:** C (Tuesday, Wednesday, Friday 9:30-10:20)
**Instructor:** Richard Weiss
**Email:** rweiss@tufts.edu
**Office:** Bromfield-Pearson 116
**Office Hours:** (Fall 2013) Monday, Wednesday, Friday 1:30 - 2:30
**Phone:** (617) 627-3802

**Prerequisites:** Math 215 and/or an interest in Coxeter groups (for the second half)

**Text:** *Abstract Algebra* (3rd Ed.) by Dummit and Foote

**Course Description:**
In the first five weeks of this course, we will study Galois theory using Chapters 13 and 14 in the textbook.

Beginning approximately February 24, we will start afresh with a unit on Coxeter groups. We will introduce Coxeter groups and investigate properties of this important and extraordinary class of groups. We will then continue with various topics involving groups acting on trees, on generalized polygons and on other geometric structures.

Students who are not interesting in attending the first part of the course on Galois theory are welcome to join us for the second part.

The learning objectives of this course are those numbered 1a–e, 2a–b (for the PhD Program) on the Math Department website.

If you are requesting an accommodation due to a documented disability, you must register with the Disability Services Office at the beginning of the semester. To do so, call the Student Services Desk at 617-627-2000 to arrange an appointment with Linda Sullivan, Program Director of Disability Services.
Math 218             Lie Groups             Spring 2014
Course Information

BLOCK: H+ (Tuesdays and Thursdays, 1:30 – 2:45 p.m.)
INSTRUCTOR: Fulton Gonzalez
EMAIL: fulton.gonzalez@tufts.edu
OFFICE: Bromfield-Pearson 203
OFFICE HOURS: (Fall 2013) Tuesdays 10:00a.m. – 1:00 p.m.
PHONE: (617) 627-2368

PREREQUISITE: Math 217


COURSE DESCRIPTION: A Lie group is a group which is also a manifold in which the group operations are $C^\infty$ maps. Lie groups are very important objects of study because they are the natural object for describing symmetries in mathematics and physics. They are named after Sophus Lie, a Norwegian mathematician in the latter half of the nineteenth century, who studied local continuous transformation groups, particularly in the context of symmetries of differential equations.

Lie groups and the related concept of principal fiber bundle are at the center of modern differential geometry. They are also play an indispensable role in physics. For example, the irreducible representations of the rotation group SO(3) explain the distribution of atomic structures, which leads to the periodic table of elements. Gauge groups, such as $SU(3) \times SU(2) \times U(1)$ for the standard model, are important in explaining the field theories of elementary particles. Lie groups are also important in quantum field theory and string theory, the “theory of everything.”

Finally, Lie groups are beautiful because they combine geometry, algebra, and analysis in fundamental but often surprising and unexpected ways. For example, symmetric spaces are defined geometrically, their properties are studied analytically, and their classification (by Élie Cartan in the early twentieth century) is completed algebraically.

In the first half of the course, we will study basic Lie theory, including the exponential mapping, Lie subgroups and subalgebras, the adjoint group, Lie transformation groups, homogeneous spaces and orbits, and compact, nilpotent and semisimple Lie groups.

In the second half of the course, we will study basic representation theory and the structure theory of semisimple Lie algebras, including Cartan’s classification.
Math 250  
Tomography  
Course Information  
Spring 2013

Block: J+ (Tuesday, Thursday 3:00-4:15)
Instructor: Todd Quinto (course coordinator)
Email: todd.quinto@tufts.edu
Office: Bromfield-Pearson 204
Office hours: (Fall 2013) (just e-mail and we can talk (I’m on sabbatical))
Phone: (617) 627-3402

Prerequisites: Math 211 or consent

Recommended Texts:


Course description:

Tomography is the mathematics behind medical and industrial CAT scanners, as well as other imaging methods in medicine, industry, and science. In each case indirect data, such as from X-rays, is used to find the internal structure of objects. Tomography has revolutionized diagnostic medicine; now doctors diagnose conditions such as stroke, epilepsy, tumors, and Alzheimer’s disease without doing exploratory surgery. Scientists use electron microscope tomography to discover the subcellar and molecular structure of biological specimens, and engineers use tomography to find structural defects in industrial nondestructive evaluation.

We will learn the mathematical analysis and applied mathematics that underlies the field. We will also do some programming in any language you like (e.g., C, C++, Fortran, Matlab, or ...). We will start with some functional analysis (distributions and Fourier transform and Sobolev Spaces). Then we will the basic formulas, properties, and algorithms for the Radon line transform. We will explore limited data problems which come up in medical and industrial CT, electron microscopy, and other situations. We plan to study other tomographic transforms, including those behind Sonar, synthetic aperture radar, and emission tomography.

We will cover microlocal analysis, a precise and powerful theory that allows one to rigorously characterize singularities of functions. We prove the microlocal properties of the Radon transform. This will give us a paradigm to understand limitations intrinsic to each of the tomography problems we study.

I anticipate having weekly homework, a final test, and perhaps presentations at the end of the course.
Math 250  Schemes  Spring 2014
Course Information

Block: D+ (T, Th 10.30-11.45)
Instructor: Montserrat Teixidor
Email: mteixido@tufts.edu
Office: Bromfield-Pearson 115
Office hours: (Fall 2012) Monday 10:30 - 11:30, Thursday 9.30-10.30 and by appointment
Phone: (617) 627-2358

Prerequisites: Math 215 or consent.


Course description: Algebraic Geometry is the study of algebraic varieties, essentially the zero set of polynomial equations in $\mathbb{R}^n$ (or more generally $K^n$ for any field $K$). Think for example of lines, planes, conics and quadrics in the plane or 3-dimensional space. The study of algebraic geometry is the natural continuation of the classical problem of algebra of finding the roots of a polynomial while building on the geometric point of view.

Maps between two varieties are given by restriction of polynomial functions on the ambient space. Because two polynomial maps will be identical if their difference vanishes on the variety, these maps correspond to the quotient of the ring of polynomials by the ideal generated by the equations that define the variety. This establishes a correspondence between affine varieties and finitely generated $K$-algebras. Schemes are built by gluing together these affine pieces much in the same way as manifolds are obtained by gluing subsets of $\mathbb{R}^n$. This point of view puts points and maps in an equal footing and allows to deal with many interesting problems like parameter spaces (that is varieties each of whose points correspond to a variety of a specified type), intersections or compactifications.

This course, will introduce schemes and its applications. It does not assume prior knowledge of Algebraic Geometry, examples will be provided all along.
Math 250-03  Algebraic Topology  Spring 2014
Course Information

Block:  E+ (Monday, Wednesday 10:30 - 11:45)
Instructor: Genevieve Walsh
Email: genevieve.walsh@tufts.edu
Office: Robinson 156
Office hours: (Fall 2013) By Appointment
Phone: (617) 627-4032

Prerequisites: Math 135 and 145, or equivalent. Graduate standing or consent of the instructor.


Course description: Algebraic Topology is the study of algebraic invariants associated to topological spaces. This course will approach this study from a decidedly geometric viewpoint. We will begin by reviewing some underlying notions, such as homotopy. We will then define the fundamental group, and compute it for lots of examples, using Van Kampen’s theorem as our main tool. We will also use the fundamental group to understand covering spaces, and define a correspondence between subgroups of the fundamental group of a space and covers of that space. Given a group $G$, we will construct a space whose homotopy type depends only on its fundamental group $G$.

Next we will turn to an abelian theory, homology. Although somewhat more complicated to define, this is an extremely useful tool. This theory assigns a sequence of abelian groups to a space, called the homology groups. The first of these groups is the abelianization of the fundamental group. Homology groups can be computed naturally using a cell complex. Finally, we will study cohomology and Poincare duality for manifolds.

Throughout, examples and geometric constructions will be emphasized, with a particular emphasis on 2- and 3-dimensional manifolds, graphs, and 2-dimensional complexes.
Math 250-04  Scientific Computing  Spring 2014
Course Information

Block: G+ MW (Monday, Wednesday 1:30 - 2:45)
Instructor: Misha Kilmer
Email: misha.kilmer@tufts.edu
Office: Bromfield-Pearson 103
Office hours: (Fall 2013) Wednesdays 2:00 - 3:00
Phone: (617) 627-2005

Course description: TBA
Math 250-05  Numerical Linear Algebra  Spring 2014

Course Information

Block: D+
Instructor: Kye Taylor
Email: kye.taylor@tufts.edu
Office: Bromfield-Pearson 217
Office hours: (Fall 2013) Tuesday and Thursday 10a-12p, Friday 10a-11a, and by appt.

Prerequisites: Math 70, Comp 11 or equivalent


Course Description:

We will study the algorithms and the relevant matrix theory for computing the solution to several linear algebra problems of great interest in a wide variety of science and engineering applications. The list of linear algebra problems we will consider includes solving linear systems through direct and iterative techniques, (orthogonal) matrix factorization, and eigenvalue/eigenvector computation. We will build on the basic linear algebra concepts (i.e. range, null space, vector subspaces, orthogonal projections) and tools from a standard linear algebra course. While paying attention to computer storage, operations counts and finite precision arithmetic, we will learn how tools from linear algebra can be used to solve real-world problems. In-class examples and homework problems will feature some of these applications (e.g. optimization, data mining, and image processing). Because this is a graduate course, we will cover state-of-the-art algorithms/theory and open research problems in the field.

Homework problems will consist of proofs as well as computer programming assignments in MATLAB (or your favorite programming language). (No previous programming experience in MATLAB is assumed as an outside-class tutorial session will be offered early in the semester.)
MATHEMATICS MAJOR CONCENTRATION CHECKLIST
For students matriculating Fall 2012 and after (and optionally for others)
(To be submitted with University Degree Sheet)

Name: I.D.#: 
E-Mail Address: College and Class: 
Other Major(s): 
(Note: Submit a signed checklist with your degree sheet for each major.)

Please list courses by number. For transfer courses, list by title, and add “T”. Indicate which courses are incomplete, in progress, or to be taken.
Note: If substitutions are made, it is the student’s responsibility to make sure the substitutions are acceptable to the Mathematics Department.

Ten courses distributed as follows:
I. Five courses required of all majors. (Check appropriate boxes.)

1. □ Math 42: Calculus III or
   □ Math 44: Honors Calculus
2. □ Math 70: Linear Algebra or
   □ Math 72: Abstract Linear Algebra
3. □ Math 135: Real Analysis I
5. □ Math 136: Real Analysis II or
   □ Math 146: Abstract Algebra II

We encourage all students to take Math 70 or 72 before their junior year. To prepare for the proofs required in Math 135 and 145, we recommend that students who take Math 70 instead of 72 also take another course above 50 (in the new numbering scheme) before taking these upper level courses.

II. Two additional 100-level math courses.

III. Three additional mathematics courses numbered 50 or higher (in the new numbering scheme); up to two of these courses may be replaced by courses in related fields including:
   Chemistry 133, 134; Computer Science 15, 126, 160, 170; Economics 107, 108, 154, 201, 202; Electrical Engineering 18, 107, 108, 125; Engineering Science 151, 152; Mechanical Engineering 137, 138, 150, 165, 166; Philosophy 33, 103, 114, 170; Physics 12, 13 any course numbered above 30; Psychology 107, 108, 140.

1. ____________
2. ____________
3. ____________

Advisor’s signature: Date: 
Chair’s signature: Date: 

Note: It is the student’s responsibility to return completed, signed degree sheets to the Office of Student Services, Dowling Hall. 
(form revised September 23, 2013)
**APPLIED MATHEMATICS MAJOR CONCENTRATION CHECKLIST**
*(To Be Submitted with University Degree Sheet)*

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**Other Major(s):**
*(Note: Submit a signed checklist with your degree sheet for each major.)*

Please list courses by number. For transfer courses, list by title, and add “T”. Indicate which courses are incomplete, in progress, or to be taken.  
*Note: If substitutions are made for courses listed as “to be taken”, it is the student’s responsibility to make sure the substitutions are acceptable.*

Thirteen courses beyond Calculus II. These courses must include:

**I. Seven courses required of all majors. (Check appropriate boxes.)*

1. [ ] Math 42: Calculus III  or  4. [ ] Math 87: Mathematical Modeling
   [ ] Math 44: Honors Calculus III  5. [ ] Math 158: Complex Variables
2. [ ] Math 70: Linear Algebra  or  6. [ ] Math 135: Real Analysis I
3. [ ] Math 51: Differential Equations

**II. One of the following:**

   Comp 15: Data Structures  Math/Comp 163: Computational Geometry

**III. One of the following three sequences:**

   Math 151/152: Applications of Advanced Calculus/Nonlinear Partial Differential Equations
   Math 161/162: Probability/Statistics

**IV. An additional course from the list below but not one of the courses chosen in section III:**


**V. Two electives (math courses numbered 61 or above are acceptable electives. With the approval of the Mathematics Department, students may also choose as electives courses with strong mathematical content that are not listed as Math courses.)*

1. [ ]  
2. [ ]

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**Advisor’s signature:**  
**Date:**

**Chair’s signature:**  
**Date:**

*Note: It is the student’s responsibility to return completed, signed degree sheets to the Office of Student Services, Dowling Hall.  
(form revised September 6, 2013)*
# DECLARATION OF MATHEMATICS MINOR

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<td>College and Class:</td>
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<td>Major(s)</td>
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**Faculty Advisor for Minor (please print)**

## MATHEMATICS MINOR CHECKLIST

Please list courses by number. For transfer courses, list by title and add “T”. Indicate which courses are incomplete, in progress, or to be taken.

Courses numbered under 100 will be renumbered starting in the Fall 2012 semester. Courses are listed here by their new number, with the old number in parentheses.

*Note: If substitutions are made for courses listed as “to be taken”, it is the student’s responsibility to make sure that the substitutions are acceptable.*

Six courses distributed as follows:

I. Two courses required of all minors. (Check appropriate boxes.)

1. □ Math 42 (old: 13): Calculus III  
2. □ Math 70 (old: 46): Linear Algebra

   or

1. □ Math 44 (old: 18): Honors Calculus  
2. □ Math 72 (old: 54): Abstract Linear Algebra

II. Four additional math courses with course numbers Math 50 or higher (in the new numbering scheme).

   These four courses must include Math 135: Real Analysis I or 145: Abstract Algebra (or both).

   *Note that Math 135 and 145 are only offered in the fall.*

   1. ______________  
   2. ______________
   3. ______________  
   4. ______________

**Advisor’s signature**  
**Date**

*Note: Please return this form to the Mathematics Department Office*  
*(Form Revised September 23, 2013)*
Jobs and Careers

The Math Department encourages you 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 (http://equinto.math.tufts.edu) is a good source.

Career Services in Dowling Hall has information about writing cover letters, resumes and job-hunting in general. They also organize on-campus interviews and networking sessions with alumni. 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 involves 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. Check out http://ase.tufts.edu/mathclub for more information.

The SIAM Student Chapter

Students in the Society for Industrial and Applied Mathematics (SIAM) student chapter organize talks on applied mathematics by students, faculty and researchers in industry. It is a great way to talk with other interested students about the range of applied math that’s going on at Tufts. You do not need to be a math major to be involved, and undergraduates and graduate students from a range of fields are members. Check out http://neumann.math.tufts.edu/~siam for more information.
BLOCK SCHEDULE

50 and 75 Minute Classes

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<tr>
<td>1:30-2:45</td>
<td>(G+ , H+)</td>
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<tr>
<td>2:30-3:20</td>
<td>(H on Fri)</td>
<td>H</td>
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<tr>
<td>3:00-3:50</td>
<td>(I, J)</td>
<td>I</td>
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<td>3:00-4:15</td>
<td>(I+, J+)</td>
<td>I+</td>
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<td>3:30-4:20</td>
<td>(I on Fri)</td>
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<tr>
<td>4:30-5:20</td>
<td>(K, L)</td>
<td>J/K</td>
<td>K+</td>
<td>J</td>
<td>L+</td>
<td>K</td>
<td>L+</td>
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<tr>
<td>4:30-5:20</td>
<td>(J on Mon)</td>
<td>J/K</td>
<td>K+</td>
<td>J</td>
<td>L+</td>
<td>K</td>
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<td>4:30-5:45</td>
<td>(K+, L+i)</td>
<td>J/K</td>
<td>K+</td>
<td>J</td>
<td>L+</td>
<td>K</td>
<td>L+</td>
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<tr>
<td>6:00-6:50</td>
<td>(M, N)</td>
<td>N/M</td>
<td>M+</td>
<td>N</td>
<td>N+</td>
<td>M</td>
<td>M+</td>
<td>N</td>
<td>N+</td>
<td>10+</td>
<td>11+</td>
<td>12+</td>
</tr>
<tr>
<td>6:00-7:15</td>
<td>(M+, N+)</td>
<td>M+</td>
<td>10+</td>
<td>N</td>
<td>N+</td>
<td>M</td>
<td>M+</td>
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<tr>
<td>7:30-8:15</td>
<td>(P, Q)</td>
<td>Q/P</td>
<td>P</td>
<td>Q</td>
<td>Q+</td>
<td>P</td>
<td>Q+</td>
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<td>7:30-8:45</td>
<td>(P+, Q+)</td>
<td>Q/P</td>
<td>P</td>
<td>Q</td>
<td>Q+</td>
<td>P</td>
<td>Q+</td>
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Notes:
- A plain letter (such as B) indicates a 50 minute meeting time.
- A letter augmented with a + (such as B+) indicates a 75 minute meeting time.
- A number (such as 2) indicates a 150 minute class or seminar. A number with a + (such as 2+) indicates a 180 minute meeting time.
- Lab schedules for dedicated laboratories are determined by department/program.
- Monday from 12:00-1:20 is departmental meetings/exam block.
- Wednesday from 12:00-1:20 is the AS&E-wide meeting time.
- If all days in a block are to be used, no designation is used. Otherwise, days of the week (MTWRF) are designated (for example, E+MW).
- Roughly 55% of all courses may be offered in the shaded area.
- Labs taught in seminar block 5+ to 9+ may run to 4:30. Students taking these courses are advised to avoid courses offered in the K or L block.