SYLLABI FOR UPPER DIVISION AND GRADUATE COURSES AND SEMINARS

The editors have attempted to make this listing as complete and accurate as current information will permit. However, additions, changes and deletions may occur because of enrollments, faculty leaves, availability of texts, and so on.

5010	**Introduction to Probability** (Fall, Spring, Summer Semester)
Instructors:	R. Brooks, D. Khoshnevisan, and S. Ethier
Text:	D. Stirzaker, *Elementary Probability*, 2nd ed., Cambridge University Press (2003) [ISBN 0-521-53428-3, 978-0-521-53428-4]
Meets with:	**6805**
Prerequisites:	Math 2210
Topics:	This is a one-semester course in probability theory that requires calculus. Topics include combinational analysis, axioms of probability, conditional probability and independence, discrete and continuous random variables, expectation, joint distributions, and the central limit theorem.

5030	**Actuarial Mathematics** (Spring Semester)
Instructor:	S. Ethier
Text:	V. I. Rotar, *Actuarial Models: The Mathematics of Insurance*, Taylor and Francis ed., (2006) [ISBN 1-58488-586-6]
Prerequisites:	Math 5010 (grade B- or better required)
Topics:	This is a one-semester course in actuarial models that will help to prepare students for the third actuarial exam. Theory of interest, utility theory, individual and collective risk models, ruin models, survival distribution, life insurance models, annuity models, premiums. Additional topics as time permits.

5040, 5050	**Stochastic Processes and Simulation I, II** (Fall, Spring Semester)
Instructor:	M. Foondun
Text:	R. Durrett, *Essentials of Stochastic Processes*, Springer (2001) [ISBN 0-387-98836-X, 978-0-387-98836-8]
Meets with:	**6810**, **6815**
Prerequisite:	Math 5010 or equivalent
Topics:	This is a two-semester course in stochastic processes and computer simulation that does not involve measure theory. The treatment is mostly rigorous, except that certain technical points may be taken for granted and computer simulation is used to enhance understanding. Topics may include Markov chains, Poisson processes, Markov processes, renewal processes, queueing theory, reliability theory, and Brownian motion. Applications will also be discussed.

5080, 5090	**Statistical Inference I, II** (Fall, Spring Semester)
Instructors:	F. Rassoul-Agha and L. Horváth
Text:	L. J. Bain and M. Engelhardt, *Introduction to Probability and Mathematical Statistics*, 2nd ed., Duxbury (2000) [ISBN 0-534-38020-4, 978-0-534-38020-5]
Prerequisite:	Math 5010
Topics:	Functions of random variables, limiting distributions, statistics and sampling distributions, point estimation, sufficiency and completeness, special distribution theory, normal sampling theory, parametric estimation, confidence regions, hypotheses testing, introduction to linear models.

5110, 5120 Mathematical Biology I, II (Fall, Spring Semester)

Instructors: J. Keener and P. Bressloff

Texts: Recommended: L. Edelstein-Keshet, *Mathematical Models in Biology (SIAM Classics in Applied Mathematics **46**)*, SIAM (2005) [ISBN 0-89871-554-7, 978-0-89871-554-5] and G. de Vries, T. Hillen, M. Lewis, J. Muller, and B. Schonfisch, *A Course in Mathematical Biology: Quantitative Modeling with Mathematical and Computational Methods (SIAM Mathematical Modeling and Computation **12**)*, SIAM (2006) [ISBN 0-89871-612-8, 978-0-89871-612-2]

Meets with: **6830**, **6835**

Prerequisites: Math 2280, 3150, or equivalent

Topics: Introduction to mathematical models which are used in ecology, cell biology, physiology and genetics. Techniques covered include ordinary, delay and partial differential equations, discrete time dynamical systems, and stochastic processes. Emphasis on modeling a biological system with appropriate tools, and using geometric and approximation techniques to derive answers to scientific questions.

5210 Introduction to Real Analysis (Spring Semester)

Instructor: K. Bromberg

Text: G. F. Simmons, *Introduction to Topology and Modern Analysis*, Krieger Publishing Company (2003) [ISBN 1-57524-238-9, 978-1-57524-238-5]

Prerequisites: Math 3210, 3220, or consent of instructor

Topics: Metric spaces, fixed-point theorems and applications, Lebesgue integral, normed linear spaces, approximation, Fourier series.

5310, 5320 Introduction to Modern Algebra I, II (Fall, Spring Semester)

Instructor: T. de Fernex and A. Singh

Text: L. N. Herstein, *Abstract Algebra*, 3rd ed., Wiley (2001) [ISBN 0-471-36879-2, 978-0-471-36879-3]

Prerequisite: Math 2250 *or* 2270, and Math 2900 *or* 3210

Topics:

(**5310**) This course begins with a review of the basic properties of sets and integers and continues with an introduction to group theory. It covers the definitions and basic properties of groups, abelian groups, symmetric groups, normal subgroups, and conjugacy. It also includes basic theorems on the structure of groups, Lagrange's theorem, and Sylow's theorem.

(**5320**) This course is an introduction to the theory of rings and fields. During the first part of the course, we will study general concepts and the relationship between them: ring, field, ideal, maximal and prime ideal, homomorphism, quotient rings, integral domains and unique factorization domains. We then proceed with an in-depth study of various polynomials rings, applying as many of the concepts as possible. The course continues with the study of field extensions, and concludes with nonconstructibility proofs from geometry. Time permitting, we will study finite fields and/or the Galois correspondence.

5410, 5420 Introduction to Differential Equations (Fall, Spring Semester)

Instructor: D. Tucker and G. Gustafson

Text: R. Borrelli and C. Coleman, *Differential Equations*, 2nd ed., Wiley (2004) [ISBN 0-471-43332-2, 978-0-471-43332-3] (Fall, Spring)

Meets with: **6840**, **6845**

Prerequisites: Math 2220 and 3310; 2250; or instructor's consent.

Topics: (**5410**) Systems, existence, uniqueness, dependence on parameters, continuation, solution basis for constant coefficients, modeling, nonlinear systems, Laplace transforms

(**5420**) Series solutions of differential equations, linearization, rest points and stability, asymptotic stability, functions of mathematical physics, partial differential equations of classical physics (heat, wave, Laplace), Sturm–Liouville systems, orthogood expansion theory, applications.

5440 **Introduction to Partial Differential Equations** (Fall Semester)

Text: H. F. Weinberger, *First Course in Partial Differential Equations*, Dover (1995) [ISBN 0-486-68640-X, 978-0-486-68640-0]

Instructor: K. Schmitt

Meets with: **6850**

Prerequisites: Math 2250 or 2270, 2280

Topics: Classical wave, Laplace, and heat equations; Fourier analysis; Green's functions; Methods of characteristics.

5470 **Applied Dynamical Systems** (Fall Semester)

Instructor: A. Borisyuk

Text: S. H. Strogatz, *Nonlinear Dynamics and Chaos*, Addison-Wesley (1994) [ISBN 0-201-54344-3, 978-0-201-54344-5]

Meets with: **6440**

Prerequisites: Instructor's permission

Topics: Nonlinear dynamical systems. Bifurcations. Chaos, strange attractors, fractals. Models from biological and chemical systems, and mechanical and electrical oscillators.

5520 **Introduction to Algebraic/Geometric Topology** (Spring Semester)

Instructor: D. Margalit

Text: W. S. Massey, *Algebraic Topology: an Introduction*, Springer (1991) [ISBN 3-540-90271-6, 978-3-540-90271-3]

Prerequisites: Math 4510

Topics: Topology of surfaces. Classification of surfaces. Euler characteristic. Homotopy of maps between topological spaces. Fundamental group of a space. Covering spaces. Applications to group theory and knot theory (as time permits). Degree of mappings of surfaces (if time permits).

5600 **Survey of Numerical Analysis** (Spring Semester)

Instructor: S. Isaacson

Text: J. D. Faires and R. L. Burden, *Numerical Methods*, 8th ed., Thomson/Brooks/Cole (2003) [ISBN 0-534-39200-8, 978-0-534-39200-0]

Meets with: **6855**

Prerequisites: Math 2210, Math 2250 or 2280

Topics: Numerical linear algebra, interpolation, integration, differentiation, approximation (including discrete and continuous least squares, Fourier analysis, and wavelets), initial and boundary value problems of ordinary and partial differential equations.

5610, **5620** **Introduction to Numerical Analysis I, II** (Fall, Spring Semester)

Instructor: P. Alfeld

Text: R. Burden and J. D. Faires, *Numerical Analysis*, 8th ed., Brooks Cole (2004) [ISBN 0-534-39200-8, 978-0-534-39200-0]

Meets with: **6610**, **6620**

Prerequisites: Multivariable calculus, linear algebra, programming ability

Topics: (**5610**) Numerical linear algebra, polynomial interpolation, numerical differentiation and integration, nonlinear equations, approximation, optimization.

(**5620**) Continuation of Math 5610. Numerical solution of initial and boundary value problems of ordinary and partial differential equations.

5700 Capstone Course in Mathematics (Fall Semester)

Instructor: K. MacArthur
Text: To be announced
Prerequisites: Completion of two of the following: Math 3100, 3210, 3320, 4030, 4090
Topics: This capstone course examines topics in secondary school mathematics from an advanced perspective. Topics are drawn from Abstract Algebra, Geometry, Analysis, and Number Theory, each rooted in the core secondary school curriculum of number and operations, algebra, geometry, and functions. Students learn to formulate and generalize definitions and theorems that help to unite and explain mathematics. They draw connections between ideas taught separately in different courses. Through their work in this course, they improve their ability to promote their pupils' understanding of mathematics and to make better decisions regarding the direction of their lessons and curriculum.

5710, 5720 Introduction to Applied Mathematics I, II (Fall, Spring Semester)

Instructor: D. Dobson
Text: G. Strang, *Introduction to Applied Mathematics*, Wellesley-Cambridge Press (1986) [ISBN 0-9614088-0-4, 978-0-9614088-0-0]
Prerequisites: Math 2250, 3150, 3160, 5710
Topics: (5710) Symmetric linear systems, positive definite matrices, eigenvalue problems, equilibrium equations for discrete and continuous systems, boundary value problems in ODEs and PDEs, boundary integrals

(5720) Fourier methods, initial value problems in ODEs and PDEs, conservation laws, network flows and combinatorics, optimization.

5740 Mathematical Modeling (Spring Semester)

Instructor: E. Cherkaev
Text: To be announced
Meets with: 6870
Prerequisites: Math 5600 or CP SC 5220
Topics: Development of mathematical models for physical, biological, engineering, and industrial phenomena and problems, using mainly ordinary and partial differential equations. Involvement of analytical and numerical tools suitable for analysis and visualization of the solutions of these problems.

5750 Topics in Applied Mathematics: Delay Differential Equations (Fall, Spring Semester)

Instructor: D. Goulet and D. Dobson
Text: To be announced
Meets with: 6880
Prerequisites: Math 5410/5420 or instructor's permission
Topics: A broad range of theory, techniques and applications; existence, uniqueness, stability, oscillatory and periodic solutions, bifurcations, asymptotic methods, numerical methods, and the use of DDE in current research.

5760, 5765 Introduction to Mathematical Finance I, II (Fall, Spring Semester)

Instructor: J. Zhu
Text: S. E. Shreve, *Stochastic Calculus for Finance I: The Binomial Asset Pricing Model*, Springer (2004) [ISBN 0-387-24968-0, 978-0-387-24968-1]
S. E. Shreve, *Stochastic Calculus for Finance II: Continuous-Time Models*, Springer (2004) [ISBN 0-387-40101-6, 978-0-387-40101-0]
Prerequisites: Math 2280 and 5010, 5040
Meets with: 6890, 6895

Topics: (**5760**) No arbitrage principle, risk-neutral measure and martigale, Black–Scholes–Merton model, stopping times and American options, random walks and exotic options.

(**5765**) Brownian motion, Ito's calculus, Markov processes and Kolmogorov equations, Girsanov's theorem, derivation of Black–Scholes formula, some other exotic options, bonds and term-structure models, and an introduction to credit models.

6010 **Linear Models** (Fall Semester)

Instructor: L. Horváth

Text: G. Seber and A. Lee, *Linear Regression Analysis*, Prentice Hall (2002) [ISBN 0-13-044941-5, 978-0-13-044941-2]

Prerequisites: Math 5010, 5080, 5090, 2270

Topics: Univariable linear models with applications to regression and ANOVA.

6020 **Multilinear Models** (Spring Semester)

Instructor: L. Horváth

Texts: G. Seber and A. Lee, *Linear Regression Analysis*, Prentice Hall (2002) [ISBN 0-13-044941-5, 978-0-13-044941-2]

R. A. Johnson and D. W. Wichern, *Applied Multivariate Statistical Analysis*, 5th ed., Prentice-Hall (2002) [ISBN 0-13-092553-5, 978-0-13-092553-4]

Prerequisites: Math 6010

Topics: Multivariate linear models with applications to regression and ANOVA.

6040 **Mathematical Probability** (Fall Semester)

Instructor: S. Ethier

Text: D. Khoshnevisan, *Probability*, AMS (2007) [ISBN 0-8218-4215-3]

Prerequisites: Math 6210

Topics: This is a one-semester graduate course on the foundations of modern probability theory. Topics include the measure-theoretic construction of probability spaces and random variables, classical convergence theorems, martingale theory, and Brownian motion.

6070 **Mathematical Statistics** (Spring Semester)

Instructor: S. Ethier

Text: No Textbook

Prerequisites: Math 2270, 5080, 5090

Topics: Review of hypothesis testing and point estimation, introduction to simulations, bootstrap methods, and time series analysis.

6130, 6140 **Introduction to Algebraic Geometry I, II**

Instructor: Y.-P. Lee

Text: P. Griffiths, *Principles of Algebraic Geometry*, Springer (1994) [ISBN 0-471-05059-8, 978-0-471-05059-9]

Prerequisite: Math 6310, 6320, 6130

Topics: (**6130**) Affine and projective varieties, tangent spaces and singularities, curve theory.

(**6140**) Surfaces, intersection theory, special varieties, introduction to schemes.

6150 **Complex Algebraic Curves (or Riemann surfaces) and Complex Algebraic Surfaces.**

Instructor: Y.-P. Lee

Texts: P. Griffiths and J. Harris, *Principles of Algebraic Geometry*, Wiley (1978) [ISBN 0-471-32792-1],

E. Arbarello and others, *Geometry of Algebraic Curves*, Springer-Verlag (1985) [ISBN 0-387-90997-4, 978-0-387-90997-4],

W. Barth, C. Peters, and A. van de Ven, *Compact Complex Surfaces*, 3rd ed., Springer-Verlag (1984) [ISBN 0-387-12172-2, 978-0-387-12172-7]

Prerequisite: Math 6220

Topics: Material will be selected from Riemann surfaces and algebraic curves, Kaehler geometry, Stein manifold theory, compact surfaces, etc.

6170 Riemannian Geometry (Fall Semester)

Instructor: A. Treibergs

Text: I. Chavel, *Riemannian Geometry: A Modern Introduction*, 2nd ed., Cambridge University Press (2006) [ISBN 0-521-85368-0, 0-521-61954-8, 978-0-521-61954-7]

Prerequisite: Math 6510 or consent of instructor

Topics: Riemannian Metrics, Connections, Geodesics and their properties; Completeness. Hopf–Rinow Theorem; Hadamard Theorem. Curvature tensor; Sectional curvature; Ricci and scalar curvature. Space Forms. Cartan's Theorem on recovering the metric from curvature; hyperbolic space and its properties. Theorems of Bonnet–Meyers–Synge. Comparison Theorems. Closed Geodesics. Preissman's Theorem. Cut locus. Conjugate locus. Injectivity radius. Isometric Immersions. Second fundamental form. Isoperimetric inequalities. Toponogov Theorem. Alexandrov's Theorem. Soul Theorem. Sphere Theorem. Gromov–Hausdorff convergence. Collapsing. Ricci Flow and Hamilton's Sphere Theorem.

6210 Real Analysis (Fall Semester)

Instructor: A. Bayer

Text: W. Cheney, *Analysis for Applied Mathematics*, Springer (2005) [ISBN 0-387-95279-9, 978-0-387-95279-6]

Prerequisite: Math 5210, 4200

Topics: Measures and integrals, L_p-spaces, Hilbert spaces, Banach spaces, Fourier series.

6220 Complex Analysis (Spring Semester)

Instructor: Staff

Text: W. Cheney, *Analysis for Applied Mathematics*, Springer (2005) [ISBN 0-387-95279-9]

Prerequisite: Math 4200, 6210

Topics: Analytic functions, complex integration, conformal mapping, families of analytic functions, zeros of analytic functions, analytic continuation.

6310, 6320 Modern Algebra I, II (Fall, Spring Semester)

Instructor: A. Singh

Texts: S. Lang, *Algebra*, Springer (2002) [ISBN 0-387-95385-X, 978-0-387-95385-4]

Prerequisite: Math 5320 or equivalent

Topics: group actions, Sylow theorems, permutation groups, solvable and nilpotent groups, free groups and presentations. Rings and modules: Euclidean rings, PIDs, modules over a PID, canonical forms, applications to linear algebra. Fields: field extensions, finite fields, cyclotomic fields, Galois theory, transcendence degree.

6410, 6420 Ordinary/Partial Differential Equations (Fall, Spring Semester)

Instructor: P. Bressloff

Text: F. Verhulst, *Nonlinear Differential Equations and Dynamical Systems*, 2nd ed., Springer (1996) [ISBN 3-540-60934-2, 978-3-540-60934-6] (6410) and notes by K. Schmitt (6420)

Prerequisite: Math 5210 or instructor's consent.

Topics: Existence/uniqueness/continuity theory for ODEs, linear ODEs, stability theory, invariant manifolds, Sturm–Liouville theory, spectral theory, PDEs of classical physics, Hilbert space methods, variational methods, distributions, regularity.

6440 Advanced Dynamical Systems (Fall Semester)

Instructor: A. Borisyuk

Text: No Textbook

Meets with: **5470**

Prerequisites: Consent of instructor

Topics: Basic abstract dynamics; stable, unstable, center manifold theory; index theories; KAM theory; chaos; dimensions of attractors; forced oscillations; applications.

6510 **Differentiable Manifolds** (Fall Semester)

Instructor: N. Smale

Texts: M. D. Spivak, *A Comprehensive Introduction to Differential Geometry*, 3rd ed., Publish or Perish (1999) [ISBN 0-914098-70-5 (vol. 1), 0-914098-71-3 (vol. 2), 0-914098-72-1 (vol. 3), 0-914098-73-X (vol. 4), 0-914098-74-8 (vol. 5), 978-0-914098-70-6 (vol. 1), 978-0-914098-71-3 (vol. 2), 978-0-914098-72-0 (vol. 3), 978-0-914098-73-7 (vol. 4), 978-0-914098-74-4 (vol. 5)] and
V. Guillemin and A. Pollack, *Differential Topology*, Prentice Hall (1974) [ISBN 0-13-212605-2, 978-0-13-212605-2]

Prerequisite: Math 4510 and 5520

Topics: Manifolds, tangent spaces, orientation, Whitney's embedding theorem, transversality, Sard's theorem, partitions of unity, tubular neighborhoods, fiber bundles, degree theory, vector fields, flows, Lie derivatives, Frobenius' integrability theorem, differential forms, DeRham cohomology.

6520 **Introduction to Algebraic Topology** (Spring Semester)

Instructor: K. Bromberg

Text: A. Hatcher, *Algebraic Topology*, Cambridge University Press (2002) [ISBN 0-521-79160-X (hard), 0-521-79540-0 (soft), 978-0-521-79160-1 (hard), 978-0-521-79540-1 (soft)]

Prerequisite: Math 5520, 6510

Topics: Simplicial and cell complexes, homology and cohomology with coefficients, excision, Mayer–Vietoris sequence, cup and cap products, DeRham theorem, Euler characteristic, Poincaré-Hopf theorem, higher homotopy groups, long exact sequence of a fiber bundle, elementary homotopy theory.

6610, 6620 **Analysis of Numerical Methods I, II** (Fall, Spring Semester)

Instructor: P. Alfeld

Text: G. H. Golub and C. F. Van Loan, *Matrix Computations*, 3rd ed., Johns Hopkins University Press (1996) [ISBN 0-8018-5414-8, 978-0-8018-5414-9]

Prerequisite: Math 5600 *or* 5620

Topics: Mathematical and computational analysis of numerical methods in linear algebra, optimization, and ordinary and partial differential equations.

6630 **Numerical Solutions of Partial Differential Equations** (Spring Semester)

Instructor: A. Fogelson

Text: K. W. Morton and D. F. Mayers, *Numerical Solution of Partial Differential Equations*, Cambridge University Press (1994) [ISBN 0-521-41855-0, 978-0-521-41855-3]

Prerequisite: Math 6610, 6620, Graduate course in PDE's.

Topics: Review of analysis of numerical methods for linear one-dimensional partial differential equations (accuracy and stability). Solution of multi-dimensional linear and nonlinear PDE problems using multigrid approaches. Introduction to methods for nonlinear hyperbolic problems including level set methods.

6710 **Applied Linear Operator and Spectral Methods** (Fall Semester)

Instructors: G. Milton

Text: J. P. Keener, *Principles of Applied Mathematics: Transformation and Approximation*, Addison-Wesley (1988) [ISBN 0-201-15674-1, 978-0-201-15674-4]

Prerequisites: Math 5210, 5410 or equivalent

Topics: The theory of linear operators applied to matrix, differential and integral equations, the Fredholm alternative, spectral theory, inverse and pseudo-inverse operators, Hilbert–Schmidt theory and eigenfunction expansions, wavelets, and Fast Fourier Transforms. Applications to a variety of problems of physics, biology, and engineering. This course along with Math 6720 forms the basis of the Applied Mathematics qualifying examination.

6720 Applied Complex Variables, Asymptotic Methods (Spring Semester)

Instructors: J. Keener

Text: J. P. Keener, *Principles of Applied Mathematics: Transformation and Approximation*, Addison-Wesley (1988) [ISBN 0-201-15674-1, 978-0-201-15674-4]

Prerequisites: Math 3160, 6710

Topics: The course will develop complex variable techniques used for studying ordinary and partial differential equations coming from physics. The emphasis is on applications rather than pure theory.
Complex variable theory; contour integration, conformal methods and applications to solving differential equations, asymptotic methods for evaluating complicated integrals, transforms (including Fourier and Laplace transforms) and their application to solving partial differential equations, wavelets.

6750 Fluid Dynamics

Instructor: A. Balk

Text: P. K. Kundu, I. M. Cohen, and H. H. Hu, *Fluid Mechanics*, 3rd ed., Elsevier Academic Press (2004) [ISBN 0-12-178253-0, 978-0-12-178253-5]

Prerequisites: Undergraduate ODE and PDE, or Consent of Instructor

Topics: Derivation of equations of fluid dynamics, Euler and Navier–Stokes equations, Bernoulli's theorem, Kelvin's circulation theorem, potential flow, airplane lift, boundary layers, waves in fluids, fluid instabilities, turbulence, dynamics of the atmosphere and ocean.

6760 Continuum Mechanics: Solids

Instructor: A. Cherkaev

Text: R. Batra, *Elements of Continuum Mechanics*, AIAA (2006) [ISBN 1-56347-699-1, 978-1-56347-699-0]

Prerequisites: Consent of Instructor

Topics: Linear and nonlinear elasticity theory, transport phenomena, electromagnetic and elastic wave propagation and variational principles. Additional possible topics include piezoelectricity, thermoelectricity, viscoelasticity, magnetic materials, the Hall effect, quasiconvexity and phase transitions, shape memory and composite materials.

6770, 6780 Mathematical Biology I, II (Fall, Spring Semester)

Instructor: A. Fogelson and A. Borisyuk

Text: C. Gardiner, *Handbook of Stochastic Methods for Physics, Chemistry and the Natural Sciences*, 3rd ed., Springer (2005) [ISBN 3-540-20882-8, 978-3-540-20882-2]

Prerequisite: 5410, 5420, or consent of instructor

Topics:

(**6770**) This course will provide an introduction to modeling of all physiology, and will cover approximately the first half of the text.

(**6780**) In this course we will look at models of aspects of the cardiovascular system including blood flow control and characteristics, flow through branching structures, biochemistry and biomechanics of blood clotting, and signal transduction by vascular cells. Analytical and computational approaches to studying the models are discussed and implemented.

6790 Case Studies in Computational Engineering and Science (Spring Semester)

Instructor: Staff

Text: To be announced

Prerequisite: Math 5740

Topics: Two to five faculty members from various disciplines will describe in detail a project in which they are engaged that involves all ingredients of computational engineering and science: a scientific or engineering problem, a mathematical problem leading to mathematical questions, and the solution and interpretation of these questions obtained by the use of modern computing techniques. Participating faculty will vary from year to year.

Note: All courses in the 6800 series meet with a 5000-series course, and are for Ph.D. students only. Extra work is required; this should be arranged with the instructor before the end of the second week of classes. See the 5000-series entries for descriptions.

6805 **Introduction to Probability** (Fall, Spring, and Summer Semester)
Meets with: **5010**

6810, 6815 **Stochastic Processes and Simulation I, II** (Fall, Spring Semester)
Meets with: **5040**, **5050**

6830, 6835 **Mathematical Biology I, II** (Fall, Spring Semester)
Meets with: **5110**, **5120**

6840, 6845 **Introduction to Differential Equations** (Fall, Spring Semester)
Meets with: **5410**, **5420**

6850 **Introduction to Partial Differential Equations** (Fall Semester)
Meets with: **5440**

6855 **Survey of Numerical Analysis** (Spring Semester)
Meets with: **5600**

6860, 6865 **Introduction to Numerical Analysis I, II** (Fall, Spring Semester)
Meets with: **5610**, **5620**

6870 **Mathematical Modeling** (Spring Semester)
Meets with: **5740**

6880 **Topics in Applied Mathematics** (Fall, Spring Semester)
Meets with: **5750**

6890 **Introduction to Mathematical Finance I** (Fall Semester)
Meets with: **5760**

6895 **Introduction to Mathematical Finance II** (Spring Semester)
Meets with: **5765**

7800 **Moduli of Curves**
Instructor: Y.-P. Lee
Text: E. Arbarello and others, *Geometry of Algebraic Curves*, Springer-Verlag (1985) [ISBN 0-387-90997-4, 978-0-387-90997-4], and others
Prerequisite: Consent of Instructor
Topics:

- Hilbert schemes
- Nodal curves
- Deformation theory
- Moduli spaces of curves
- Projectivity of moduli spaces
- Line bundles on moduli spaces
- The Teichmüller point of view
- Smooth Galois covers of moduli spaces
- Cycles on the moduli space of stable curves
- Cellular decomposition of moduli spaces (via hyperbolic geometry)
- First consequence of the cellular decompostion
- Intersection theory of tautological classes
- The Hurwitz scheme

7805	**Seminar in Algebraic Geometry**
Instructor:	Staff
Text:	To be announced
Prerequisite:	Consent of Instructor

7835	**Seminar in Number Theory** (Fall Semester)
Instructor:	W. Niziol
Text:	No Textbook
Prerequisite:	Consent of Instructor

7880	**Topics in Probability**
Instructor:	F. Rassoul-Agha
Text:	No Textbook
Prerequisite:	Consent of Instructor
Topics:	Various topics in the area of probability, to be offered on the basis of need or interest. May be repeated for credit when the topics vary.

7890	**Topics in Representation Theory**
Instructor:	D. Miličić
Text:	No Textbook
Prerequisite:	Consent of Instructor
Topics:	Various topics in representation theory, to be offered on the basis of need or interest. May be repeated for credit when the topics vary.