

MATHEMATICS

Contact Information

Mathematics

<https://math.rice.edu/>

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Alan Reid

Department Chair

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Mathematics lies at the foundation of many disciplines in the sciences, engineering fields, and the social sciences, and this influence is growing as these subjects become increasingly quantitative. Recognizing this important role in the wide variety of directions available to our degree recipients, the program in mathematics provides undergraduates with a spectrum of choices. These range from nontheoretical treatments of calculus and courses in combinatorics, elementary number theory, and projective geometry to a broad variety of sophisticated mathematics, including real and complex analysis, differential geometry, abstract algebra, algebraic and geometric topology, algebraic geometry, dynamics, and partial differential equations.

Faculty research interests cover algebraic geometry, algebraic topology, analysis and partial differential equations, differential geometry, dynamics, geometric group theory, geometric topology, mathematical physics, number theory, and representation theory.

Bachelor's Programs

- **Bachelor of Arts (BA) Degree with a Major in Mathematics** (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/mathematics/mathematics-ba/>)
- **Bachelor of Science (BS) Degree with a Major in Mathematics** (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/mathematics/mathematics-bs/>)

Minor

- **Minor in Mathematics** (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/mathematics/mathematics-minor/>)

Master's Program

- Master of Arts (MA) Degree in the field of Mathematics*

Doctoral Program

- **Doctor of Philosophy (PhD) Degree in the field of Mathematics** (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/mathematics/mathematics-phd/>)

* Although students are not normally admitted to a Master of Arts (MA) degree program, graduate students may earn the MA as they work towards the PhD.

Chair

Alan Reid

Professors

David Damanik
David Fisher
Shelly L. Harvey
B. Frank Jones, Jr.
Nets Katz
Christopher J. Leininger
Milivoje Lukic
Alan Reid
Stephen W. Semmes
Anthony Varilly-Alvarado
Chelsea Walton

Associate Professor

Zhiyong Gao

Assistant Professors

Gregory Chambers
Brandon Levin
Joanna Nelson
Christos Mantoulidis

Professors Emeriti

Robin Forman
Robert M. Hardt
F. Reese Harvey
John C. Polking
Raymond O. Wells, Jr.

Associate Teaching Professors

Betul Orcan-Ekmekci
Stephen Wang

Lecturer

Ethan Gwaltney

Instructors

Nickolas Castro
Kenneth Chiu
George Domat
Hongdi Huang
Jason Joseph
Khanh Le
Long Li
Tal Malinovitch
Jacob Russell
Ryan Spitler
Jize Yu

Joint Appointment

Maarten V. de Hoop

Adjunct Faculty

Ray Johnson
Michael Wolf

For Rice University degree-granting programs:

To view the list of official course offerings, please see [Rice's Course Catalog \(https://courses.rice.edu/admweb/!SWKSCAT.cat?p_action=cata\)](https://courses.rice.edu/admweb/!SWKSCAT.cat?p_action=cata)

To view the most recent semester's course schedule, please see [Rice's Course Schedule \(https://courses.rice.edu/admweb/!SWKSCAT.cat\)](https://courses.rice.edu/admweb/!SWKSCAT.cat)

Mathematics (MATH)

MATH 101 - SINGLE VARIABLE CALCULUS I

Short Title: SINGLE VARIABLE CALCULUS I

Department: Mathematics

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Limits, continuity, differentiation, integration, and the Fundamental Theorem of Calculus. Mutually Exclusive courses may only be taken with instructor permission. May substitute MATH 111-112 or take MATH 101 after completing MATH 111. Should not be taken if student already has credit for MATH 102, MATH 211, MATH 212, or MATH 221, without permission. Mutually Exclusive: Cannot register for MATH 101 if student has credit for MATH 105/MATH 112.

Course URL: math.rice.edu (<http://math.rice.edu>)

MATH 102 - SINGLE VARIABLE CALCULUS II

Short Title: SINGLE VARIABLE CALCULUS II

Department: Mathematics

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Continuation of MATH 101. Includes further techniques of integration, as well as infinite sequences and series, Taylor polynomials and Taylor series, parametric equations, arc length, polar coordinates, complex numbers, and Fourier polynomials. Should not be taken if student already has credit for MATH 211, MATH 212, or MATH 221, without permission. Mutually Exclusive: Cannot register for MATH 102 if student has credit for MATH 106.

Course URL: math.rice.edu (<http://math.rice.edu>)

MATH 105 - AP/OTH CREDIT IN CALCULUS I

Short Title: AP/OTH CREDIT IN CALCULUS I

Department: Mathematics

Grade Mode: Transfer Courses

Course Type: Transfer

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Provides transfer credit based on student performance on approved examinations in calculus, such as the AB Calculus Advanced Placement exam or the International Baccalaureate higher-level calculus exams. This credit counts toward the total credit hours required for graduation, and satisfies major requirements in lieu of MATH 101, but does not count for distribution. Mutually Exclusive: Cannot register for MATH 105 if student has credit for MATH 101/MATH 111/MATH 112.

MATH 106 - AP/OTH CREDIT IN CALCULUS II

Short Title: AP/OTH CREDIT IN CALCULUS II

Department: Mathematics

Grade Mode: Transfer Courses

Course Type: Transfer

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Provides transfer credit based on student performance on approved examinations in calculus, such as the BC Calculus Advanced Placement exam or the International Baccalaureate higher-level calculus exams. This credit counts toward the total credit hours required for graduation, and satisfies major requirements in lieu of MATH 102, but does not count for distribution. Mutually Exclusive: Cannot register for MATH 106 if student has credit for MATH 102.

MATH 111 - CALCULUS: DIFFERENTIATION AND ITS APPLICATIONS

Short Title: CALCULUS: DIFFERENTIATION

Department: Mathematics

Grade Mode: Standard Letter

Course Type: Lecture

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Study of calculus, forming with MATH 112 a version of MATH 101/102 that does not cover infinite series. MATH 111 covers functions, limits, continuity, and derivatives and their applications. Mutually Exclusive courses may only be taken with instructor permission. Should not be taken if student already has credit for MATH 101, MATH 102, MATH 112, MATH 211, MATH 212, or MATH 221 without permission. Mutually Exclusive: Cannot register for MATH 111 if student has credit for MATH 105.

Course URL: math.rice.edu (<http://math.rice.edu>)

MATH 112 - CALCULUS: INTEGRATION AND ITS APPLICATIONS

Short Title: CALCULUS: INTEGRATION + APPS

Department: Mathematics

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Continuation of the study of calculus from MATH 111. Integration, the Fundamental Theorem of Calculus, techniques of integration and applications. Should not be taken if student already has credit for MATH 102, MATH 211, MATH 212, MATH 221, without permission. Mutually Exclusive: Cannot register for MATH 112 if student has credit for MATH 101/MATH 105.

Course URL: math.rice.edu (<http://math.rice.edu>)

MATH 115 - THE ART OF MATHEMATICS**Short Title:** THE ART OF MATH**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Math 115 is intended primarily for students majoring in non-STEM fields seeking knowledge of the nature of mathematics as well as training in mathematical thinking and problem-solving. The goal of the course is to demonstrate that math is not necessarily about formulas, but is rather a process of thinking which is relevant to them on a daily basis. Instructor Permission Required.**MATH 211 - ORDINARY DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA****Short Title:** ORD DIFFERENTIAL EQUATIONS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Study of ordinary differential equations (e.g., solutions to separable and linear first-order equations and to higher-order linear equations with constant coefficients, the properties of solutions to differential equations, and numerical solution methods) and linear algebra (e.g., vector spaces and solutions to algebraic linear equations, dimension, eigenvalues, and eigenvectors of a matrix), as well as the application of linear algebra to first-order systems of differential equations and the qualitative theory of nonlinear systems and phase portraits. Mutually Exclusive: Cannot register for MATH 211 if student has credit for MATH 220.**MATH 212 - MULTIVARIABLE CALCULUS****Short Title:** MULTIVARIABLE CALCULUS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Calculus of multiple variables. Vectors, partial derivatives and gradients, double and triple integrals, vector fields, line and surface integrals, Green's theorem, Stokes's theorem, and Gauss's theorem. May substitute Math 221 and 222. Mutually Exclusive: Cannot register for MATH 212 if student has credit for MATH 222/MATH 232.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 220 - HONORS ORDINARY DIFFERENTIAL EQUATIONS****Short Title:** HONORS ORD DIFFERENTIAL EQNS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** A rigorous introduction to the study of ordinary differential equations, including results about the existence, uniqueness and stability of solutions. Some concepts from multi-variable calculus and linear algebra will be introduced along the way. This course will introduce students to the understanding and writing of proofs. Mutually Exclusive: Cannot register for MATH 220 if student has credit for MATH 211.**MATH 221 - HONORS CALCULUS III****Short Title:** HONORS CALCULUS III**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** This course and MATH 222 include the material of MATH 212 and much more. Topology of \mathbb{R}^n , calculus for functions of several variables, linear and multilinear algebra, theory of determinants, inner product spaces, integration on manifolds.**MATH 222 - HONORS CALCULUS IV****Short Title:** HONORS CALCULUS IV**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** See MATH 221. A student may not receive credit for both MATH 222 and MATH 212. Mutually Exclusive: Cannot register for MATH 222 if student has credit for MATH 212/MATH 232.

MATH 232 - HONORS MULTIVARIABLE CALCULUS**Short Title:** HONORS MULTIVARIABLE CALCULUS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Prerequisite(s):** MATH 220 or MATH 354 or MATH 355**Description:** Calculus of several variables (partial derivatives and gradients, double and triple integrals, vector fields, line and surface integrals, Green's theorem, Stokes's theorem, Gauss's theorem). Content is similar to that of MATH 212, but MATH 232 will use linear algebra to extend results to \mathbb{R}^n . There will also be an emphasis on rigorous mathematical arguments. Recommended Prerequisite(s): MATH 290 is recommended as a corequisite for students who have not taken MATH 220 or MATH 354. Mutually Exclusive: Cannot register for MATH 232 if student has credit for MATH 212/MATH 222.**MATH 238 - SPECIAL TOPICS****Short Title:** SPECIAL TOPICS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Laboratory, Lecture, Internship/Practicum, Seminar, Independent Study, Lecture/Laboratory**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Topics and credit hours may vary each semester. Contact Department for current semester's topic(s). Repeatable for Credit.**MATH 280 - UNDERGRADUATE MATH TEACHING PRACTICUM****Short Title:** UG MATH TEACHING PRACTICUM**Department:** Mathematics**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Internship/Practicum**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** In this course, undergraduates who have previously excelled in MATH courses will develop teaching skills while supporting faculty as teaching assistants (TAs) in a particular MATH course for the benefit of the students taking that particular course. This course is open only to undergraduates with special permission of the course instructor and can be repeated for credit. Instructor Permission Required. Repeatable for Credit.**MATH 290 - FOUNDATIONS OF MATHEMATICAL WRITING****Short Title:** MATHEMATICAL WRITING SEMINAR**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Half-semester course aimed at students concurrently taking their first mathematical proofs course. The course will cover foundational topics in mathematics such as logic, sets, relations, and functions, while providing students with detailed feedback on expressing mathematics in writing. Should not be taken if student already has credit for MATH 220, 221, 222, 302, or 354. Instructor Permission Required.**MATH 300 - TOPICS IN UNDERGRADUATE MATH****Short Title:** TOPICS IN UNDERGRADUATE MATH**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Treatment of topics in undergraduate mathematics. Topics vary by year. May be repeated for credit with permission of department. Instructor Permission Required. Repeatable for Credit.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 302 - ELEMENTS OF ANALYSIS****Short Title:** ELEMENTS OF ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 102 or MATH 106**Description:** Introductory treatment of topics in analysis and topology, with the real line as a central example. Techniques include connected and compact sets, sequences and subsequences, continuity, and uniform approximation. Clear, cogent, and complete mathematical arguments are emphasized.**Course URL:** math.rice.edu (<http://math.rice.edu>)

MATH 304 - ELEMENTS OF KNOT THEORY**Short Title:** ELEMENTS OF KNOT THEORY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 221 or MATH 354 or MATH 355**Description:** Introduction to the mathematical theory of knots.

Techniques to distinguish knots from one another, Reidemeister moves, mod-p colorings, knot determinants, knot polynomials, Seifert surfaces, Euler characteristic, knot groups, and untying knots in four dimensions.

We will also discuss open problems in knot theory.

Course URL: math.rice.edu (<http://math.rice.edu>)**MATH 306 - ELEMENTS OF ABSTRACT ALGEBRA****Short Title:** ELEMENTS OF ABSTRACT ALGEBRA**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 354 or MATH 355) and (MATH 302 or MATH 354 or MATH 220 or MATH 221)**Description:** Introductory treatment of the basic structures of abstract algebra: groups, rings, and fields. Clear, cogent, and complete mathematical arguments are emphasized. A student may not receive credit for both MATH 306 and MATH 356. Mutually Exclusive: Cannot register for MATH 306 if student has credit for MATH 356.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 321 - INTRODUCTION TO ANALYSIS I****Short Title:** INTRODUCTION TO ANALYSIS I**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 220 or MATH 221 or MATH 354 or MATH 302**Description:** A thorough treatment of the foundations of real analysis such as metric spaces, compactness, sequences and series of functions, differentiation, Riemann integration. Mutually Exclusive: Cannot register for MATH 321 if student has credit for MATH 331.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 322 - INTRODUCTION TO ANALYSIS II****Short Title:** INTRODUCTION TO ANALYSIS II**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 321 or MATH 331**Description:** Further study in real analysis, including analysis in higher dimensions. Possible additional topics include Hilbert spaces, Fourier series, Sturm-Liouville theory.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 323 - INTRODUCTION TO MATHEMATICAL CRYPTOGRAPHY****Short Title:** INTRO TO MATH CRYPTOGRAPHY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** COMP 382 or COMP 448 or MATH 448 or MATH 365**Description:** The course introduces students to modern cryptographic techniques, focusing mainly on mathematical tools. The course covers topics such as Diffie-Hellman key exchange, the ElGamal public key crypto system, integer factorization and RSA, and elliptic curves and lattices in cryptography Cross-list: COMP 323. Mutually Exclusive: Cannot register for MATH 323 if student has credit for COMP 523.**MATH 331 - HONORS ANALYSIS****Short Title:** HONORS ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 220 or MATH 221 or MATH 302 or MATH 354**Description:** A careful treatment of basic topics in real analysis, including metric spaces and their topology, sequences and series, continuity, and differentiation. The content of this course is similar to that of MATH 321, but the intensity and conceptual level will be higher. Mutually Exclusive: Cannot register for MATH 331 if student has credit for MATH 321.**Course URL:** math.rice.edu (<http://math.rice.edu>)

MATH 354 - HONORS LINEAR ALGEBRA**Short Title:** HONORS LINEAR ALGEBRA**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level

Description: Vector spaces, linear transformations and matrices, theory of systems of linear equations, determinants, eigenvalues and diagonalizability, inner product spaces; and optional material chosen from: dual vector spaces, spectral theorem for self-adjoint operators, Jordan canonical form. Content is similar to that of MATH 355, but with more emphasis on theory. The course will include instruction on how to construct mathematical proofs. This course is appropriate for potential Mathematics majors and others interested in learning how to construct rigorous mathematical arguments. Recommended Prerequisite(s): MATH 102 or MATH 106. Mutually Exclusive: Cannot register for MATH 354 if student has credit for MATH 355.

MATH 355 - LINEAR ALGEBRA**Short Title:** LINEAR ALGEBRA**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level

Description: Systems of linear equations, matrices, vector spaces, linear transformations, determinants, inner products, eigenvalues and eigenvectors, and the Spectral Theorem for real symmetric matrices. Mutually Exclusive: Cannot register for MATH 355 if student has credit for MATH 354.

MATH 356 - ABSTRACT ALGEBRA I**Short Title:** ABSTRACT ALGEBRA I**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 354 or MATH 355) and (MATH 302 or MATH 354 or MATH 220 or MATH 221)

Description: An introduction to algebraic structures. Covers basic group theory (including subgroups and quotients, permutation and matrix groups, group actions) and basic ring theory (including ideals and quotients, polynomial rings, unique factorization). Mutually Exclusive: Cannot register for MATH 356 if student has credit for MATH 306.

Course URL: math.rice.edu (<http://math.rice.edu>)**MATH 357 - ABSTRACT ALGEBRA II****Short Title:** ABSTRACT ALGEBRA II**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 356

Description: Fields and field extensions, modules over rings, further topics in groups, rings, fields, and their applications.

MATH 365 - NUMBER THEORY**Short Title:** NUMBER THEORY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 220 or MATH 221 or MATH 302 or MATH 354 or COMP 182

Description: Prime numbers and factorization, modular arithmetic, Diophantine equations, quadratic reciprocity, and other topics such as cryptography or continued fractions.

Course URL: math.rice.edu (<http://math.rice.edu>)**MATH 366 - GEOMETRY****Short Title:** GEOMETRY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level

Description: Topics chosen from Euclidean, spherical, hyperbolic, and projective geometry, with emphasis on the similarities and differences found in various geometries. Isometries and other transformations are studied and used throughout. The history of the development of geometric ideas is discussed. This course is strongly recommended for prospective high school teachers.

MATH 368 - TOPICS IN COMBINATORICS**Short Title:** TOPICS IN COMBINATORICS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level

Description: Study of combinatorics and discrete mathematics. Topics that may be covered include graph theory, Ramsey theory, finite geometries, combinatorial enumeration, combinatorial games.

MATH 370 - CALCULUS ON MANIFOLDS**Short Title:** CALCULUS ON MANIFOLDS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 302 or MATH 321 or MATH 331) and (MATH 354 or MATH 355)**Description:** Differentiation and integration on manifolds: calculus on R^n , exterior differentiation, differentiation forms, vector fields, Stokes' theorem.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 371 - LIE THEORY****Short Title:** LIE THEORY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 306 or MATH 356**Description:** Study of classical groups as symmetries of Euclidean spaces. Geometry of complex numbers and quaternions, rotations and reflections of R^n , the orthogonal, unitary and symplectic groups. Tangent spaces to matrix groups, Lie algebras and the exponential map. If time permits: the structure of Lie algebras and the matrix logarithm. Recommended Prerequisite(s): MATH 354 or MATH 355 (may be taken the same semester).**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 373 - ELLIPTIC CURVES****Short Title:** ELLIPTIC CURVES**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 306 or MATH 356**Description:** Elliptic curves are central to modern number theory and instrumental in the proof of Fermat's Last Theorem. Topics will include: The addition law, solutions over the rational numbers, explicit computations, applications to factorization and cryptography; if time permits, infinite series attached to elliptic curves and the Birch-Swinnerton-Dyer conjecture. Recommended Prerequisite(s): 200 Level Math Course**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 374 - INTRODUCTION TO REPRESENTATION THEORY****Short Title:** INTRO TO REPRESENTATION THEORY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 306 or MATH 356**Description:** First course in representation theory, with an emphasis on concrete examples, especially the symmetric group. Topics include representations of finite groups, characters, classification, symmetric functions, Young symmetrizers, and Schur-Weyl duality. Prior experience with proofs is necessary; some familiarity with linear or abstract algebra would be helpful, but can be acquired along the way. Recommended Prerequisite(s): Linear Algebra (MATH 221, MATH 354, or MATH 355) and MATH 356.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 376 - ALGEBRAIC GEOMETRY****Short Title:** ALGEBRAIC GEOMETRY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 354 or MATH 355) and (MATH 306 or MATH 356)**Description:** An introduction to algebraic geometry, with an emphasis on algorithms. Topics include: polynomial rings and ideals, Groebner bases and elimination theory, affine varieties, Hilbert's Nullstellensatz, and the Algebra-Geometry correspondence. Projective varieties; Bezout's Theorem.**MATH 381 - INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS****Short Title:** INTRO PARTIAL DIFF EQUATIONS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Laplace transform: inverse transform, applications to constant coefficient differential equations. Boundary value problems: Fourier series, Bessel functions, Legendre polynomials. Recommended Prerequisite(s): MATH 211.

MATH 382 - COMPUTATIONAL COMPLEX ANALYSIS**Short Title:** COMPUTATIONAL COMPLEX ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Study of the Cauchy integral theorem, Taylor series, residues, as well as the evaluation of integrals by means of residues, conformal mapping, and application to two-dimensional fluid flow. Recommended Prerequisite(s): MATH 212 OR 221. Mutually Exclusive: Cannot register for MATH 382 if student has credit for MATH 427/MATH 517.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 390 - UNDERGRADUATE COLLOQUIUM****Short Title:** UNDERGRADUATE COLLOQUIUM**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Lectures by undergraduate students on mathematical topics not usually covered in other courses. Presentation of one lecture and attendance at all sessions required. Distribution Credit for MATH 390 no longer eligible beginning Fall 2019. Repeatable for Credit.**MATH 401 - DIFFERENTIAL GEOMETRY OF CURVES AND SURFACES****Short Title:** DIFF GEOM OF CURVES/SURFACES**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 222 or MATH 354 or MATH 355) and (MATH 321 or MATH 331)**Description:** Study of the differential geometry of curves and surfaces in R^3 . Includes an introduction to the concept of curvature and thorough treatment of the Gauss-Bonnet theorem. Recommended Prerequisite(s): MATH 211 or MATH 220 or familiarity with ODEs**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 402 - DIFFERENTIAL GEOMETRY****Short Title:** DIFFERENTIAL GEOMETRY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 444 or MATH 539**Description:** MATH 402 is the undergraduate version of the graduate class MATH 500 (being generic for all related instances of dual enrollment classes). This is a course in smooth and Riemannian manifolds. Tensors, Riemannian metrics, differential forms. Lie derivatives. Distributions and foliations, including the Frobenius Theorem and an introduction to contact structures. Lie groups and the exponential map. Connections on Vector Bundles. Geodesics and completeness. Curvature. First and second variations of length and area. Jacobi Fields. Additional topics may vary from year to year. Graduate/Undergraduate Equivalency: MATH 500. Mutually Exclusive: Cannot register for MATH 402 if student has credit for MATH 500.**MATH 410 - CALCULUS OF VARIATIONS****Short Title:** CALCULUS OF VARIATIONS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 101 or MATH 105) and (MATH 102 or MATH 106) and (MATH 211 or MATH 212 or MATH 221 or MATH 222)**Description:** Study of classical and modern theories about functions having some integral expression which is maximal, minimal, or critical. Geodesics, brachistochrone problem, minimal surfaces, and numerous applications to physics. Euler-Lagrange equations, 1st and 2nd variations, Hamilton's Principle.**MATH 412 - PROBABILITY THEORY****Short Title:** PROBABILITY THEORY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 321 or MATH 331**Description:** A simultaneous introduction to probability theory and measure theory, from basic definitions to the central limit theorem. The selection of topics in measure theory is in the service of probability theory, and the course carefully examines interplay between the analytic and probabilistic notions.

MATH 423 - PARTIAL DIFFERENTIAL EQUATIONS I**Short Title:** PARTIAL DIFFERENTIAL EQNS I**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** First order of partial differential equations. The method of characteristics. Analysis of the solutions of the wave equation, heat equation and Laplace's equation. Integral relations and Green's functions. Potential theory, Dirichlet and Neumann problems. Asymptotic methods: the method of stationary phase, geometrical optics, regular and singular perturbation methods. Cross-list: CMOR 405. Graduate/Undergraduate Equivalency: MATH 513. Recommended Prerequisite(s): MATH 321 AND MATH 322 Mutually Exclusive: Cannot register for MATH 423 if student has credit for MATH 513.**MATH 424 - TOPICS IN PARTIAL DIFFERENTIAL EQUATIONS****Short Title:** TOPICS IN PARTIAL DIFF EQNS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 423**Description:** Continuation of MATH 423. Analysis of the solutions of second order differential equations. Integral relations and Green's functions. Potential theory, Dirichlet and Neumann problems. Asymptotic methods: the method of stationary phase, geometrical optics, regular and singular perturbation methods. Euler and Navier-Stokes equations. Graduate/Undergraduate Equivalency: MATH 514. Mutually Exclusive: Cannot register for MATH 424 if student has credit for MATH 514. Repeatable for Credit.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 425 - INTEGRATION THEORY****Short Title:** INTEGRATION THEORY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 321 or MATH 331**Description:** Lebesgue theory of measure and integration. Graduate/Undergraduate Equivalency: MATH 515. Mutually Exclusive: Cannot register for MATH 425 if student has credit for MATH 515.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 426 - TOPICS IN REAL ANALYSIS****Short Title:** TOPICS IN REAL ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 425**Description:** Content varies from year to year. May include Fourier series, harmonic analysis, probability theory, advanced topics in measure theory, ergodic theory, and elliptic integrals. Graduate/Undergraduate Equivalency: MATH 516. Mutually Exclusive: Cannot register for MATH 426 if student has credit for MATH 516. Repeatable for Credit.**MATH 427 - COMPLEX ANALYSIS****Short Title:** COMPLEX ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 354 or MATH 222 or MATH 302**Description:** Study of the Cauchy-Riemann equation, power series, Cauchy's integral formula, residue calculus, and conformal mappings. Emphasis on the theory. Graduate/Undergraduate Equivalency: MATH 517. Recommended Prerequisite(s): MATH 321 or MATH 331. Mutually Exclusive: Cannot register for MATH 427 if student has credit for MATH 382/MATH 517.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 428 - TOPICS IN COMPLEX ANALYSIS****Short Title:** TOPICS IN COMPLEX ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 382 or MATH 427**Description:** Special topics include Riemann mapping theorem, Runge's Theorem, elliptic function theory, prime number theorem, Riemann surfaces, et al. Graduate/Undergraduate Equivalency: MATH 518. Mutually Exclusive: Cannot register for MATH 428 if student has credit for MATH 518. Repeatable for Credit.

MATH 435 - DYNAMICAL SYSTEMS**Short Title:** DYNAMICAL SYSTEMS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level

Description: Existence and uniqueness for solutions of ordinary differential equations and difference equations, linear systems, nonlinear systems, stability, periodic solutions, bifurcation theory. Theory and theoretical examples are complemented by computational, model driven examples from biological and physical sciences. Cross-list: CMOR 435. Recommended Prerequisite(s): (MATH 212 or MATH 221) and (CAAM 335 or MATH 355 or MATH 354) and (MATH 302 or MATH 321 or MATH 331)

Course URL: math.rice.edu (<http://math.rice.edu>)

MATH 443 - GENERAL TOPOLOGY**Short Title:** GENERAL TOPOLOGY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 321 or MATH 331

Description: Study of basic point set topology. Includes a treatment of cardinality and well ordering, as well as metrization. Graduate/Undergraduate Equivalency: MATH 538. Mutually Exclusive: Cannot register for MATH 443 if student has credit for MATH 538.

Course URL: math.rice.edu (<http://math.rice.edu>)**MATH 444 - GEOMETRIC TOPOLOGY****Short Title:** GEOMETRIC TOPOLOGY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 356 and MATH 443 and (MATH 322 or MATH 370 or MATH 401)

Description: Introduction to algebraic methods in topology and differential topology. Elementary homotopy theory. Covering spaces. Differentiable Manifolds. Graduate/Undergraduate Equivalency: MATH 539. Mutually Exclusive: Cannot register for MATH 444 if student has credit for MATH 539.

Course URL: math.rice.edu/~jkn3/geotop.html (<http://math.rice.edu/~jkn3/geotop.html>)**MATH 445 - ALGEBRAIC TOPOLOGY****Short Title:** ALGEBRAIC TOPOLOGY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 444

Description: Introduction to the theory of homology. Includes simplicial complexes, cell complexes and cellular homology and cohomology, as well as manifolds, and Poincare duality. Graduate/Undergraduate Equivalency: MATH 540. Mutually Exclusive: Cannot register for MATH 445 if student has credit for MATH 540.

MATH 448 - CONCRETE MATHEMATICS**Short Title:** CONCRETE MATHEMATICS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** COMP 182 or MATH 220 or MATH 221 or MATH 302 or MATH 354

Description: Concrete mathematics is a blend of continuous and discrete mathematics. Major topics include sums, recurrences, integer functions, elementary number theory, binomial coefficients, generating functions, discrete probability and asymptotic methods. Cross-list: COMP 448.

MATH 451 - DIFFERENTIABLE MANIFOLDS**Short Title:** DIFFERENTIABLE MANIFOLDS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 354 or MATH 355) and (MATH 321 or MATH 331) and MATH 443

Description: This is a course on differentiable manifolds. Topics include: Differential of a smooth map. Transversality. Implicit function theorem, submersions, and immersions. Tangent and Cotangent bundles. Vector fields, flows. Lie derivatives. Lie groups. Differential forms, Integration on manifolds, Stokes theorem. DeRham theory. Additional topics may include distributions and foliations, including the Frobenius Theorem. Graduate/Undergraduate Equivalency: MATH 551. Recommended Prerequisite(s): MATH 444 or MATH 463 or MATH 370 or MATH 401

MATH 452 - RIEMANNIAN GEOMETRY**Short Title:** RIEMANNIAN GEOMETRY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 354 or MATH 355) and (MATH 321 or MATH 331) and MATH 443**Description:** This is a course on Riemannian manifolds. Topics will include: Tensors, Riemannian metrics. Connections. The exponential map. Geodesics and completeness. Curvature. First and second variations of length and area. Jacobi Fields. Additional topics may vary from year to year. Graduate/Undergraduate Equivalency: MATH 552. Recommended Prerequisite(s): MATH 370 or MATH 401 or MATH 444 or MATH 451 Mutually Exclusive: Cannot register for MATH 452 if student has credit for MATH 552.**MATH 463 - ADVANCED ALGEBRA I****Short Title:** ADVANCED ALGEBRA I**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 357**Description:** This course will cover graduate level topics in group theory, ring theory, and module theory. Specific topics include the isomorphism theorems for groups, rings, and modules; group actions; solvable and nilpotent groups; Sylow's theorems; semi-direct products of groups; ideals; rings of fractions; various unique factorization domains; Hilbert's Basis Theorem; Gröbner Bases; tensor product of modules and universal property; modules over principal ideal domains; and canonical forms. The course will also include an introduction to category theory as time permits. Graduate/Undergraduate Equivalency: MATH 563. Mutually Exclusive: Cannot register for MATH 463 if student has credit for MATH 563.**MATH 464 - ADVANCED ALGEBRA II****Short Title:** ADVANCED ALGEBRA II**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 463**Description:** This course will cover topics in field theory, Galois theory, and advanced topics in commutative algebra and in multilinear algebra. Specific topics include various algebraic field extensions; fundamental theorem of Galois theory; solvable and radical extensions; transcendental extensions; tensor, symmetric, and exterior algebras; projective, injective, and flat modules; advanced ideal theory; localization; and chain conditions for rings and modules. The course will also include additional advanced topics, such as homological algebra, as time permits. Graduate/Undergraduate Equivalency: MATH 564. Mutually Exclusive: Cannot register for MATH 464 if student has credit for MATH 564.**MATH 465 - TOPICS IN ALGEBRA: INTRODUCTION TO ALGEBRAIC GEOMETRY****Short Title:** TOPICS IN ALGEBRA**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 356 and MATH 357 (may be taken concurrently)**Description:** Varieties as solution sets of systems of polynomial equations, varieties in projective space, rational and regular functions, maps of varieties, local properties and singularities. Graduate/Undergraduate Equivalency: MATH 565. Mutually Exclusive: Cannot register for MATH 465 if student has credit for MATH 565. Repeatable for Credit.**MATH 466 - TOPICS IN ALGEBRA II****Short Title:** TOPICS IN ALGEBRA II**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 356 and MATH 357 (may be taken concurrently)**Description:** Content varies from year to year. Graduate/Undergraduate Equivalency: MATH 566. Mutually Exclusive: Cannot register for MATH 466 if student has credit for MATH 566.**MATH 468 - POTPOURRI****Short Title:** POTPOURRI**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course deals with miscellaneous special topics not covered in other courses. Repeatable for Credit.**MATH 471 - MATHEMATICS OF APERIODIC ORDER****Short Title:** MATHEMATICS OF APERIODIC ORDER**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 321 or MATH 354 or MATH 355**Description:** Mathematical models of quasicrystals, whose discovery in the early 1980's led to a paradigm shift in materials science. Topics include: classical theory of ordered structures (i.e., lattices modeling crystals), Delone subsets and tilings of Euclidean space, aperiodically ordered structures generated by inflation or cut-and-project schemes. Graduate/Undergraduate Equivalency: MATH 571. Recommended Prerequisite(s): MATH 356. Mutually Exclusive: Cannot register for MATH 471 if student has credit for MATH 571.

MATH 477 - SPECIAL TOPICS**Short Title:** SPECIAL TOPICS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Internship/Practicum, Seminar, Lecture, Laboratory**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Topics and credit hours may vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.**MATH 479 - MATHEMATICS UNDERGRADUATE RESEARCH****Short Title:** MATH UNDERGRADUATE RESEARCH**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** In depth investigation of a particular area of mathematics of mutual interest to the student and the faculty adviser. Instructor Permission Required. Repeatable for Credit.**Course URL:** math.rice.edu (<http://math.rice.edu>)**MATH 490 - SUPERVISED READING****Short Title:** SUPERVISED READING**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Independent Study**Credit Hours:** 1-6**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Repeatable for Credit.**MATH 499 - MATHEMATICAL SCIENCES VIGRE SEMINAR****Short Title:** MATHEMATICAL SCIENCES**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Repeatable for Credit.**MATH 500 - DIFFERENTIAL GEOMETRY****Short Title:** DIFFERENTIAL GEOMETRY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** MATH 444 or MATH 539**Description:** A graduate course in smooth and Riemannian manifolds. Tensors, Riemannian metrics, differential forms. Lie derivatives. Distributions and foliations, including the Frobenius Theorem and an introduction to contact structures. Lie groups and the exponential map. Connections on Vector Bundles. Geodesics and completeness. Curvature. First and second variations of length and area. Jacobi Fields. Additional topics may vary from year to year. Graduate/Undergraduate Equivalency: MATH 402. Mutually Exclusive: Cannot register for MATH 500 if student has credit for MATH 402. Repeatable for Credit.**MATH 501 - TOPICS IN DIFFERENTIAL GEOMETRY****Short Title:** TOPICS DIFFERENTIAL GEOMETRY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topic to be announced. Repeatable for Credit.**MATH 502 - TOPICS IN DIFFERENTIAL GEOMETRY****Short Title:** TOPIC DIFFERENTIAL GEOMETRY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topic to be announced. Repeatable for Credit.**MATH 513 - PARTIAL DIFFERENTIAL EQUATIONS I****Short Title:** PARTIAL DIFFERENTIAL EQNS I**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** First order of partial differential equations. The method of characteristics. Analysis of the solutions of the wave equation, heat equation and Laplace's equation. Integral relations and Green's functions. Potential theory, Dirichlet and Neumann problems. Asymptotic methods: the method of stationary phase, geometrical optics, regular and singular perturbation methods. Additional course work is required beyond the undergraduate course requirements. Cross-list: CMOR 505. Graduate/Undergraduate Equivalency: MATH 423. Recommended Prerequisite(s): MATH 321 AND MATH 322 Mutually Exclusive: Cannot register for MATH 513 if student has credit for MATH 423.

MATH 514 - TOPICS IN PARTIAL DIFFERENTIAL EQUATIONS**Short Title:** TOPICS IN PARTIAL DIFF EQNS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** MATH 513 or MATH 423

Description: Continuation of MATH 513. Analysis of the solutions of second order differential equations. Integral relations and Green's functions. Potential theory, Dirichlet and Neumann problems. Asymptotic methods: the method of stationary phase, geometrical optics, regular and singular perturbation methods. Euler and Navier-Stokes equations. Graduate/Undergraduate Equivalency: MATH 424. Mutually Exclusive: Cannot register for MATH 514 if student has credit for MATH 424.

Course URL: math.rice.edu (<http://math.rice.edu>)**MATH 515 - INTEGRATION THEORY****Short Title:** INTEGRATION THEORY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: . Graduate/Undergraduate Equivalency: MATH 425. Mutually Exclusive: Cannot register for MATH 515 if student has credit for MATH 425.

MATH 516 - TOPICS IN REAL ANALYSIS**Short Title:** TOPICS IN REAL ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** MATH 425

Description: . Graduate/Undergraduate Equivalency: MATH 426. Mutually Exclusive: Cannot register for MATH 516 if student has credit for MATH 426. Repeatable for Credit.

MATH 517 - COMPLEX ANALYSIS**Short Title:** COMPLEX ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Graduate/Undergraduate Equivalency: MATH 427. Mutually Exclusive: Cannot register for MATH 517 if student has credit for MATH 382/MATH 427.

MATH 518 - TOPICS IN COMPLEX ANALYSIS**Short Title:** TOPICS IN COMPLEX ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** MATH 382 or MATH 427

Description: . Graduate/Undergraduate Equivalency: MATH 428. Mutually Exclusive: Cannot register for MATH 518 if student has credit for MATH 428. Repeatable for Credit.

MATH 521 - ADVANCED TOPICS IN REAL ANALYSIS**Short Title:** ADV TOPIC: REAL ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topic to be announced. Repeatable for Credit.**MATH 522 - TOPICS IN ANALYSIS****Short Title:** TOPICS IN ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topic to be announced. Repeatable for Credit.**MATH 523 - FUNCTIONAL ANALYSIS****Short Title:** FUNCTIONAL ANALYSIS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Banach spaces: review of L^p spaces, linear operators, dual space, Hahn-Banach theorem, weak topologies, Banach-Alaoglu theorem, compact and bounded operators, closed graph theorem; Hilbert spaces: self-adjoint and unitary operators (including spectral theorem), symmetric operators and self-adjoint extensions; if time allows, distributions and Sobolev spaces. Repeatable for Credit.

MATH 524 - TOPICS IN PARTIAL DIFFERENTIAL EQUATIONS**Short Title:** TOPICS IN PDE**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topic to be announced. Repeatable for Credit.

MATH 527 - ERGODIC THEORY AND TOPOLOGICAL DYNAMICS**Short Title:** ERGODIC THRY&TOP DYNAMICS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topic to be announced. Repeatable for Credit.**MATH 528 - ERGODIC THEORY AND TOPOLOGICAL DYNAMICS****Short Title:** ERGODIC THRY&TOPOLOGICAL DYN**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Repeatable for Credit.**MATH 538 - GENERAL TOPOLOGY****Short Title:** GENERAL TOPOLOGY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** . Graduate/Undergraduate Equivalency: MATH 443. Mutually Exclusive: Cannot register for MATH 538 if student has credit for MATH 443.**MATH 539 - GEOMETRIC TOPOLOGY****Short Title:** GEOMETRIC TOPOLOGY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** MATH 356 and MATH 443**Description:** . Graduate/Undergraduate Equivalency: MATH 444. Mutually Exclusive: Cannot register for MATH 539 if student has credit for MATH 444.**MATH 540 - ALGEBRAIC TOPOLOGY****Short Title:** ALGEBRAIC TOPOLOGY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** MATH 539**Description:** . Graduate/Undergraduate Equivalency: MATH 445. Mutually Exclusive: Cannot register for MATH 540 if student has credit for MATH 445.**MATH 541 - TOPICS IN TOPOLOGY****Short Title:** TOPICS IN TOPOLOGY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topic to be announced. Repeatable for Credit.**MATH 542 - TOPICS IN ADVANCED TOPOLOGY****Short Title:** TOPICS IN ADVANCED TOPOLOGY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topic to be announced. Repeatable for Credit.**MATH 543 - TOPICS IN LOW-DIMENSIONAL TOPOLOGY****Short Title:** TOPICS IN L-D TOPOLOGY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Repeatable for Credit.**MATH 544 - TOPOLOGY OF MANIFOLDS****Short Title:** TOPOLOGY OF MANIFOLDS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** (MATH 444 or MATH 539) and (MATH 445 or MATH 540)**Description:** A graduate course on the topology of fiber bundles, especially vector bundles and principal bundles, as well as their characteristic classes. It will cover differential forms as well as Stiefel-Whitney, Euler, Chern, and Pontryagin classes. If time allows, other topics may be included. The prerequisites for the class are the material from Math 444/539 and Math 445/540. In particular, the student should be familiar with smooth manifolds, the tangent spaces, homotopy groups, covering spaces, and homology groups.**MATH 551 - DIFFERENTIABLE MANIFOLDS****Short Title:** DIFFERENTIABLE MANIFOLDS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This is a course on differentiable manifolds. Topics include: Differential of a smooth map. Transversality. Implicit function theorem, submersions, and immersions. Tangent and Cotangent bundles. Vector fields, flows. Lie derivatives. Lie groups. Differential forms, Integration on manifolds, Stokes theorem. DeRham theory. Additional topics may include distributions and foliations, including the Frobenius Theorem. Graduate/Undergraduate Equivalency: MATH 451. Recommended Prerequisite(s): MATH 539

MATH 552 - RIEMANNIAN GEOMETRY**Short Title:** RIEMANNIAN GEOMETRY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This is a course on Riemannian manifolds. Topics will include: Tensors, Riemannian metrics. Connections. The exponential map. Geodesics and completeness. Curvature. First and second variations of length and area. Jacobi Fields. Additional topics may vary from year to year. Graduate/Undergraduate Equivalency: MATH 452. Recommended Prerequisite(s): MATH 451/551 or MATH 401/500 Mutually Exclusive: Cannot register for MATH 552 if student has credit for MATH 452.

MATH 563 - ADVANCED ALGEBRA I**Short Title:** ADVANCED ALGEBRA I**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course will cover graduate level topics in group theory, ring theory, and module theory. Specific topics include the isomorphism theorems for groups, rings, and modules; group actions; solvable and nilpotent groups; Sylow's theorems; semi-direct products of groups; ideals; rings of fractions; various unique factorization domains; Hilbert's Basis Theorem; Gröbner Bases; tensor product of modules and universal property; modules over principal ideal domains; and canonical forms. The course will also include an introduction to category theory as time permits. Graduate/Undergraduate Equivalency: MATH 463. Mutually Exclusive: Cannot register for MATH 563 if student has credit for MATH 463.

MATH 564 - ADVANCED ALGEBRA II**Short Title:** ADVANCED ALGEBRA II**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** MATH 463 or MATH 563

Description: This course will cover graduate level topics in field theory, Galois theory, and advanced topics in commutative algebra and in multilinear algebra. Specific topics include various algebraic field extensions; fundamental theorem of Galois theory; solvable and radical extensions; transcendental extensions; tensor, symmetric, and exterior algebras; projective, injective, and flat modules; advanced ideal theory; localization; and chain conditions for rings and modules. The course will also include advanced topics, such as homological algebra, as time permits. Graduate/Undergraduate Equivalency: MATH 464. Mutually Exclusive: Cannot register for MATH 564 if student has credit for MATH 464.

MATH 565 - TOPICS IN ALGEBRA: INTRODUCTION TO ALGEBRAIC GEOMETRY**Short Title:** TOPICS IN ALGEBRA**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Varieties as solution sets of systems of polynomial equations, varieties in projective space, rational and regular functions, maps of varieties, local properties and singularities. Graduate/Undergraduate Equivalency: MATH 465. Mutually Exclusive: Cannot register for MATH 565 if student has credit for MATH 465. Repeatable for Credit.

MATH 566 - TOPICS IN ALGEBRA II**Short Title:** TOPICS IN ALGEBRA II**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Graduate/Undergraduate Equivalency: MATH 466. Mutually Exclusive: Cannot register for MATH 566 if student has credit for MATH 466. Repeatable for Credit.

MATH 567 - TOPICS IN ALGEBRAIC GEOMETRY**Short Title:** TOPICS IN ALGEBRAIC GEOMETRY**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Possible topics include rational points on algebraic varieties, moduli spaces, deformation theory, and Hodge structures. Recommended Prerequisite(s): MATH 463 and MATH 464. Repeatable for Credit.

MATH 571 - MATHEMATICS OF APERIODIC ORDER**Short Title:** MATHEMATICS OF APERIODIC ORDER**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Mathematical models of quasicrystals, whose discovery in the early 1980's led to a paradigm shift in materials science. Topics include: classical theory of ordered structures (i.e., lattices modeling crystals), Delone subsets and tilings of Euclidean space, aperiodically ordered structures generated by inflation or cut-and-project schemes. Graduate/Undergraduate Equivalency: MATH 471. Recommended Prerequisite(s): MATH 356 Mutually Exclusive: Cannot register for MATH 571 if student has credit for MATH 471.

MATH 590 - CURRENT MATHEMATICS SEMINAR**Short Title:** CURRENT MATHEMATICS SEMINAR**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Lectures on topics of recent research in mathematics delivered by mathematics graduate students and faculty. Repeatable for Credit.**MATH 591 - GRADUATE TEACHING SEMINAR****Short Title:** GRADUATE TEACHING SEMINAR**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Discussion on teaching issues and practice lectures by participants as preparation for classroom teaching of mathematics. Repeatable for Credit.**MATH 677 - SPECIAL TOPICS****Short Title:** SPECIAL TOPICS**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Internship/Practicum, Laboratory, Lecture, Seminar, Independent Study**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Graduate or Visiting Graduate level students.**Course Level:** Graduate**Description:** Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.**MATH 680 - MATHEMATICS COLLOQUIUM****Short Title:** MATHEMATICS COLLOQUIUM**Department:** Mathematics**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Lecture**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Presentations of research topics in mathematics and related fields. Repeatable for Credit.**MATH 681 - TOPOLOGY SEMINAR****Short Title:** TOPOLOGY SEMINAR**Department:** Mathematics**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Presentations of research in topology and related areas. Repeatable for Credit.**MATH 682 - ALGEBRAIC GEOMETRY SEMINAR****Short Title:** ALGEBRAIC GEOMETRY SEMINAR**Department:** Mathematics**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Presentations of research in algebraic geometry and related areas. Repeatable for Credit.**MATH 683 - GEOMETRY SEMINAR****Short Title:** GEOMETRY SEMINAR**Department:** Mathematics**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Research in geometry and related areas will be presented by both external and internal speakers. The participation in this course will support the learning experience of students enrolled in the MATH PhD program at Rice who work with a faculty member whose primary research interests intersect geometry and related areas. Repeatable for Credit.**MATH 684 - ANALYSIS SEMINAR****Short Title:** ANALYSIS SEMINAR**Department:** Mathematics**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Presentations of research in analysis and related areas. Repeatable for Credit.**MATH 690 - SUPERVISED READING****Short Title:** SUPERVISED READING**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Independent Study**Credit Hours:** 1-6**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Repeatable for Credit.**MATH 699 - MATHEMATICAL SCIENCES VIGRE SEMINAR****Short Title:** MATHEMATICAL SCIENCES**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 1-9**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Repeatable for Credit.

MATH 700 - SUMMER RESEARCH FOR PHD STUDENTS**Short Title:** SUMMER RESEARCH**Department:** Mathematics**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Research**Credit Hours:** 9**Restrictions:** Enrollment is limited to Graduate level students. Enrollment limited to students in a Doctor of Philosophy degree.**Course Level:** Graduate**Description:** Summer research for MATH PhD students. Can be repeated for credit. Repeatable for Credit.**MATH 800 - GRADUATE THESIS AND RESEARCH****Short Title:** GRADUATE THESIS AND RESEARCH**Department:** Mathematics**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 1-15**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Repeatable for Credit.

Description and Code Legend

Note: Internally, the university uses the following descriptions, codes, and abbreviations for this academic program. The following is a quick reference:

Course Catalog/Schedule

- Course offerings/subject code: MATH

Department Description and Code

- Mathematics: MATH

Undergraduate Degree Descriptions and Codes

- Bachelor of Arts degree: BA
- Bachelor of Science degree: BS

Undergraduate Major Description and Code

- Major in Mathematics (attached to both the BA and BS Degrees):
MATH

Undergraduate Minor Description and Code

- Minor in Mathematics: MATM

Graduate Degree Descriptions and Codes

- Master of Arts degree: MA
- Doctor of Philosophy degree: PhD

Graduate Degree Program Description and Code

- Degree Program in Mathematics: MATH

CIP Code and Description ¹

- **MATH** Major/Program: CIP Code/Title: 27.0101 - Mathematics, General
- **MATM** Minor: CIP Code/Title: 27.0101 - Mathematics, General

¹ Classification of Instructional Programs (CIP) 2020 Codes and Descriptions from the National Center for Education Statistics: <https://nces.ed.gov/ipeds/cipcode/>