Fall 2009
Course Descriptions

All times/days should be compared with the official university timetable. (This document is not updated with any changes that may occur after June 18, 2009.)
http://registrar.wisc.edu/timetable/

Math 703: Methods of Applied Mathematics 1

Instructor: Leslie Smith MWF 9:55-10:45 Room: B203 VV

Textbooks:
Introduction to Applied Mathematics, Strang, Wellesley-Cambridge Press.
Advanced Mathematical Methods for Scientists and Engineers, Bender and Orszag, Springer.

Prerequisites: Math 319 (ODEs), Math 321 (Vector and complex analysis), Math 322 (Sturm-Liouville, Fourier Series, intro to PDEs), Math 340 (Linear Algebra) or equivalent

DESCRIPTION:
The course introduces methods to solve mathematical problems that arise in areas of application such as physics, engineering and statistics. Roughly speaking, we can divide these problems into two categories: (i) equilibrium, i.e., statics problems and (ii) departures from equilibrium, i.e., dynamics problems. The first part of the course will be devoted to the study of equilibrium; linear algebra provides a unifying framework for discrete equilibrium problems from several application areas. This algebraic structure is also the basis for numerical solution of both discrete and continuous equilibrium systems. In the continuous case, equilibrium mechanics leads to boundary value problems for differential equations: in one dimension, one finds ordinary differential equations, e.g., Sturm-Liouville equations; for higher dimensional systems, one finds partial differential equations, e.g., Laplace's equation, Poisson's equation and the equations for Stokes flow. Dynamics problems become initial value problems for ordinary and partial differential equations. Thus we will study some well-known techniques for solving differential equations, e.g., Separation of Variables and Green's functions. Asymptotic methods for the global analysis of ordinary differential equations will be introduced, e.g., boundary layer theory and WKB theory. The Calculus of Variations will enable us to understand the different formulations of mechanics (by Newton, Lagrange and Hamilton). We will finish with an introduction to Fluid Dynamics.

Math 707: Elasticity (meets with EMA 700)

Instructor: Fabian Waleffe TR 1:00-2:15 Room: 2321 ENGR HALL

Prerequisites: Vector calculus including index notation (Math 321), intro to PDEs (Math 322), Advanced mechanics of materials (EMA 506), continuum mechanics (EMA 622) or equivalent

DESCRIPTION:
Equations of elasticity in curvilinear and rectangular coordinates; two dimensional problems; problems of prismatic bars; variational methods and energy principles; complex variable and numerical methods; thermal stress problems.

Math 709: Statistics I

Instructor: Jun Shao — MWF 9:55-10:45 — Room: 133 S M I
TR 8:25-9:15 — Room: 5295 MED SC CTR

No Description available

Math 714: (also CS 714) Methods of Computational Math I

Instructor: James Rossmanith — TR 8:00-9:15 — Room: B105 VAN VLECK

Textbooks: R.J. LeVeque, Finite Difference Methods for Ordinary and Partial Differential Equations: Steady-State and Time-Dependent Problems. SIAM, 2007. ISBN: 0898716292

Prerequisites: Undergraduate numerical analysis (level of Math/CS 514) and undergraduate partial differential equations (level of Math 322)

Math 721: Real Analysis I

Instructor: Alexandru Ionescu — TR 9:30-10:45 — Room: B105 VAN VLECK

No Description available

Math 727: Calculus of Variations

Instructor: Sergey Bolotin — MWF 13:20-14:10 — Room: B131 VAN VLECK

Textbooks: Possible text: G. Buttazzo, M. Giaquinta, S. Hildebrandt, One-dimensional Variational Problems, Oxford Lecture Series in Mathematics, Vol. 15, OUP (1998).

Prerequisites: Ordinary Differential Equations (Math 319), Undergraduate Analysis (Math 521) or equivalent. Math 721 is not a prerequisite, but it will be very helpful.

DESCRIPTION:
Calculus of variations is one of the oldest mathematical subjects but still an active field of research. This course is mainly about one dimensional calculus of variations where no serious functional analysis is required. We will start with necessary conditions for an extremum, Euler-Lagrange equations, theory of second variation, and then proceed to sufficient conditions and field theory. In the second part of the course we develop direct methods of the calculus of variations and prove existence theorems for minima and other types of critical points. This requires some basic tools from functional analysis. Applications will be chosen from geometry, differential equations and classical mechanics.

Math 741: Abstract Algebra I

Instructor: Don Passman — TR 13:00-14:15 — Room: B119 VAN VLECK

Textbooks: Isaacs "Algebra: A Graduate Course" useful but not required

Prerequisites: None

DESCRIPTION:
This is the first semester of our basic one year course in abstract algebra. Here we stress the noncommutative aspects of the subject, namely group theory and noncommutative ring theory.

The group theory material includes permutation groups, the Sylow theorems, solvable and nilpotent groups, and some simple groups. The ring theory material includes the radical and Density theorem, Artinian rings, the Wedderburn theorems, and completely reducible modules. Numerous examples will be offered to illustrate the theory.

Math 747: Lie Algebras

Instructor: Paul Terwilliger MWF 11:00-11:50 Room: B211 VAN VLECK

Textbooks: Roger Carter: Lie algebras of finite and affine type. Cambridge U. Press, 2005

Prerequisites: None

DESCRIPTION:
This course is an introduction to Lie algebras, with a focus on semisimple Lie algebras over the complex numbers. Topics will include: solvable and nilpotent Lie algebras, Cartan subalgebras, the Cartan decomposition, the Killing form, the root system, the Weyl group, Dynkin diagrams, Cartan matrices, the PBW theorem, and Verma modules. The lectures will be self contained and no prior knowledge of the subject is assumed. This course should be valuable to anyone interested in Lie theory, quantum groups, algebraic combinatorics, number theory, and special functions.

Math 749: Analytic Number Theory

Instructor: Riad Masri TR 9:30-10:45 Room: B211 VAN VLECK

No Description available

Math 751: Introductory Topology I

Instructor: L. Maxim MWF 12:05 - 12:55 Room: B211 VAN VLECK

No Description available

Math 761: Differentiable Manifolds

Instructor: Gloria Mari Beffa TR 2:30-3:45pm Room: 113 INGRAHAM

Textbooks: A Comprehensive Introduction to Differential Geometry, Vol. 1, by Michael Spivak

Prerequisites: Math 522 or equiv

DESCRIPTION:
This course is the first introduction to differentiable manifolds. We will cover the basics: differentiable manifolds, vector bundles, implicit function theorem, submersions and immersions, vector fields and flows, foliations and Frobenius theorem, differential forms and exterior calculus, integration and Stokes' theorem, De Rham theory, etc. If time allows it, we will branch into Riemannian manifolds.

Math 763: Algebraic Geometry

Instructor: Andrei Caldararu TR 11:00-12:15 Room: B305 VAN VLECK

DESCRIPTION:
This is the basic introductory course in algebraic geometry. We will cover the material in the first chapter of Hartshorne's "Algebraic Geometry" book (GTM 52), but with multiple detours to cover more examples (the main weakness of Hartshorne's book is the lack of examples). Other texts that we may use briefly are Joe Harris's book "Algebraic Geometry" (GTM 133) and/or Miles Reid's introductory book. So our main object of study will be varieties (not schemes) over an algebraically closed field, and we won't be touching at all on cohomology of sheaves. Familiarity with commutative algebra and algebraic topology will be useful, but not absolutely required. A general grasp of abstract algebra will be needed, though. The pace of the course will be mainly determined by the students, so I encourage anyone who is interested to attend the first few lectures and decide if it is at their level or not.

Math 770: Foundations of Mathematics

Instructor: Joseph Miller MWF 8:50-9:40 Room: B131 VAN VLECK

Textbooks: Mathematical Logic, 2nd Edition, by Ebbinghaus, Flum, Thomas.

DESCRIPTION:
First-order logic syntax and semantics, Completeness and Compactness Theorems, Lowenheim-Skolem Theorem, computable and computably enumerable sets, Incompleteness Theorem, axioms of Zermelo-Fraenkel set theory with choice, ordinal and cardinal arithmetic.

Math 773: Computability Theory

Instructor: Selwyn Ng MWF 1:20-2:10 Room: B135 VAN VLECK

Textbooks: R. I. Soare: Recursively enumerable sets and degrees (preprint available in class)

Prerequisites: Consent of instructor

DESCRIPTION:
Turing degree and jump, strong reducibilities, arithmetic hierarchy, index sets, simple and (hyper)hypersimple sets, easy forcing arguments in computability theory, finite and infinite injury, Friedberg-Muchnik and Sacks Splitting Theorem, Sacks Jump and Sacks Density Theorems, the miminal pair method, high and low sets, Pi^0_1 classes, computable ordinals.

Math 801: Waves in Fluids

Instructor: Paul Milewski TR 11:00-12:15 Room: 1190 GRAINGER

Textbooks: Reference Books:
- (i) Whitham, G. Linear and Nonlinear Waves
- (ii) Lighthill, J. Waves in Fluids
- (iii) Craik, A. D. D. Wave Interactions and Fluid Flows

Prerequisites: Knowledge of Fluid Dynamics (705 or equivalent) and PDEs (703,704 or equivalent). Some experience with numerics helpful. Please contact the instructor for details.

DESCRIPTION:
This course will present the main concepts and equations of nonlinear waves using surface waves and internal waves as a physical context. We shall cover the following topics:

(i) Introduction/review of incompressible fluid dynamics, including free surface problems.
(ii) Shallow water theory: hydraulic approximation, breaking waves and shocks. Mixing in fluids.
(iii) Weakly dispersive models: Boussinesq, Korteweg-de Vries and Serre (Green-Naghdi).
(iv) Dispersion - waves in deep water - phase and group speed and the kinematics of linear waves.
(v) Dispersion and nonlinearity: the Nonlinear Schrodinger Equation.
(vi) Solitary and generalized solitary waves. Solitons.

The goal is to give students both the tools and intuition for the dynamics of nonlinear and/or dispersive waves.

Math 819: Partial Differential Equations

Instructor: Mikhail Feldman TR 13:00 - 14:15 Room: B131 VAN VLECK

Textbooks: Partial Differential Equations by L. C. Evans, AMS, Graduate Studies in Mathematics, v. 19

DESCRIPTION:
This is an introductory course in partial differential equations. We will follow the textbook by L. C. Evans. The course will consist of the following parts:
1. Basic properties of solutions of Laplace's equation and the heat and wave equations.
2. Second order linear elliptic and parabolic equations: existence, regularity, maximum principles.
3. First order nonlinear PDE: introduction to Hamilton-Jacobi equations and conservation laws.

Math 823: Topics in Complex Analysis

Instructor: Xianghong Gong MWF 11:00-11:50 AM Room: B131 VAN VLECK

Textbooks: Introduction to Complex Analysis in Several Variables, by Lars Hormander; Analysis of Several Complex Variables, by Takeo Ohsawa.

DESCRIPTION:
We will cover the L^2 theory for the $\overline{\partial}$operator and some applications. We will focus on the following topics: Plurisubharmonic functions and pseudoconvex domains. Basic L^2estimates. the Ohsawa-Takegoshi extension theorem and the Skoda division theorem. Siu's theorem on Lelong numbers of plurisubharmonic functions. If time permits, we will discuss the Bergman kernel and its application to the study of biholomorphisms.

Math 827: Fourier Analysis

Instructor: Andreas Seeger MWF 9:55-10:45 Room: B211 VAN VLECK

Textbooks: Recommended lecture notes: Thomas Wolff ``Lectures on Harmonic Analysis''. Edited by Izabella Laba and Carol Shubin. American Mathematical Society, University Lecture Series, vol. 29.
You may also download files at: http://www.math.ubc.ca/~ilaba/wolff/#files

Prerequisites: Basic real analysis, consent of Instructor

DESCRIPTION:

This is an introductory graduate course into methods of Fourier analysis. Topics include the basic theory of the Fourier transform, Fourier multipliers, function spaces, uncertainty principle, stationary phase method and oscillatory integrals, Fourier restriction theorems and related topics. If time permits we may also discuss geometric problems which can be approached using methods from Fourier analysis, for example the Falconer distance problem.

Math 831: Probability I

Instructor: Timo Seppalainen TR 11:00-12:15 Room: B211 VAN VLECK

Prerequisites: Comfort with rigorous analysis and some elementary probability are necessary. Probability theory operates in a measure-theoretic framework, so it is important to know basic measure theory. Depending on the needs of the audience, the course can start with a quick overview of the necessary measure theory.

DESCRIPTION:
This is the first semester of a two-semester graduate-level introduction to probability theory and it also serves as a stand-alone introduction to the subject. The course will focus on discrete-time stochastic processes and cover at least the following topics: foundations (probability spaces and existence of processes), independence, zero-one laws, laws of large numbers, weak convergence and the central limit theorem, conditional expectations and their properties, and martingales (convergence theorem and basic properties).

Math 833: Random Matrices

Instructor: Benedek Valko TR 9:30-10:45 Room: B131 VAN VLECK

Textbooks: Reference books:

(i) Mehta, M. Random Matrices
(ii) Forrester, P. Log-gases and Random matrices (book in preparation: http://www.ms.unimelb.edu.au/~matpjf/matpjf.html)
(iii) Deift, P. A. Orthogonal polynomials and random matrices: a Riemann-Hilbert approach.

Prerequisites: Basics in probability theory and linear algebra. Some knowledge of stochastic processes will also be helpful.

DESCRIPTION:
The course is an introduction to random matrix theory. We will cover results on the asymptotic properties of various random matrix models (Wigner matrices, Gaussian ensembles, Dyson's beta-ensemble). We will investigate the limit of the empirical spectral measure both on a global and local scale.

Math 847: Topics in Algebra---Gross-Zagier formula

Instructor: Tonghai Yang MWF 2:25-3:15pm Room: B105 VAN VLECK

Textbooks: None

Prerequisites: Basics on algebraic number theory, and modular forms. A little knowledge on modular curves, elliptic curves, and adeles will be helpful.

DESCRIPTION:
Gross and Zagier discovered about 30 years ago a deep and beautiful formula---the Gross-Zagier formula---which reveals a deep connection between the arithmetic on an elliptic curve and the central derivative of its L-function (analysis). It has far reaching applications, such as the Birch and Swinnerton-Dyer conjecture. A lot of progress and generalization has been made ever since, most notably by Shou-Wu Zhang (to totally real number fields), Bertolini and Darmon (p-adic version), Kudla, Rapoport, and myself (arithmetic Siegel-Weil formula). In this course, I will mainly discuss the original gross-Zagier formula and very recent development of Zhang and his students Xinyi Yuan and Wei Zhang on unifying the Gross-Zagier formula with a formula of Waldspurger on the central L-value, following Gross's suggestion. If times allows, we will discuss other development on Gross-Zagier formula too.

Basic References:

1. H. Darmon and S.W. Zhang (eds): Heegner points and Rankin L-series, 191--214, Math. Sci. Res. Inst. Publ., 49, Cambridge Univ. Press, Cambridge, 2004.
2. Gross, Benedict H. Heights and L-series. Proceedings of the International Congress of Mathematicians, Vol. 1, 2 (Berkeley, Calif., 1986), 425--433, Amer. Math. Soc., Providence, RI, 1987. (Reviewer: Joseph H. Silverman) 11G40 (11G05)
3. Gross, Benedict H.; Zagier, Don B. Heegner points and derivatives of L-series. Invent. Math. 84 (1986), no. 2, 225--320.
4. X. Yuan, W. Zhang, and S.W. Zhang, Heights of CM points I, Gross–Zagier formula, preprint (2008)
http://www.math.columbia.edu/~szhang/papers/HCMI.pdf
5. Waldspurger, J.-L. Sur les valeurs de certaines fonctions Lautomorphes en leur centre de symétrie. (French) [Values of certain automorphic L-functions at their center of symmetry] Compositio Math. 54 (1985), no. 2, 173--242. (Reviewer: Stephen Gelbart) 11F70 (11F67 22E55).
6. Gross, Benedict H. Heegner points on $X_0(N)$. Modular forms (Durham, 1983), 87--105, Ellis Horwood Ser. Math. Appl.: Statist. Oper. Res., Horwood, Chichester, 1984. (Reviewer: Loren D. Olson) 11G05 (11G16

Math 865: Advanced Topics in Geometry

Instructor: Jeff Viaclovsky TR 14:30--15:45 Room: 115 INGRAHAM

DESCRIPTION:
Various topics in Riemannian Geometry will be covered, including Bochner-Weitzenbock formulas, conformal geometry, geometric structures and curvature functionals on 4-manifolds, and ALE spaces.

Math 873: Topics in Logic - Forcing

Instructor: A.Miller MWF 12:05-12:55 Room: B131 VAN VLECK

Textbooks: Bartoszynski, Tomek; Judah, Haim; Set theory. On the structure of the real line. A K Peters, Ltd., Wellesley, MA, 1995. xii+546 pp. ISBN: 1-56881-044-X

Shelah, Saharon; Proper forcing. Lecture Notes in Mathematics, 940. Springer-Verlag, Berlin-New York, 1982. xxix+496 pp. ISBN: 3-540-11593-5

Prerequisites: Math 771 or equivalent

DESCRIPTION:
Forcing and the real line. I plan to teach a course on techniques of forcing. Although I will review the basic facts about forcing, I will assume students have taken a course which has covered the material of Chapter 7 of Kunen's book:
Kunen, Kenneth; Set theory. An introduction to independence proofs. Studies in Logic and the Foundations of Mathematics, 102. North-Holland Publishing Co., Amsterdam-New York, 1980. xvi+313 pp. ISBN: 0-444-85401-0

MATH 941: Seminar-Algebra

Instructor: Benkart,Georgia.;Terwilliger,Paul	M 1:20PM - 2:10PM	903 VV
Instructor: Terwilliger,Paul	M 2:25PM - 3:15PM	B131 VV
Instructor: Isaacs, Marty	M 3:30PM - 4:20PM	B131 VV
Instructor: Passman,Donald	W 3:30PM - 4:20PM	B131 VV
Instructor: Ellenberg;Ono;Yang	TR 2:30PM - 3:45PM	B105 VV
Instructor: Caldararu,Andrei	F 2:25PM - 3:15PM	B131 VV

MATH 951: Seminar in Topology

Instructor: TBA	MWF 1:20PM - 2:10PM	B105 VV

MATH 990: Reading and Research

See timetable

MATH 991: Seminar-Applied Mathematics

Instructor: Paul Milewski	W 3:30PM - 4:20PM	B235 VV