Pi Mu Epsilon

& Gamecock Math Club

Getting to Know Your 500-Level MATH Courses at the University of South Carolina

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MATH 511/STAT 511: Probability

Prerequisite: Grade of C or higher or concurrent enrollment in MATH 241

The purpose of this course is to give you an introduction to probablity theory and probablity distributions. The material presented will not only serve as a basis for the subsequent courses, STAT 512/513, but is also extremely useful and fascinating in its own right. STAT 511 has a prerequisite of a standard multivariable calculus course, and a strong familiarity with differentitation, integration, infinite series and sequences, and related facts, is necessary. This course is very important for those of you considering careers in actuarial sciences.

The course covers the axiomatic approach to probability, counting techniques, Bayes Theorem, random variables, probability distributions for discrete and continuous random variables, mathematical expectation, moment generating functions, joint and conditional distributions for multiple random variables, and measures of association (covariance and correlation). This course focuses on both theory and application. You will be expected to derive theoretical results using algebra and calculus and apply these results to problems from a multitude of spplications.

Spring 2017 Professor:

Hong Wang

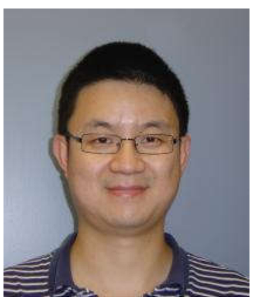
MATH 520: Ordinary Differential Equations

Prerequisite: Grade of C or better in MATH 344 or MATH 544

Upon completion of this course, students will be knowledgeable about and will be able to analyze solutions to differential equations of the first order and linear systems of ordinary differential equations. They will also be able to apply these ideas to determine elementary qualitative properties of nonlinear systems.

Differential equations is the language of science. Many basic scientific laws express the change in one quantity in terms of the values of the other quantities. These laws can be combined to create a mathematical model for the physical situation. Once the model is found the challenge is to understand the "solution" to the model – often without actually having explicit formulas. The primary focus of this course is the mathematical analysis of differential equations. Students will learn a few special techniques to find analytic (but not necessarily explicit) solutions to differential equations.

Spring 2017 Professor:



Yi Sun

MATH 521: Boundary Value Problems and Partial Differential Equations

Prerequisite: Grade of C or higher in MATH 520 or in both MATH 241&242

Differential equations is the language of science. Many basic scientific laws express the change in one quantity in terms of the values of other quantities. You were exposed to these ideas, first, for ordinary differential equations — that is, for functions of one variable. Many more physical problems involve quantities that depend on more than one variable — for example, u(t, x, y, z) could be the temperature at any location (x, y, z) in a three-dimensional object at any instant in time t. We will focus on some of the classical methods to find explicit solutions to partial differential equations: separation of variables, integral transforms, and the method of characteristics. In each case the basic idea is the same — do something to convert the PDE into something "simpler". Often the simpler problem will be an ordinary differential equation or an algebraic equation. Almost all of the PDEs that we consider will be linear. Nonlinear PDEs are, in general, much more difficult. One of the first ways to analyze nonlinear PDEs is to approximate it with a linear PDE.

Successful students in Boundary Value Problems and Differential Equations will be knowledgeable about and will be able to analyze solutions to two-point boundary value problems, boundary value problems for partial differential equations, eigenfunction expansions and separation of variables, transform methods for solving PDEs, Green's functions for PDEs, and the method of characteristics.

Spring 2017 Professor:

Daniel Dix

MATH 532: Modern Geometry

Prerequisite: Grade of C or higher in MATH 300

The course focuses on two main topics: Non-Euclidean Geometry and modern approaches to Euclidean Geometry. The former topic will introduce the axioms of affine and projective planes and focus on establishing results from these axioms. As such, this part of the course will help build skills with proofs in mathematics. In addition, this part of the course will establish some concrete examples of affine and projective planes using modular arithmetic. The second part of the course will investigate the use of vectors, matrices, translations and rotations to establish interesting facts from Euclidean Geometry. The idea in this part of the course is to expose students to some fascinating material in Euclidean Geometry that goes beyond what one sees in a standard high school curriculum.

Spring 2017 Professor:

Xian Wu

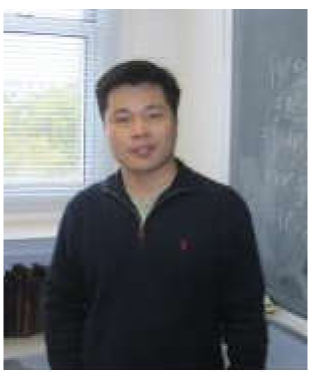
MATH 544: Linear Algebra

Prerequisite: Grade of C or higher in MATH 300

Linear algebra is one of the fundamental topics in mathematics. Even if you do not know what linear algebra is, we have all been using many of the ideas for several years. While matrices will be common in this course, linear algebra is much more than "matrix algebra". A second and equally important objective of this course is the exposure to mathematical proofs. The early parts of the course emphasize manipulative aspects more than theoretical issues. As the course progresses, however, the same topics will be revisited – with more of an emphasis on the abstract theory of linear algebra. Students will master concepts and solve problems based on matrix algebra, solution of linear systems, notions of vector space, linear independence, basis, and dimension, linear transformations, change of basis, eigenvalues, eigenvectors, and diagonalization.

A solid knowledge of linear algebra – both manipulations and theory – will be helpful in almost any upper-division course in mathematics or any course that uses mathematics: differential equations, numerical analysis, optimization, etc.

Spring 2017 Professors:



Xinfeng Liu

Eva Czabarka

MATH 546: Algebraic Structures I

Prerequisite: Grade of C or higher in MATH 544

In this course, the student gets to experience mathematical thought beyond Calculus. As such, more sophistication is expected of the student. Most of the course will focus on group theory. Group theory is perhaps the area of mathematics with the fewest moving parts and the most ubiquity. Through studying group theory, each student will be exposed to the thought process involved in higher-level mathematics. Students will master concepts and solve problems based on permutation and abstract groups, subgroups, quotient groups, homomorphisms, isomorphisms, direct products, and rings.

This course is the first of a two-semester sequence. Both courses of the sequence are recommended for students planning to attend graduate school in mathematics.

Spring 2017 Professor:

Matt Boylan

MATH 547: Algebraic Structures II

Prerequisite: Grade of C or better in MATH 546

MATH 547 is the continuation of MATH 546. MATH 546 is about groups, while MATH 547 is about rings and fields. A field is a set F with two operations, usually called addition and multiplication. Under addition, F is an abelian group, with an identity element called 0. Under multiplication, $F\setminus\{0\}$, is an abelian group. The distributive axiom describes the interplay between the two operations. A ring is a set with two operations. Some of the field axioms hold in a ring. Some examples of fields are: the set of rational numbers, the set of real numbers, and the set of complex numbers. Every field is automatically a ring. The set of integers is a good example of a ring which is not a field. If R is a ring, then the set of all polynomials $\{f(x)\}$ with coefficients from R is another ring.

Students in this course will master concepts and solve problems on rings: ideals, polynomial rings, Euclidean domains, unique factorization domains; fields: extensions, Galois Theory, Euclidean constructions: modules over principal ideal domains.

Spring 2017 Professor:

Adela Vraciu

MATH 550: Vector Analysis

Prerequisite: Grade of C or higher in MATH 241

This course is an extension of MATH 241 and has much the same problem solving character with a dose of theory and abstraction. Proofs will be given in class and you will be expected to do some computationally driven proofs on your own, but the course will not have the same proof oriented character as a course like MATH 554. This course makes a nice transition from calculus to higher-level theoretical math courses.

After a quick review of MATH 241, the main material of the course consists of the "Big Three" Theorems of Green, Stokes, and Gauss and how to use them. Students will demonstrate an understanding of vector functions by solving problems in the context of vector fields (e.g., by distinguishing gradient fields from non-gradient fields), line integrals, surface integrals, divergence and curl. Students will be able to exploit algebraic and geometric methods to compute integrals using the theorems of Green, Stokes, and Gauss, as well as direct computation using parameterizations.

Spring 2017 Professors:

Peter Nyikos

Stephen Dilworth

MATH 552: Applied Complex Analysis

Prerequisite: Grade of C or higher in MATH 241

The emphasis of this course will be on the analysis of functions whose domain and/or range are sets of complex numbers. Much of this analysis will be very similar to the real-valued calculus that is the prerequisite for this course. Another objective is to define versions of elementary functions when the argument is a complex number. The "new" functions should be consistent with their real-valued counterparts and should maintain all of the usual properties.

The Cauchy Integral Theorem is one of the major triumphs of complex analysis. This theorem can be viewed as an extension of Green's Theorem (which provided a connection between double integrals and line integrals). One of the most important applications of the Cauchy Integral Theorem is the easy evaluation of many contour integrals.

Students will master the fundamental concepts from Complex Analysis, including the concept of a holomorphic function, complex line integrals, Cauchy's Theorem, Cauchy's Integral Formula, classification of zeros and singularities, and applications to residue calculus.

Spring 2017 Professor:

George Androulakis

MATH 554: Analysis I

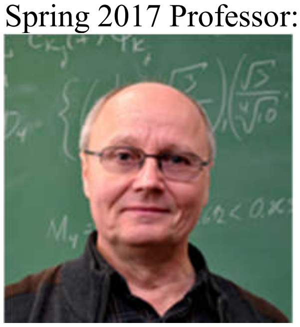
Prerequisite: Grade of C or higher in MATH 300 and at least one of MATH 511, 520, 534, 550, or 552

While most of science is based on inductive reasoning, mathematics is based on deductive reasoning. This means that new results are formed from logical combinations of hypothesis and statements accepted as true. Every result and technique learned in calculus (and other mathematics courses) is logically consistent and can be derived in a rigorous manner. In this course students begin to study some basic properties used to develop the fundamental calculus results including convergence of sequences, limit of a function, continuity (point-wise and uniform), derivative of a function, Rolle's theorem and the mean value theorem, L'Hospital's rule, inverse function theorem, Riemann integrals, Fundamental Theorem of Calculus, and derivatives of integrals. To be able to understand these results, and their proofs, it is necessary to develop a solid foundation in the real number system. It is also necessary to develop the ability to read, understand and write mathematical proofs. One of the most important steps in the creation of a mathematical proof is a solid understanding of the basic definitions. Unlike most previous courses you have taken, it is essential to pay attention to the details and technicalities. While this may be slightly unnatural, it is a skill that can be acquired through practice and patience.

Students will become knowledgeable about and will master concepts of real analysis. Students will improve their ability to write and read mathematical proofs, particularly those related to the least upper bound axiom, compactness, sequences, continuity, uniform continuity, differentiation, Riemann integration, and the Fundamental Theorem of Calculus.

This course is the first of a two-semester sequence. Both courses of the sequence are recommended for students planning to attend graduate school in mathematics.

Spring 2017 Professor:



Vladimir Temlyakov

MATH 555: Analysis II

Prerequisite: Grade of C or better in MATH 554

This course is a continuation of Math 554, Analysis I. If you enjoyed Math 554, you should strongly consider taking this course. It is also a must for anyone who is interested in pursuing graduate work in fields which use Mathematics. Topics which we will cover in this course include uniform continuity, derivatives, the Mean Value Theorem, L'Hopital's Rule, Riemann integrals, Riemann integrability, the Fundamental Theorem of Caluclus, integration by parts, sequences and series, pointwise convergence, uniform convergence, metric spaces, sets of measure zero, and a connection between the latter and Riemann integrability.

Spring 2017 Professor:

Anton Schep

MATH 574: Discrete Mathematics

Prerequisite: Grade of C or higher in MATH 300

Students will master concepts and solve problems in discrete mathematics, including propositional and predicate logic, basic set theory, counting, relations, and graphs. Students will master the fundamentals of proof techniques, including proof by contradiction, induction and the pigeon-hole principle. They will also master the concepts and be able to solve problems associated with enumeration, permutations and combinations, recurrence relations, and the groundwork for the more advanced topics of graph theory and game theory.

Spring 2017 Professor:

Joshua Cooper

MATH 576: Combinatorial Game Theory

Prerequisite: Grade of C or higher in MATH 344, MATH 544, or MATH 574

Through this course, students learn the winning strategy in certain combinatorial games such as Nim, Hackenbush, and Domineering. Students will learn equalities and inequalities among games, Sprague-Gundy theory of impartial games, and games which are numbers.

Spring 2017 Professor:

Linyuan Lu

MATH 587 (CSCE 557): Introduction to Cryptography

Prerequisite: Grade of C or better in CSCE 145, or in MATH 241, and either CSCE 355 or MATH 574

This course should give you a well-rounded theoretical knowledge of the most important aspects of cryptography, together with sufficient practical mastery to permit implementation of some cryptosystems and cryptanalytic techniques in software.

Cryptography is essential to communicating securely through a public medium, such as the telephone or internet. Cryptography serves as the foundation for secure bank transactions, confidential e-commerce, and for military and national security-related communication, and is therefore ubiquitous in the wired and wireless world. Effective cryptography relies on several important mathematical as well as computer-scientific principles, and is thus well-suited for study (research and teaching) in both academic arenas. This is why the Math and CSE departments have decided to cross-list this course between them.

This course, together with a sequel graduate course in CSE in the implementation and use of methods for secure communication, is an essential component in the CSE department's certificate program in Information Assurance and Security. It also partially satisfies requirements for designating the Department of Computer Science and Engineering by the National Security Agency as a Center of Excellence in Information Assurance and Security.

This course covers the central topics in cryptography (the art of designing codes and ciphers), cryptanalysis (the art of breaking codes and ciphers), and cryptology (the mathematical science of cryptography and cryptanalysis).

Topics include: Design of codes and ciphers for secure communication, including encryption, authentication, and integrity verification: codes, ciphers, cryptographic hashing, and public key cryptosystems. Cryptological mathematical principles, cryptanalysis, and protocols for security.

We will introduce the requisite mathematical concepts when they are needed, including information theory, linear algebra, modular arithmetic, and arithmetic over finite fields.

Spring 2017 Professor:

Stephen Fenner

MATH 599 (BIO 599): Quantitative Biology

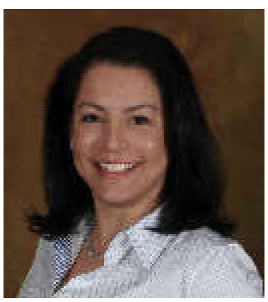
Prerequisite: None

In this course we will learn how the interplay of mathematics and biology can be used to explain complex biological systems. Experimental advances in biology are providing us with remarkable details about the basic processes of life. The challenge posed by these experiments is to propose quantitative models that can explain the data and, most importantly, models that provide theoretical predictions to test hypothesis via new experiments.

Upon completion the students will be able to

- Write down mathematical models to describe molecular, cellular, and organismal processes.
- Solve the mathematical models numerically or analytically and evaluate them against experimental data.
- Become proficient in the use of MATLAB for biological applications, both in terms of writing programs and using software packages.

Spring 2017 Professor:



Paula Vasquez