This booklet contains the complete schedule of courses offered by the Math Department in the Fall 2019 semester, as well as descriptions of our upper-level courses and a few lower-level courses. For descriptions of other lower-level courses, see the University catalog.

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

Descriptions may not be available for all courses*

Course schedule
Math 61
Math 63
Math 123
Math 135
Math 136
Math 145
Math 150-01
Math 151
Math 155
Math 161
Math 168
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Applied Mathematics Major Concentration Checklist
Mathematics Minor Checklist
Jobs and Careers, Math Society, and SIAM
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<tr>
<td>Math 0019</td>
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<td>Social Choice</td>
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<td>TR - 01:30PM-02:45PM</td>
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Math 61 Discrete Mathematics Fall 2019
Course Information

BLOCK: H+, TuTh 1:30-2:45
INSTRUCTOR: David Smyth
EMAIL: david.smyth@tufts.edu
OFFICE: Bromfield-Pearson 217
OFFICE HOURS: TBA

PREREQUISITE: No formal prerequisites. Readiness to think deeply about challenging material is, however, essential.

TEXT: You are not required to own a copy of the text, but the book we will follow is *Mathematical Thinking: Problem-Solving and Proofs* (2nd Edition) by John D’Angelo and Douglas West.

COURSE DESCRIPTION: This course has two primary goals. The first is to introduce you to the basic conceptual building blocks - sets, functions, and relations - that lie at the foundation of all higher mathematics and computer science. The second is to give you experience in developing, writing, and explaining mathematical proofs. You will practice these skills each week by writing up solutions to a range of interesting problems across discrete mathematics. In particular, we will cover the following topics.

1. Set Theory, the building blocks of mathematical universe
2. Logical quantifiers and connectives, the building blocks of logical statements
3. Induction, i.e. how to prove infinitely many statements in a finite amount of time.
4. Functions, Bijections, and Cardinality.
5. Binomial Coefficients and Combinatorics.
6. Number Theory and Modular Arithmetic
7. Probability Theory and Game Theory
8. Graph Theory
BLOCK: E+ Monday Wednesday 10:30 - 11:45  
INSTRUCTOR: Genevieve Walsh  
EMAIL: genevieve.walsh@tufts.edu  
OFFICE: SEC LL 011  
OFFICE HOURS: (Fall 2019) Tu, Th 9:00-10:30 and by appointment

PREREQUISITE: Math 42 (Multivariate Calculus), willingness to present in class. Linear Algebra (70) or Combinatorics (61) is helpful, but not required.


COURSE DESCRIPTION: This is a course in basic number theory. To that end, the topics we consider will be divisibility, the fundamental theorem of arithmetic, prime numbers, modular arithmetic, public Key Cryptography, and theorems of Euler and Fermat. With some luck we will get to polynomial congruences. Number Theory is an incredibly beautiful subject, with applications in many areas of mathematics, computing, and the sciences. It is also very amenable to being built up from definitions and basic properties of numbers.

This is also a course where you will become very adept at proving theorems, making up your own conjectures, and deciding if other people’s theorems are correct. The course will be taught in a “Inquiry based learning style”, where you are given a list of definitions and theorems and questions, and the proofs and answers are up to the class. Almost every day, students will be presenting material that they have prepared, and the class will be deciding if they accept the proofs. This is a lot like “real” mathematics, in that problems are considered open until they are proven to the satisfaction of the class. This is a great way to learn mathematics, and to become more comfortable with proofs. It is also very fun!
Math 123 Mathematical Aspects of Data Analysis Fall 2019

Course Information

BLOCK: J+, TuTh 3:00–4:15
INSTRUCTOR: James Murphy
EMAIL: jm.murphy@tufts.edu
OFFICE: Bromfield-Pearson 208
OFFICE HOURS: (Fall 2019) Tu, Th 4:30-6:00 and by appointment
PHONE: 617-627-3235

PREREQUISITE: Math 42 (Multivariate Calculus), Math 70 (Linear Algebra) or Math 72 (Abstract Linear Algebra), and willingness to do Matlab programming. Matlab experience is helpful, but not required.

TEXT: We will use Christoph Börgers slides as a reference. Course notes will be posted after each lecture on the instructor’s website. Two useful references are (Zaki, M.J., and W. Meira. Data Mining and Analysis: Fundamental Concepts and Algorithms. Cambridge University Press, 2014) and (Hastie, T., R. Tibshirani, and J. Friedman. The Elements of Statistics Learning. Springer).

DESCRIPTION: The course is an introduction to mathematical data science. No specific background in probability theory, statistics, or machine learning is required. The course will emphasize theory, but will also program in MATLAB. Topics include:

- Principal component analysis, singular value decompositions, kernel principal component analysis
- Introductory numerical linear algebra
- Basic methods for unsupervised learning: k-means, hierarchical clustering, density methods
- Spectral graph theory
- Nearest neighbor classification
- Separating hyperplanes and support vector machines
- Introduction to neural networks and deep learning
- Applications to image processing and network analysis
Math 135  Real Analysis I  Fall 2019
Course Information

BLOCK: G+MW (Mon., Wed. 1:30–2:45)  BLOCK: E+MW (Mon., Wed. 10:30–11:45)
INSTRUCTOR: Zbigniew Nitecki  INSTRUCTOR: Loring Tu
EMAIL: zbigniew.nitecki@tufts.edu  EMAIL: Loring.tu@tufts.edu
OFFICE: Bromfield-Pearson 214  OFFICE: Bromfield-Pearson 206
OFFICE HOURS: (Spring 2019)  OFFICE HOURS: (Spring 2019)
MON. 11:30-12:00, WED & FRI 11:30-12:45  Mon Wed 2:45–3:45 and most afternoons
PHONE: (617) 627-3843  PHONE: (617) 627-3262

PREREQUISITES: Math 42 or 44, and 70, or consent.
TEXT: To be determined

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 32, 34, and 42, where the emphasis is on intuition and computation, the
emphasis in real analysis is on justification and proofs.¹

In this course, we will study the topology of the real line and Euclidean space as well as
other metric spaces, compactness, connectedness, continuous mappings, and uniform convergence.
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.

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).

¹Students who have taken Math 44 will see much that is familiar, but in a much grander setting. Similarly, your
proof-reading and-writing skills will be taken to a higher level.
Math 136  Real Analysis II  Fall 2019

Course Information

BLOCK: K+, Mon Wed 4:30–5:45
INSTRUCTOR: Loring Tu
EMAIL: loring.tu@tufts.edu
OFFICE: Bromfield-Pearson 206
OFFICE HOURS: (Spring 2019) Mon Wed 2:45–3:45 and most afternoons
PHONE: (617) 627-3262

PREREQUISITE: 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 three main topics: derivatives, integrals, and Fourier series, useful in fields as diverse as physics and economics.

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) and the mean-value theorem, familiar from calculus course. Two new results are the implicit function theorem, giving conditions under which a system of equations can be solved locally, and the inverse function theorem, giving conditions under which a function is locally invertible.

We will define the Riemann integral for functions \( f: A \to \mathbb{R} \) where \( A \) is a bounded subset of \( \mathbb{R}^n \). This will allow us to define the volume of many sets in \( \mathbb{R}^n \). For example, the volume of the unit interval \([0, 1] \subset \mathbb{R}\) is one, as you might guess. However, the set of rational numbers in \([0, 1]\) does not have volume. We define a generalization, sets of measure zero (such as \( \mathbb{Q} \cap [0, 1] \)), and use this concept to characterize the functions that are Riemann integrable. We prove some familiar theorems such as Fubini’s theorem and the change of variables formula.

Finally, we will learn Fourier Series and Hilbert Spaces. Using concepts from real analysis, we will solve the partial differential equation describing heat distribution in an insulated rod. We anticipate proving that the solution becomes infinitely smooth as soon as the experiment starts and that the temperature of every point on the rod approaches the average temperature as time increases.

There will be weekly problem sets, two tests during the term, and a cumulative final exam.
Math 145 Abstract Algebra
Course Information

Block: B, TThF, 8.30 -9.20 AM
Instructor: Kim Ruane
Email: Kim.Ruane@tufts.edu
Office: SEC LL009
Office hours: (Spring 2019) By appoint.
Phone: 617-627-2006

Block: D+ (Tu, Th 10:30-11:45)
Instructor: montserat teixidor
Email: mteixido@tufts.edu
Office: Bromfield-Pearson 115
Office hours: (Spring 2019) By appoint.
Phone: (617) 627-2358

Prerequisites: Math 70 or 72. Recommended: a proof course such as MATH 61, 63 or 72.


Course description: Algebra, along with Analysis and Geometry is one of the main pillars of mathematics. Historically (and in your high school curriculum), algebra was concerned with the manipulation of equations and, in particular, with the problem of finding the roots of polynomials. The Babylonians already knew how to solve quadratic equations. The solutions to cubic and fourth degree polynomial equations were solved in Italy during the Renaissance. About the time of Beethoven, a young French mathematician Evariste Galois made the dramatic discovery that for polynomials of degree greater than four, no similar solution exists and in the process, introduced the branch of mathematics known as group theory. Algebra has continued its development to the present day most notably with the classification of finite simple groups and with Andrew Wiles proof of Fermat’s Last Theorem. The concept of a group is now one of the most important in mathematics. Roughly speaking, group theory is the study of symmetry. There are deep connections between group theory, geometry and number theory. Groups pop up in every area of mathematics: symmetry groups can be used to find solutions to differential equations, associating groups (and rings) to topological spaces allows to distinguish among them. Groups also appear in the attempts of physicists to describe the basic laws of nature.

In Math 145, we introduce the concepts of group and ring. Their properties mimic the arithmetic properties of numbers and polynomials. Studying groups in the abstract allows us to understand the underlying structures that appear in each specific examples and provides uniform methods to deal with problems. For the connection Galois discovered between group theory and the roots of polynomials, you will need to wait till Math 146.
PREREQUISITE: Math 70 Linear Algebra, Math 72 Abstract Linear Algebra, or consent of the instructor.

COURSE DESCRIPTION: It is hard to overemphasize the ubiquity with which linear algebra appears in mathematics, physical and life sciences, economics, etc. This course should provide a broader perspective about some of these mathematical applications.

This is a second course in linear algebra. I’ll assume that you know basic definitions and results of linear algebra. The course is especially recommended for anyone who enjoyed the first semester of linear algebra and desires to gain some breadth and depth in the subject.

The course will begin by reviewing some of the foundations of linear algebra both for recall and to emphasize coordinate-free language. We’ll discuss the following:

- bases, coordinates, linear transformations, including invariant subspaces, determinants.
- inner product spaces, including orthogonal complements and orthogonal projections.
- eigenvalues, including notions of multiplicity, and the characteristic polynomial.

Having considered these foundations, we’ll go on to examine a number of further interesting results and applications, which tentatively include:

- canonical forms of matrices including the Jordan normal form.
- unitary similarity and normal matrices, including the spectral theorem.
- Hermitian matrices, including polar factorization and singular-value decomposition.
- matrix exponentials and connection to solutions of systems of linear differential equations.
- simultaneous tringularization of matrices and invariant subspaces.
- finite fields and error-correcting codes.


I expect that the course will have a midterm, a final, and weekly homework sets.
Partial Differential Equations I
Course Information

BLOCK: P+ (Mon, Wed 7:30–8:45 pm)
INSTRUCTOR: Bruce Boghosian
EMAIL: bruce.boghosian@tufts.edu
OFFICE: 211 Bromfield-Pearson Hall
OFFICE HOURS: TBD
PHONE: (617) 627-3054

PREREQUISITES: MA 42 or MA 44, MA 51 or MA 155, and MA 70 or MA 72. (Note: MA 151 and ME 150 cannot both be taken for credit.)

TEXT: To be determined

COURSE DESCRIPTION: Partial differential equations are the principal language of mathematical science, and this course will provide the student with a working knowledge of that language. We shall derive and analyze the important prototypical linear partial differential equations for potential theory, diffusion and wave motion. We will study their fundamental solutions, mean-value formulas, maximum principles and energy principles. The mathematical tools that we will use for this purpose include elements of vector calculus, linear algebra, ordinary differential equations, Sturm-Liouville problems, special functions, Fourier series, eigenfunction expansions, Fourier transforms and Green’s functions.

This course is suitable for upper level undergraduate and beginning graduate students from Mathematics, Engineering, Biology, Chemistry and Physics.
Course Information

Time: Block T+, T Th 9:00-10:15am
Instructor: Eunice Kim
Office: SEC LL 010
Office hours: TBA
Phone: 617-627-6308
e-mail: eunice.kim@tufts.edu

Prerequisites: One of the following two: Math 42 or Math 44, and one of the following three: Math 51 or Math 70 or Math 72.


Content: The mathematical ideas studied in the course are:

1. existence and uniqueness of solutions of initial value problems
2. equilibria and their stability
3. limit cycles (oscillations) and their stability
4. saddle-node, pitchfork, transcritical, Hopf, and homoclinic bifurcations, and structural stability of bifurcations
5. flows and their reduction to iterated maps
6. chaotic dynamics, strange attractors, fractal dimension

This is a course on ordinary differential equations, with emphasis on qualitative, geometric aspects of the subject. Main mathematical ideas will be motivated and illustrated extensively using applications such as population growth models, computational epidemiology and thresholds in epidemics, the competitive exclusion principle in ecology, predator-prey cycles, chemical oscillators, chaos and coding, billiard problems.

The course is suitable for upper level undergraduate and beginning graduate students from Mathematics, Engineering, Biology, Chemistry, and Physics. Applied Mathematics majors can use Math 155 in place of Math 51 to satisfy their Differential Equations requirement.
Course Information

**BLOCK:** M+, MW 6-7:15  
**INSTRUCTOR:** Christoph Börgers  
**EMAIL:** cborgers@tufts.edu  
**OFFICE:** Bromfield-Pearson 215  
**OFFICE HOURS:** (Spring 2019) Tu 3–4:30, Th 10:30–12, and by appointment  
**PHONE:** (617) 627-2366

**PREREQUISITE:** Math 42 (Calculus III) or Math 44 (Honors Calculus III), or permission

[https://www.math.dartmouth.edu/~prob/prob/prob.pdf](https://www.math.dartmouth.edu/~prob/prob/prob.pdf)

---

**COURSE DESCRIPTION:**

Probability theory is both one of the most useful areas of applied mathematics, and at the same time a major area of pure mathematics (a branch of analysis). The emphasis in this course is on concepts, examples, and applications. The goal is to learn the basic ideas of probability theory in an intuitive way, and get a feeling for some of its many applications.

The course is full of interesting paradoxes illustrating the failures of our “common sense” intuition about randomness. Here is just one example. Suppose subway trains arrive in the station at completely random times. Your friend, who operates a newsstand in the station, has recorded the times of train arrivals carefully, over a long time period. She reports that on the average, trains arrive every 10 minutes. You arrive at the station every morning sometime between 8 and 9. You seem to have to wait an annoyingly long time for the next train arrival on the average — so you decide to keep a log, and discover that your average wait is a full 10 minutes. If your friend is right, it seems that each morning, the train operator waits for you, and departs just as you arrive on the platform, to spite you. But trains operate on a random schedule, and anyway you aren’t the kind of person who believes in conspiracies. There is only one rational explanation: You ask your newsstand friend if the trains arrive less frequently during morning rush hour. No, she replies, mornings, afternoons, evenings are all the same — always an average 10 minutes between train arrivals. Both you and your friend have kept accurate records, and averaged correctly. You will learn what explains this waiting time paradox. It reveals a surprising flaw in our intuition about random schedules. (It also has very interesting consequences in Physics.)

The mathematical high point of the course is the central limit theorem. It is among the most astonishing results in the undergraduate mathematics curriculum, and without question one of the most important results in all of mathematics. It explains the fundamental role played by the function $e^{-x^2}$ in understanding the cumulative effect of many small random events. The graph of this function is the famous bell-shaped curve.
Math 168 Algebraic Topology
Course Information

BLOCK: H+ (Tu, Thur 12:00–13:15)
INSTRUCTOR: Robert Kropholler
EMAIL: robert.kropholler@tufts.edu
OFFICE: SEC 010
OFFICE HOURS: (Spring 2019) Tu, Thur 12 – 13:15
PHONE: (617) 627-2363

PREREQUISITES: Basic knowledge of group theory, at least 1 course above the 100 level or consent.

TEXT: Topology and Groups by Marc Lackenby.

COURSE DESCRIPTION: Topology is the subject of understanding topological spaces up to continuous deformations and stretching. However, given two topological spaces, it can be tricky to understand whether they are the same. For instance, it is often said that a topologist can’t tell the difference between a donut and a coffee mug, yet we can tell the difference between a sphere and a donut.

Many topological spaces can be differentiated from one another by algebraic invariants. These come in many flavours, such as homotopy \( \pi_n(X, b) \), homology \( H_n(X) \), and cohomology \( H^n(X) \). I will discuss the first of these and focus primarily on \( \pi_1(X, b) \), also known as, the fundamental group. I will start by recalling the definitions from topology required for the course. I will then define simplicial and cellular complexes, which form a large class of topological spaces. These will be used to give concrete examples later in the course.

I will define homotopy and the fundamental group \( \pi_1(X, b) \), with some examples being discussed. We will then study groups via group presentations, which will allow us to define one of the key theorems: understanding the fundamental group of a space by breaking it into smaller spaces (the Seifert-van Kampen Theorem). The remainder of the course will consider covering spaces which prove to be very useful throughout the subject of algebraic topology.
Define the function \( f(x) \) on the interval \([0, 1]\) by

\[
f(x) = \begin{cases} 
1 & \text{if } x \text{ is rational}, \\
0 & \text{if } x \text{ is irrational}.
\end{cases}
\]

It is easy to see that the Riemann integral\(^1\) of \( f(x) \), defined as the limit of Riemann sums, does not exist. However, since almost all; i.e., all except a countable number of, real numbers are irrational, one would, in a sense, want the integral of \( f(x) \) to exist and be equal to zero. Lebesgue’s theory of integration, which first appeared in his famous 1904 book *[Lecons sur intégration et la recherche des fonctions primitives]*, Gauthier-Villars, Paris, 1904; second edition, 1928] treats discontinuous functions as “natural” objects to integrate and paves the way for integration on spaces besides Euclidean space (e.g. topological groups). It is immediate from Lebesgue’s construction that the integral of \( f(x) \) exists and equals zero.

In this course, we will introduce measure theory and the tools needed to define abstract integrals, and in particular the Lebesgue integral on \( \mathbb{R}^n \). We will explore important concepts such as the great convergence theorems (i.e., under what conditions is \( \lim \int f_n = \int \lim f_n \)?), \( L^p \) spaces, Banach and Hilbert spaces, complex measures, and various ways of differentiating measures, including the Radon-Nikodym Theorem. Finally, we study Fourier transforms and some applications. The course will roughly follow the first eight chapters of Rudin’s book.

There will be two exams - a midterm and a final - as well as weekly problem sets.

\(^1\)Which was actually formally defined by Cauchy.
Course Information

**LOCK**: J+, TuTh 3:00-4:15
**INSTRUCTOR**: David Smyth
**EMAIL**: david.smyth@tufts.edu
**OFFICE**: Bromfield-Pearson 217
**OFFICE HOURS**: TBA

**PREREQUISITE**: First course in groups and rings.

**TEXT**: There is no required text, but *Algebra* by Artin and *Abstract Algebra* by Dummit and Foote are standard references for this material.

**COURSE DESCRIPTION**: The first part of the course will focus on group theory. I expect to cover group actions, the Sylow theorems, classification of groups of small order, and the representation theory of finite groups. The second part of the course will cover some foundational results in commutative and homological algebra: commutative rings, modules, categories, functors, and derived functors.
Block: E+MW (Mon, Wed 10:30-11:45 a.m.)
Instructor: Zbigniew Nitecki
Email: znitecki@tufts.edu
Office: Bromfield-Pearson 214
Office hours: (Spring 2019) M 11:40-12:15, WF 11:40-12:55
Phone: (617) 627-3843

Prerequisites: Math 135, 136, and 145.


Course description:

Undergraduate calculus progresses from differentiation and integration of functions on the real line to functions on the plane and in 3-space. Then one encounters vector-valued functions and learns about integrals on curves and surfaces. Real analysis extends differential and integral calculus from $\mathbb{R}^3$ to $\mathbb{R}^n$. This course is about the extension of calculus from curves and surfaces to higher dimensions.

The higher-dimensional analogues of smooth curves and surfaces are called *manifolds*. Higher-dimensional manifolds arise even if one is interested only in the three-dimensional space which we inhabit. For example, if we call a rotation followed by a translation an affine motion, then the set of all affine motions in $\mathbb{R}^3$ is a six-dimensional manifold. As another example, the zero set of a system of equations is often, though not always, a manifold. We will study conditions under which a topological space becomes a manifold. Combining aspects of algebra, topology, and analysis, the theory of manifolds has found applications to many areas of mathematics and even classical mechanics, general relativity, and quantum field theory.

Topics to be covered included manifolds and submanifolds, smooth maps, tangent spaces, vector bundles, vector fields, Lie groups and their Lie algebras, differential forms, exterior differentiation, orientations, and integration.

There will be weekly problem sets, a midterm, and a final. Students who have not take Math 136 (Real Analysis II) may take it concurrently with this course. Undergraduates who have done well in the prerequisite courses should find this course within their competence.
MATHEMATICS MAJOR CHECKLIST

STUDENTS: Submit with the Advisement Report and any other major or minor checklists to the Student Services Desk by the due date. See attached for instructions and policies. If substitutions are made, it is the student’s responsibility to make sure the substitutions are acceptable to the Math Department.

Student Name: ___________________________ I.D.: _______________________
Other Major(s): __________________________ Minors: _______________________

TEN COURSES TO BE DISTRIBUTED AS Follows:

I. Five courses required of all majors:

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Semester/Year</th>
<th>Grade</th>
<th>Credit</th>
<th>OR</th>
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<tbody>
<tr>
<td>1.</td>
<td>Math 42 Calculus III</td>
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<td></td>
<td>OR Math 44 Honors Calculus</td>
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<tr>
<td>2.</td>
<td>Math 70 Linear Algebra</td>
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<td>OR Math 72 Abstract Linear Algebra</td>
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<td>3.</td>
<td>Math 135 Real Analysis I</td>
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<td>4.</td>
<td>Math 145 Abstract Algebra I</td>
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<td>5.</td>
<td>Math 136 Real Analysis II</td>
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<td>OR Math 146 Abstract Algebra II</td>
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</table>

II. Two additional 100-level math courses.

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<th>Course Number</th>
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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, 154, 201, 202, 207; 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.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
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IV. If you have taken any other Mathematics courses that are not being used for the above requirements, and you would like to have them considered for Latin Honors, please list them here:

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<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Semester/Year</th>
<th>Grade</th>
<th>Credit</th>
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V. List any of the above courses that you are also using towards another major.

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<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Semester/Year</th>
<th>Grade</th>
<th>Credit</th>
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Student’s Signature: ___________________________ Date: ________________

I/We certify that completion of the above courses will satisfy all requirements for the Mathematics major.

Advisor’s Signature: _ Date: _

Department Chair’s Signature: _ Date: _________________

MATHEMATICS MAJOR INSTRUCTIONS AND POLICIES

- Ten courses required, beyond Calculus II.
- No major course may be taken Pass/Fail.
- If you have more than one major, please see Bulletin for rules on double-counting courses.
- If you have a minor, no more than two course credits used toward the minor may be used toward foundation, distribution, major, or other minor requirements.
- Please see Departmental Website for complete major requirements and policies.
APPLIED MATHEMATICS MAJOR CHECKLIST

STUDENTS: Submit with the Advisement Report and any other major or minor checklists to the Student Services Desk by the due date. See attached for instructions and policies. If substitutions are made, it is the student’s responsibility to make sure the substitutions are acceptable to the Math Department.

Student Name: __________________________________________ I.D.: __________________________

Other Major(s): ________________________________________ Minors: __________________________

THIRTEEN COURSES TO BE DISTRIBUTED AS FOLLOWS:

I. Seven courses required of all majors:

<table>
<thead>
<tr>
<th>Course</th>
<th>Semester/Year</th>
<th>Grade</th>
<th>Credit</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 42 Calculus III</td>
<td>_________</td>
<td>_____</td>
<td>_____</td>
<td>OR</td>
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<tr>
<td>Math 44 Honors Calculus</td>
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<tr>
<td>Math 70 Linear Algebra</td>
<td>_________</td>
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<td>OR</td>
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<tr>
<td>Math 72 Abstract Linear Algebra</td>
<td>_________</td>
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<tr>
<td>Math 51 Differential Equations</td>
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<tr>
<td>Math 155 Nonlinear Dynamics &amp; Chaos</td>
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<tr>
<td>Math 145 Abstract Algebra I</td>
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<tr>
<td>Math 61/Comp 61 Discrete Mathematics</td>
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<tr>
<td>Comp 15 Data Structures</td>
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<tr>
<td>Math/Comp 163 Computational Geometry</td>
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</table>

II. One of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Semester/Year</th>
<th>Grade</th>
<th>Credit</th>
</tr>
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<tbody>
<tr>
<td>Math 126 Numerical Analysis/</td>
<td>_________</td>
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<tr>
<td>Math 128 Numerical Algebra</td>
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<tr>
<td>Math 151 Applications of Advanced Calculus/</td>
<td>_________</td>
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<tr>
<td>Math 152 Nonlinear Partial Differential Equations</td>
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<td>Math 161 Probability</td>
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<td>Math 162 Statistics</td>
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III. One of the following three sequences:

<table>
<thead>
<tr>
<th>Course</th>
<th>Semester/Year</th>
<th>Grade</th>
<th>Credit</th>
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<tbody>
<tr>
<td>Math 126 Numerical Analysis/</td>
<td>_________</td>
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<tr>
<td>Math 128 Numerical Algebra</td>
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<tr>
<td>Math 151 Applications of Advanced Calculus/</td>
<td>_________</td>
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<tr>
<td>Math 152 Nonlinear Partial Differential Equations</td>
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<tr>
<td>Math 161 Probability</td>
<td>_________</td>
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<tr>
<td>Math 162 Statistics</td>
<td>_________</td>
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</table>
IV. An additional course from the list below but not one of the courses chosen in section III:

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Semester/Year</th>
<th>Grade</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>Math 126</td>
<td>Numerical Analysis</td>
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<tr>
<td>Math 128</td>
<td>Numerical Algebra</td>
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<tr>
<td>Math 151</td>
<td>Partial Differential Equations I</td>
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<td>Math 152</td>
<td>Partial Differential Equations II</td>
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<tr>
<td>Math 161</td>
<td>Probability</td>
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<tr>
<td>Math 162</td>
<td>Statistics</td>
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IV. Two elective courses (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.)

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Semester/Year</th>
<th>Grade</th>
<th>Credit</th>
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V. If you have taken any other Mathematics courses that are not being used for the above requirements, and you would like to have them considered for Latin Honors, please list them here:

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Semester/Year</th>
<th>Grade</th>
<th>Credit</th>
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VI. List any of the above courses that you are also using towards another major.

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<th>Course Number</th>
<th>Course Title</th>
<th>Semester/Year</th>
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Student’s Signature: ___________________________ Date: ________________

I/We certify that completion of the above courses will satisfy all requirements for the Applied Mathematics major.

Advisor’s Signature: __________ Date: __________

Department Chair’s Signature: __________ Date: __________
• Thirteen courses required, beyond Calculus II.

• No major course may be taken Pass/Fail.

• If you have more than one major, please see Bulletin for rules on double-counting courses.

• If you have a minor, no more than two course credits used toward the minor may be used toward foundation, distribution, major, or other minor requirements.

• Please see Departmental Website for complete major requirements and policies.
MATHEMATICS MINOR CONCENTRATION CHECKLIST

In addition to this form, students must complete the “Declaration of Major(s)/Minor/Change of Advisor for Liberal Arts Students” form.

Name: __________________________ I.D. #: ______________________

E-Mail Address: __________________________ College and expected graduation semester/year: __________________________

Major(s): __________________________

Faculty Advisor for Minor (please print) __________________________

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.)

If “in progress” or future semester, note semester.

1. [ ] Math 42 (old: 13): Calculus III or ______
   [ ] Math 70 (old: 46): Linear Algebra or ______
   [ ] Math 44 (old: 18): Honors Calculus ______
   [ ] 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 typically only offered in the fall.

1. __________________ ______ 2. __________________ ______
2. __________________ ______ 3. __________________ ______
4. __________________ ______

Student’s signature: __________________________ Date: __________

Advisor’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 2, 2015)
**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](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 [https://www.facebook.com/tuftsmathsociety](https://www.facebook.com/tuftsmathsociety) 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 [https://sites.google.com/site/tuftsiam](https://sites.google.com/site/tuftsiam) for more information.
**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).
* No more than 55% of all courses may be offered in the shaded area.
* Labs taught in seminar block 5+-9+ may run to 4:30. Students taking these courses are advised to avoid courses offered in the K or L block.