Fall 2020 Graduate Course Descriptions

MATH 501. AIM Student Seminar — **TBA** — **Fri 1:00 PM-2:00 PM**; **Fri 2:00 PM-3:00 PM**

At least two 300 or above level math courses, and Graduate standing; Qualified undergraduates with permission of instructor only. (1). May be repeated for a maximum of 6 credits. Offered mandatory credit/no credit.

MATH 501 is an introductory and overview seminar course in the methods and applications of modern mathematics. The seminar has two key components: (1) participation in the Applied and Interdisciplinary Math Research Seminar; and (2) preparatory and post-seminar discussions based on these presentations. Topics vary by term.

MATH 520. Life Contingencies I — **Natarajan,B Roger** — **T/Th 11:30 AM-1:00 PM**; **Natarajan,B Roger** — **T/Th 10:00 AM-11:30 AM**

MATH 424 and 425 with minimum grade of C-, plus declared Actuarial/Financial Mathematics Concentration. (Prerequisites enforced at registration.) (3). (BS). May not be repeated for credit.

Quantifying the financial impact of uncertain events is the central challenge of actuarial mathematics. The goal of this course is to teach the basic actuarial theory of mathematical models for financial uncertainties, mainly the time of death. The main topics are the development of (1) probability distributions for the future lifetime random variable; (2) probabilistic methods for financial payments on death or survival; and (3) mathematical models of actuarial reserving.

MATH 523. Loss Models I — **Young,Virginia R** — **T/Th 8:30 AM-10:00 AM**; **Bernhardt,Thomas** — **T/Th 1:00 PM-2:30 PM**

MATH/STATS 425. (Prerequisites enforced at registration.) (3). (BS). May not be repeated for credit.

Risk management and modeling of financial losses. Review of random variables (emphasizing parametric distributions), review of basic distributional quantities, continuous models for insurance claim severity, discrete models for insurance claim frequency, the effect of coverage modification on severity and frequency distributions, aggregate loss models, and simulation.

MATH 525/STATS 525. Probability Theory — **Gilbert,Anna** — **T/Th 8:30 AM-10:00 AM**; **Gilbert,Anna** — **T/Th 10:00 AM-11:30 AM**; **Minoccheri,Cristian** — **M/W/F 8:00 AM-9:00 AM**

MATH 451 (strongly recommended). MATH 425/STATS 425 would be helpful. (3). (BS). May not be repeated for credit.

This course is a thorough and fairly rigorous study of the mathematical theory of probability at an introductory graduate level. The emphasis will be on fundamental concepts and proofs of major results, but the usages of the theorems will be discussed through many examples. This is a core course sequence for the Applied and Interdisciplinary Mathematics graduate program. This course is the first half of the Math/Stats 525-526 sequence.

The following topics will be covered: sample space and events, random variables, concept and definition of probability and expectation, conditional probability and expectation, independence, moment generating functions, Law of large numbers, Central limit theorem, Markov chains, Poisson process and exponential distribution.

Required Textbook: Probability and Random Processes by Grimmett, Geoffrey R. / Stirzaker, David R. (9780198572220) - 3RD 01

MATH 526/STATS 526. Discrete State Stochastic Processes — **Chakraborty,Suman** — **T/Th 10:00 AM-11:30 AM**; **Chakraborty,Suman** — **T/Th 8:30 AM-10:00 AM**

MATH 525 or STATS 525 or EECS 501. (3). (BS). May not be repeated for credit.

This is a course on the theory and applications of stochastic processes, mostly on discrete state spaces. It is a second course in probability which should be of interest to students of mathematics and statistics as well as students from other disciplines in which stochastic processes have found significant applications.

The material is divided between discrete and continuous time processes. In both, a general theory is developed and detailed study is made of some special classes of processes and their applications. Some specific topics include generating functions; recurrent events and the renewal theorem; random walks; Markov chains; branching processes; limit theorems; Markov chains in continuous time with emphasis on birth and death processes and queueing theory; an introduction to Brownian motion; stationary processes and martingales.

MATH 540/BIOINF 540. Mathematics of Biological Networks **Lindsly,Stephen** **T/Th 8:30 AM-10:00 AM**
Rajapakse,Indika **T/Th 8:30 AM-10:00 AM**

(BS). May not be repeated for credit.

This course addresses methods and principles involved in constructing and studying the structure and function of biological networks using examples from real datasets (emphasis on genome-wide chromosome conformation capture (Hi-C), RNA-sew, and imaging). Basic mathematical principles required for understanding biological networks included. Topics include: review of basic probability theory, spectral graph theory, higher-order singular value decomposition, graphs and their Laplacians. Fiedler number and Fiedler vector, clustering network controllability.

This course is cross listed with Bioinformatics, which controls the course scheduling.

MATH 555 Introduction to Functions of a Complex Variable with Applications **Patel, Neel** **T/Th 1:00 PM-2:30 PM**

MATH 451 or equivalent experience with abstract mathematics. (3). (BS). May not be repeated for credit.

Intended primarily for students of engineering and of other cognate subjects. Doctoral students in mathematics elect Mathematics 596. Complex numbers, continuity, derivative, conformal representation, integration, Cauchy theorems, power series, singularities, and applications to engineering and mathematical physics.

Required Textbook: Complex Analysis with Applications by Silverman, Richard A. (9780486647623) – 74

MATH 556. Applied Functional Analysis **Borcea, Liliana** **T/Th 10:00 AM-11:30 AM**

MATH 217, 419, or 420; MATH 451; and MATH 555. (3). (BS). May not be repeated for credit.

This is an introduction to methods of applied functional analysis. Students are expected to master both the proofs and applications of major results. The prerequisites include linear algebra, undergraduate analysis, advanced calculus and complex variables. This course is a core course for the Applied and Interdisciplinary Mathematics (AIM) graduate program.

Required Textbook: Applied Analysis - by Hunter, John K. (9789812705433) – 01
Optional: Lecture Notes on Functional Analysis by Bressan, Alberto (9780821887714) - 13

MATH 558. Applied Nonlinear Dynamics **Miller, Peter** **T/Th 2:30 PM-4:00 PM**

MATH 451. (3). (BS). May not be repeated for credit.

This course is an introduction to dynamical systems (differential equations and iterated maps). The aim is to survey a broad range of topics in the theory of dynamical systems with emphasis on techniques and results that are useful in applications, including chaotic dynamics. This is a core course for the Applied and Interdisciplinary Mathematics (AIM) graduate program.

Required Textbook: Nonlinear Ordinary Differential Equations by Jordan, Dominic / Smith, Peter (9780199208258) - 4TH 07

MATH 561/IOE 510/TO 518. Linear Programming I **Lee,Jon** **M/W 9:00 AM-10:30 AM**

MATH 217, 417, or 419. (3). (BS). May not be repeated for credit. F, W, Sp.

Formulation of problems from the private and public sectors using the mathematical model of linear programming. Development of the simplex algorithm; duality theory and economic interpretations. Postoptimality (sensitivity) analysis application and interpretations. Introduction to transportation and assignment problems; special purpose algorithms and advanced computational techniques. Students have opportunities to formulate and solve models developed from more complex case studies and to use various computer programs.

Textbook: https://github.com/jon77lee/JLee_LinearOptimizationBook/blob/master/JLee.3.12.pdf

MATH 565. Combinatorics and Graph Theory	**Mustata,Mircea**	**T/Th 10:00 AM-11:30 AM**

MATH 465. (3). (BS). May not be repeated for credit.

Topics in the graph theory part of the course include (if time permits) trees, k-connectivity, Eulerian and Hamiltonian graphs, tournaments, graph coloring, planar graphs, Euler's formula, the 5-Color theorem, Kuratowski's theorem, and the matrix-tree theorem. The second part of the course will deal with topics in the theory of finite partially ordered sets. This will include material about Mobius functions, lattices, simplicial complexes, and matroids.

MATH 568/BIOINF 568 Mathematical and Computational Neuroscience	**Booth,Victoria**	**M/W 10:00 AM-11:30 AM**

MATH 463 or 462 (for undergraduate students) or Graduate standing. (Prerequisites enforced at registration.) (3). (BS). May not be repeated for credit.

Computational neuroscience provides a set of quantitative approaches to investigate the biophysical mechanisms and computational principles underlying the function of the nervous system. This course introduces students to mathematical modeling and quantitative techniques used to investigate neural systems at many different scales, from single neuron activity to the dynamics of large neuronal networks.

MATH 571. Numerical Linear Algebra	**Viswanath,Divakar**	**T/Th 8:30 AM-10:00 AM**
	Viswanath,Divakar	**T/Th 10:00 AM-11:30 AM**

MATH 214, 217, 417, 419, or 420; and one of MATH 450, 451, or 454. (3). (BS). May not be repeated for credit.

Direct and iterative methods for solving systems of linear equations (Gaussian elimination, Cholesky decomposition, Jacobi and Gauss-Seidel iteration, SOR, introduction to multi-grid methods, steepest descent, conjugate gradients), introduction to discretization methods for elliptic partial differential equations, methods for computing eigenvalues and eigenvectors.

MATH 573. Financial Mathematics I	**Norgilas,Dominykas**	**T/Th 1:00 PM-2:30 PM**

(3). (BS). May not be repeated for credit.

This is a core course for the quantitative finance and risk management masters program and introduces students to the main concepts of Financial Mathematics. This course emphasizes the application of mathematical methods to the relevant problems of financial industry and focuses mainly on developing skills of model building.

MATH 591. Differentiable Manifolds	**Uribe,Alejandro**	**M/W/F 10:00 AM-11:00 AM**

MATH 451, 452 and 590. (3). (BS). May not be repeated for credit.

This is one of the basic courses for students beginning the PhD program in mathematics. The approach is rigorous and emphasizes abstract concepts and proofs.

Topics: Product and quotient topology, group actions, topological groups, topological manifolds, smooth manifolds, manifolds with boundary, smooth maps, partitions of unity, tangent vectors and differentials, the tangent bundle, submersions, immersions and embeddings, smooth submanifolds, Sard's Theorem, the Whitney Embedding Theorem, transversality, Lie groups, vector fields, Lie brackets, Lie algebras, multilinear algebra, vector bundles, differential forms, exterior derivatives, orientation, Stokes' Theorem, introduction to De Rham cohomology groups, homotopy invariance.

Required Textbook: An Introduction to Manifolds, Loring W. Tu, Second Edition, ISBN: 978-1-4419-7399-3

MATH 593. Algebra I	**Snowden,Andrew**	**M/W/F 2:00 PM-3:00 PM**

MATH 412, 420, and 451 or MATH 494. (3). (BS). May not be repeated for credit.

Topics include basics about rings and modules, including Euclidean rings, PIDs, UFDs. The structure theory of modules over a PID will be an important topic, with applications to the classification of finite abelian groups and to Jordan and rational canonical forms of matrices. The course will also cover tensor, symmetric, and exterior algebras, and the classification of bilinear forms with some emphasis on the field case.

MATH 596. Analysis I **Jonsson,Mattias** **DAY and TIMES TBA**
Topic Title: Complex Analysis
MATH 451. (3). (BS). May not be repeated for credit. Students with credit for MATH 555 may elect MATH 596 for two credits only.

This course covers the Complex Analysis portion of the syllabus for the Qualifying Review Exam in Analysis. Topics to be covered include:

- Complex elementary functions, conformal mapping, the Riemann sphere, linear fractional transformations, rational functions
- Complex derivatives, Cauchy-Riemann equations
- Contour integration, Cauchy's theorem, Cauchy-Green formula, Cauchy's integral formula and consequences, power series expansion and consequences
- Harmonic functions, maximum principle, Dirichlet's problem
- Isolated singularities, residues, application to computation of definite integrals, meromorphic functions, argument principle, Rouche's theorem
- Equicontinuity, Montel's theorem, Schwartz's lemma, Riemann mapping theorem
- Homework will be assigned weekly, and midterm and final exams will be given.

Text: Gamelin, "Complex Analysis" – please contact the instructor prior to a book purchase as text may change.

MATH 602. Real Analysis II **Wu,Sijue** **M/W 2:30 PM-4:00 PM**

MATH 590 and 597. (3). (BS). May not be repeated for credit.

Functional analysis is a core subject in mathematics. It has connections to probability and geometry, and is of fundamental importance to the development of analysis, differential equations, quantum mechanics and many other branches in mathematics, physics, engineering and theoretical computer science. The goal of this course is to introduce students to the basic concepts, methods and results in functional analysis. Topics to be covered include linear spaces, normed linear spaces, Banach spaces, Hilbert spaces, linear operators, dual operators, the Riesz representation theorem, the Hahn-Banach theorem, uniform boundedness theorem, open mapping theorem, closed graph theorem, compact operators, Fredholm Theory, reflexive Banach spaces, weak and weak* topologies, spectral theory, and applications to classical analysis and partial differential equations.

Material will be taken from the first 33 chapters of the text. Grades will be based on a few sets of homework and attendance and participation.

Required Textbook: Functional Analysis, Peter D. Lax, ISBN-13: 978-0471556046, ISBN-10: 0471556041

MATH 612. Algebra II **TBA** **M/W/F 1:00 PM-2:00 PM**

MATH 593 and 594; and Graduate standing. (3). (BS). May not be repeated for credit.

Semisimple Lie algebras and their representations are at the crossroads of many important branches of mathematics--witness the ubiquity of Dynkin diagrams, for example. This course should be valuable for those interested in representation theory and Lie theory, as well as for those with interests in allied areas, such as algebraic combinatorics or non-commutative algebra. We will cover the basic theory of Lie algebras, with emphasis on the complex semisimple case. We plan to cover most of the topics in Humphreys' book, with priority given to the finite-dimensional representation theory.

MATH 614. Commutative Algebra **Hochster,Mel** **M/W/F 2:00 PM-3:00 PM**

MATH 593 and Graduate standing. (3). (BS). May not be repeated for credit.

MATH 623/IOE 623. Computational Finance **Cohen,Asaf** **T/Th 10:00 AM-11:30 AM**

MATH 316 and MATH 425 or 525. (3). (BS). May not be repeated for credit.

This is a course in computational methods in finance and financial modeling. Particular emphasis will be put on interest rate models and interest rate derivatives. Specific topics include Black-Scholes theory, no-arbitrage and complete markets theory, term structure models, Hull and White models, Heath-Jarrow-Morton models, the stochastic differential equations and martingale approach, multinomial tree and Monte Carlo methods, the partial differential equations approach, finite difference methods.

Required Texts:
Monte Carlo methods in financial engineering / Paul Glasserman/ 0387004513

Optional Texts:
The Mathematics Of Financial Derivatives A Student Introduction, Paul Wilmott, Sam Howison, Jeff Dewynne, 9780511812545

MATH 625/STATS 625. Probability and Random Processes I **Conlon,Joseph** **T/Th 10:00 AM-11:30 AM**
MATH 597, Measure theory at the level of Math 597 and Graduate standing. (3). (BS). May not be repeated for credit.

The goal of this course is to develop some of the major ideas of probability theory. Two central themes throughout the course are:
(a) The strong law of large numbers (SLLN).
(b) The central limit theorem (CLT).

The strong law is the law of averages, that for example the fraction of heads in N tosses of a fair coin tends to 1/2 as N becomes large, with probability 1. The central limit theorem proves that the fluctuation in the number of heads from N/2 is approximately the square root of N times a Gaussian random variable with mean 0.

The course begins with the proof of theorems (a) and (b) for independent random variables. Specializing to Bernoulli variables, we then interpret these theorems in terms of random walk on the integers Z. With the introduction of some further ideas, most notably zero-one laws and the reflection principle, we prove for Bernoulli variables the law of the iterated logarithm, which is an optimal strengthening of SLLN.

The remainder of the course develops deep generalizations of the ideas discussed in the previous paragraph. The first of these is the idea of a Martingale, which is ubiquitous in current research, particularly in mathematical finance. Next is the notion of measure preserving transformation and ergodicity, from which one obtains an optimal SLLN for general independent random variables. Finally Brownian motion is constructed as a generalized CLT. Time permitting, there will be also some discussion of Markov chains and information theory.

Optional Textbooks: Probability Theory and Examples, R. Durrett, 5th edition, 2019, 9781108473682
Probability by L. Breiman, SIAM reprint in classics of applied mathematics series 1992. ISBN: 9780898712964

MATH 627/ BIOSTAT 680 Applications of Stochastic Processes I **Wen,Xiaoquan** **M/W 8:30 AM-10:00 AM**

Graduate standing; BIOSTAT 601, 650, 602 and MATH 450. (3). (BS). May not be repeated for credit.

BIOSTAT 680 is a cross listed courses. Contact BIOSTAT for course details.

MATH 631. Introduction to Algebraic Geometry **Pixton,Aaron** **T/Th 11:30 AM-1:00 PM**

MATH 594 or permission of instructor. Graduate standing. (3). (BS). May not be repeated for credit.

This is the first half of a year-long sequence in algebraic geometry. In the first semester, we will introduce the basic notions and objects of modern algebraic geometry - sheaves and schemes. We will be loosely following Ravi Vakil's notes "Foundations of Algebraic Geometry".

Prerequisites: General topology. Familiarity with the language of category theory. Commutative algebra is recommended but not essential; you should have a solid grasp of localizations (of rings/modules) and tensor products though."

MATH 636. Topics in Differential Geometry: Complex Manifolds Burns, Dan T/Th 11:30 AM-1:00 PM

MATH 635 and Graduate standing. (3). (BS). May not be repeated for credit.

We will follow-up from basic differential geometry as in Math 635 and discuss complex manifolds, which are a very rich class of manifolds, especially when provided with Kaehler metrics, a very rich class of metrics. We are planning to cover geometric basics, and then discuss some of the interplay between complex and symplectic geometry for Kaehler manifolds. We will emphasize examples, especially homogeneous manifolds such as Hermitian symmetric spaces, affine symmetric spaces and their compactifications. Fibrations of complex manifolds by (real) Lagrangian manifolds will be another topic of interest. Time permitting, we will discuss the role of Lagrangian fibrations in geometric quantization and in the Strominger-Yau–Zaslow approach to mirror symmetry, hopefully culminating in a brief sketch of the recent work of Yau and others on the curvature equation approach to this conjectural geometric realization of mirror symmetry. The emphasis will be on the geometry, and the PDEs will be summarized and used. There will be occasional problem sets and a presentation, time permitting.

Course will be based on lectures and notes; many references will be suggested along the way.

MATH 656. Introduction to Partial and Differential Equations Bieri,Lydia T/Th 2:30 PM-4:00 PM

MATH 558, 596 and 597 or permission of instructor. Graduate standing. (3). (BS). May not be repeated for credit.

"Partial differential equations are at the core of models in science, technology, economics and related fields. These equations and their solutions have interesting structures that are studied by methods of analysis, geometry, probability and other mathematical fields.

This course will introduce students in pure and applied mathematics to concepts and methods, that mathematicians have developed to understand and analyze the properties of solutions to partial differential equations.

Topics to be covered will include nonlinear first order equations, linear elliptic, hyperbolic and parabolic equations. The method of characteristics, energy methods, maximum principle, Fourier transform and Sobolev spaces.

Required: Partial Differential Equations, L.C. Evans, 2nd
Optional: Fritz John: "Partial Differential Equations", Springer.

MATH 660/ IOE 610. Linear Programming II Nagarajan, Viswanath M/W 9:00 AM-10:30 AM

MATH 561 and Graduate standing. (3). (BS). May not be repeated for credit.

IOE 610 is a cross listed courses. Contact IOE for course details.

MATH 663/ IOE 611. Nonlinear Programming Epelman,Marina A T/Th 12:00 PM-1:30 PM

MATH,MATH 561. (3). (BS). May not be repeated for credit.

IOE 611 is a cross listed courses. Contact IOE for course details.

MATH 665. Topic in Combinatorics: Total Positivity Speyer,David E T/Th 11:30 AM-1:00 PM

MATH 664 or equivalent. Graduate standing. (3). (BS). May not be repeated for credit.

The study of total positivity began in the nineteenth century by studying matrices all of whose minors are positive, a condition which is natural in statistics and control theory. It has since turned into a major combinatorial field with connections to cluster algebras, Lie theory, and to combinatorial problems such as enumeration of noncrossing paths, perfect matchings of graphs and spanning trees. This will be a concrete introduction to total positivity with a goal of getting students ready to work on problems in these areas.

No book for this course

MATH 671 Analysis of Numerical Methods I: **Veerapaneni,Shravan** **T/Th 2:30 PM-4:00 PM**
Topic: Fast algorithms and PDE-constrained optimization

MATH. 571, 572, or permission of instructor. Graduate standing. (3). (BS). May not be repeated for credit.

This course will cover selected topics in fast algorithms research. Emphasis will be given on techniques that can be used for discretization and computational solution of partial differential equations (PDEs). Applications in PDE-constrained optimization will be considered.

Pre Reqs: Numerical analysis, basic theory of ordinary and partial differential equations

No book for this course

MATH 676. Theory of Algebraic Numbers **Zieve,Michael E** **M/W 11:30 AM-1:00 PM**

MATH 575, 594, and Graduate standing. (3). (BS). May not be repeated for credit.

This course covers basic algebraic number theory, including rings of integers, extensions of prime ideals, unique factorization of prime ideals, finiteness of the ideal class group, the structure of the unit group, decomposition and inertia groups in relation to prime splitting, absolute values, localizations, and completions. Applications will be given to diophantine equations, recursive sequences, and computing Galois groups of polynomials.

No book for this course.

MATH 678 Modular Forms **Koziol,Karol** **T/Th 2:30 PM-4:00 PM**
Topic: Representation theory of p-adic groups

MATH 575, 596, and Graduate standing. (3). (BS). May be repeated for credit.

"The Langlands program is a wide-reaching web of conjectures which lies at the helm of modern number theory. Beginning with Gauss' law of quadratic reciprocity, the Langlands program encapsulates important results such as Fermat's Last Theorem and the Sato–Tate Conjecture. One of the main goals of this body of work is to relate two very different types of objects: representations of algebraic groups (e.g., GL_n) on the one hand, and representations of Galois groups on the other. The aim of this course will be to explain the local version of this story. Namely, we will develop techniques to study representations of p-adic Lie groups (such as GL_n(Q_p)), with a particular focus on mod p coefficients and applications to the p-adic Langlands program. Topics to be covered include:

(1) background on representations of finite groups of Lie type,
(2) general theory of smooth representations of p-adic groups,
(3) (non-)classification of irreducible representations,
(4) structure and application of Iwahori–Hecke algebras,
(5) connections with the p-adic/mod p Langlands program,
(6) pathologies and remedies,
(7) (time permitting) derived structure.

The course should be accessible to anyone with a good grasp of (graduate-level) abstract algebra and Galois theory.

No book for this course

MATH 681. Mathematical Logic **Blass,Andreas R** **T/Th 1:00 PM-2:30 PM**

Mathematical maturity appropriate for a 600-level MATH course. Graduate standing. (3). (BS). May not be repeated for credit.

"Historically, mathematical logic is the mathematical study of mathematics itself, especially of the process of deductive reasoning. A central question is the adequacy of deductive reasoning: Can all the consequences of a set of assumptions be obtained from those assumptions by a sequence of very simple inferences? This question is an instance of a general theme that runs through much of mathematical logic, namely the interplay between mathematical statements (which are to be manipulated in the desired simple inferences) and the mathematical structures that they describe (which underlie the notion of logical consequence).

Part of Math 681 is devoted to making this interplay precise and establishing a positive answer to the central question in some situations, including the particularly important case of first-order logic. This logic with its simple inferences serves as the explicit or implicit foundation for essentially all mathematical reasoning. In this connection, I'll also discuss at least one alternative way of verifying correctness in first-order reasoning. This way, though farther from intuition than the simple inferences mentioned above, is in general much more efficient and has found applications in automated theorem-proving.

Another part of the course will indicate why first-order logic plays such a central role in mathematics. It is easy to produce logical systems stronger than first-order logic, and one might be tempted to use them as an improved foundation for mathematics. But the notions of "consequence" for these systems are necessarily far more complicated and cannot be captured by any reasonable step-by-step inferences. A mathematics based on them could not have proofs in anything like the usual sense of the term.

A third part of the course uses the interplay between mathematical statements and the structures they describe, to establish some results in other areas of mathematics. These results do not directly involve logical matters, but their proofs are based on the results from logic proved earlier in the course. One example is the existence of the models used in non-standard analysis.

Optional Text: Fundamentals of Mathematical Logic, Peter G. Hinman, 1-56881-262-0

CANCELLED:

MATH 695. Algebraic Topology I **Li,Shizhang** **M/W/F 9:00 AM-10:00 AM**

MATH 591 or permission of instructor. Graduate standing. (3). (BS). May not be repeated for credit.

Cohomology Theory (singular and Čech), the Universal Coefficient Theorems, Kunneth Theorems (product spaces and their homology and cohomology), fiber bundles, higher homotopy groups, Hurewicz' Theorem, Poincaré and Alexander duality, basic homological algebra and spectral sequences.

Potential extra topics include: Lefschetz--Picard theory, Serre's computations of a few homotopy groups of spheres, real homotopy groups of Kähler manifolds, K-theory, Morse theory.

Students are required to give an 1 hour presentation on a relevant topic (at an appropriate level for this course).

Optional Texts:
Algebraic Topology, Allen Hatcher, ISBN 0-521-79540-0
Differential Forms in Algebraic Topology by Bott, Raoul and Tu, Loring W, ISBN 978-0-387-90613-3
A concise course in Algebraic Topology"" by Peter May, ISBN 13: 9780226511825"

MATH 697. Topics in Topology: Moduli Spaces Of Riemann Surfaces **Wright,Alex** **M/W/F 12:00 PM-1:00 PM**

Graduate standing. (2 - 3). (BS). May not be repeated for credit.

A selection of topics in Teichmuller theory, including the basics, chosen to appeal to a broad audience.

No Book for this course.

MATH 711. Advanced Algebra **TBA** **M/W/F 10:00 AM-11:00 AM**

MATH 594 or 612 or permission of instructor. Graduate standing. (3). (BS). May not be repeated for credit.

MATH 731 Topics in Algebraic Geometry Bhatt,Bhargav M/W 1:00 PM-2:30 PM
Topic: D-modules

Graduate standing. MATH 631 and 632. Prior familiarity with derived categories will be useful but not essential. (3). (BS). May not be repeated for credit.

The first half of this course will be dedicated to the basic theory of algebraic D-modules on varieties in characteristic 0. In the second half, we shall turn attention to more advanced topics chosen depending on audience interests (options include the Riemann-Hilbert correspondence and perverse sheaves, or the theory of D-modules on abelian varieties, or various aspects of theory of D-modules in characteristic p).

No book for this course