Math 5000: Linear Algebra for Machine Learning  
MWF 11:00–11:50  
Prof. D. Szyld

This Mathematics course covers the basic mathematical foundations of Machine Learning. This is an advanced undergraduate course (or beginning grad course) where the mathematics of Deep Learning and Neural Nets is studied. Appropriate background in linear algebra and probability concepts are given together with optimization tools. The course will mimic a very successful course by Prof. Gilbert Strang at MIT.

If you want to have the mathematics behind these topics, and thus have a deeper understanding, this course is for you.

Course Textbook: G. Strang, "Linear Algebra and Learning from Data."

Math 5032: Introduction to Stochastic Calculus  
TR 12:30-1:50  
Prof. A. Yilmaz

The development of stochastic calculus, and in particular of Itô calculus based on Brownian motion and Gaussian processes, is one of the great achievements of twentieth-century probability. This course introduces the theory of Itô calculus and stochastic differential equations (avoiding concepts and results from measure theory whenever possible), illustrates it with concrete examples and numerical projects (using Python), and presents its applications to option pricing in finance (most notably the Black-Scholes-Merton formula — 1997 Nobel Prize in Economics).


Math 5058: Introduction to Methods in Applied Mathematics II  
TR 2:00–3:20  
Prof. I. Klapper

This introductory level course gives a general overview of mathematical concepts and tools for applied mathematics. Topics to be covered include dynamical systems and bifurcation theory; asymptotic analysis and perturbation theory; systems of hyperbolic conservation laws. Material is independent of Math 5057.

Prerequisites: Undergraduate level Calculus III and Ordinary differential equations.

Textbooks:
(1) M. H. Holmes, Introduction to Perturbation Methods, Springer, 1995;
(2) S. H. Strogatz, Nonlinear dynamics and chaos, Westview Press, 2001
Math 8012: Abstract Algebra II
TR 2:00-3:20
Prof. J. Lang

This course, the second semester of a year-long graduate-level introduction to abstract algebra, will start with a thorough discussion of field extensions. This will be followed by Galois theory, one of the core topics of abstract algebra. The third part of the course will be devoted to rings and modules. Topics to be covered in this part include noetherian rings and modules, the structure of modules over principal ideal domains and, if time permits, an introduction to tensor products and other constructions of modern multilinear algebra.

The abstract algebra sequence Math 8011/8012 is a prerequisite for many of the higher-level graduate courses in pure mathematics, and it provides the background needed for the PhD qualifying exam in Algebra.

Prerequisites: Math 8011 or equivalent or permission of instructor.


Math 8024: Numerical Differential Equations II
MW 1:00-2:20
Prof. G. Queisser

This course is designed for graduate students of all areas who are interested in numerical methods for differential equations, with focus on a rigorous mathematical basis. Many modern and efficient approaches are presented, after fundamentals of numerical approximation are established. This course continues last semester’s 8023. Topics covered include nonlinear hyperbolic conservation laws, finite volume methods, ENO/WENO, SSP Runge–Kutta schemes, wave equations, interface problems, level set method, Hamilton-Jacobi equations, discontinuous Galerkin methods, Stokes problem, Navier–Stokes equation, and pseudospectral approaches for fluid flow. Further topics possible upon request.

Textbooks:

2. Stanley Osher, Ron Fedkiw, Level Set Methods and Dynamic Implicit Surfaces, Springer, 2002
Math 8042: Real Analysis II  
TR 9:30-10:50  
Prof. C. Gutierrez

This is the second semester of a year long course covering the core areas of analysis. Emphasis will be on exercises and problems. The course will prepare students to take the Real Analysis section of the qualifying exam.

Topics to be covered:

1. Abstract measures and integration
2. Differentiation of measures
3. Hausdorff measures
4. Basic functional analysis, Hilbert spaces, $L^p$-spaces
5. Fourier series and transforms


An electronic version of the book is available from Temple library. A paper copy of the book may be purchased from Amazon or the Temple bookstore.

Additional references:

1. An Introduction to Measure Theory, Terence Tao, AMS, 2011.

Prerequisites: Basic knowledge of real variables and Euclidean topology, sequences of functions, and Riemann integration; Lebesgue measure and integration.

Math 8052: Complex Analysis II  
TR 11:00–12:20  
Prof. Y. Grabovsky

Topics to be covered include maximum and minimum principles, spaces of holomorphic and meromorphic functions, the Riemann Mapping Theorem; Weierstrass and Hadamard’s Factorization Theorems; Runge and Mittag-Leffler’s theorems; analytic continuation and introduction to Riemann Surfaces; entire functions and Picard’s Theorems.

Prerequisites: Math 8051 or permission of instructor.

Textbook: John B. Conway, Functions of One Complex Variable, Springer.
Math 8062: Differential Geometry & Topology II  
MW 9:00–10:20  
Prof. S. Taylor

This will be a standard course in algebraic topology. We will study the fundamental group, covering space theory and homology theory in detail. We will also aim to get a glimpse of cohomology theory leading up to Poincaré duality. This will cover most of Chapters 1 and 2, plus part of Chapter 3 of the textbook Algebraic Topology by Allen Hatcher.

Prerequisites: Math 8061 or permission of instructor.


Math 8985: Teaching in Higher Education  
F 9:30–10:20  
Profs. M. Hegg and M. Lorenz

This course is required for all first-year graduate students, with the aim of preparing the participants for effective teaching in math at Temple and beyond. Materials and class activities are all informed by research on teaching and learning, and will help prepare participants to lead inclusive, active, and engaging mathematics classrooms. All materials will be provided by the instructors; no textbook is required.

Math 9003: Modular Functions  
MW 9:00-10:20  
Prof. V. Dolgushev

The course can be roughly divided into 4 parts. In the first part, we introduce the full modular group, congruence subgroups, define modular forms and talk about complex tori as elliptic curves. In this part, we also introduce modular curves and talk about modular curves as Riemann surfaces. In the second part, we will deduce the dimension formulas for spaces of modular forms. In the third part, we come back to Eisenstein series. In this part, we also touch related subjects that are interesting in their own right: Dirichlet characters, zeta and L-functions. The fourth part is devoted to cusp forms and Hecke operators. The Petersson inner product on the space of cusp forms will be introduced in this part. If time permits, we will talk about modular curves as algebraic curves.

Textbook: F. Diamond and J. Shurman, A First Course in Modular Forms.
Math 9400: Topics in Analysis  
TR 9:30-10:50  
Prof. M. Ignatova  

The course is devoted to a rapid introduction to current topics of interest in the mathematical analysis of PDE of fluids. Results on well posedness of Euler, Navier-Stokes and related equations will be described. Classical and modern approaches for long time behavior, regularity and singularity formation will be presented, including Beale-Kato-Majda-type results for conservative systems and Ladyzhenskaya-Prodi-Serrin-type conditions for dissipative systems.  


Math 9500: Topics in Geometry & Topology  
MW 10:30–11:50  
Prof. M. Stover  

We will study finite-volume hyperbolic 2- and 3-manifolds and their totally geodesic submanifolds. We will begin with geometric structures and prove local rigidity of hyperbolic structures in dimension 3. Then we will study the geodesic and unipotent flows on these spaces and invariant measures for these flows. This will segue into the study of totally geodesic submanifolds of hyperbolic 3-manifolds (which are closely related to invariant measures for the unipotent flow). The only prerequisites are the qual courses in algebra and differential topology.