MATHEMATICS AND STATISTICS (DIV III)

Chair: Professor SUSAN LOEPP

Professors: C. ADAMS*, R. DE VEAUX, B. KLINGENBERG, T. GARRITY*, S. JOHNSON, S. LOEPP, A. PACELLI, C. SILVA**. Associate Professors: S. MILLER, M. STOICIU. Assistant Professors: J. BLACKWOOD*, L. GOLDMAKHER**, P. HARRIS, B. HEGGESETH*, R. MORRISON, L. TUPPER, D. TUREK. Lecturer: L. PEDERSEN. Visiting Assistant Professors: D. DAVIS, A. SARRIA, P. TABRIZIAN. Bolin Fellows: C. COLBERT, H. LINDO.

MAJOR IN MATHEMATICS

The major in Mathematics is designed to meet two goals: to introduce some of the central ideas in a variety of areas of mathematics and statistics, and to develop problem-solving ability by teaching students to combine creative thinking with rigorous reasoning. Mathematics is a gateway to many career paths including statistics, teaching, consulting, business, engineering, finance, actuarial studies and applied mathematics. Students are strongly encouraged to consult with the department faculty on choosing courses appropriate to an individualized program of study.

REQUIREMENTS (nine courses plus colloquium)

The major in Mathematics consists of nine courses plus the colloquium requirement. Mathematics is highly cumulative, and students should plan a route to completing the major that ensures the proper sequencing and prerequisites for all needed courses. Note that not all upper level courses are offered every year.

Calculus (two courses)

Mathematics 140 Calculus II
Mathematics 150 or 151 Multivariable Calculus

Applied/Discrete Mathematics/Statistics (one course)

Mathematics 209 Differential Equations
or Mathematics 210 Mathematical Methods for Scientists (Same as Physics 210)
or Mathematics 200 Discrete Mathematics
or Statistics 201 Statistics and Data Analysis
or Statistics 231 Statistical Design of Experiments
or a more advanced applied/discrete/statistics course with prior department approval

Core Courses (three courses)

Mathematics 250 Linear Algebra
Mathematics 350 Real Analysis or Mathematics 351 Applied Real Analysis
Mathematics 355 Abstract Algebra

Completion (three courses plus colloquium)

Two electives from courses numbered 300 and above, or STAT 231
Any 400-level course taken in the senior year (excluding thesis work and independent studies)
Participation in the Department Colloquium, in which all senior majors present and attend talks on mathematical or statistical topics of their choice. Majors have to attend at least 20 colloquia in their senior year and present one themselves.

ADVANCED PLACEMENT

Students who come to Williams with advanced placement will be moved up in the Mathematics major, and should consult with faculty to be placed in the best class reflecting their experience and background. A student who places out of a course substitutes another course numbered 200 or above in Mathematics or Statistics to complete the nine course major. Students should select courses best suited to their preparation and goals, and consult with the department faculty concerning appropriate courses and placement. The department reserves the right to refuse registration in any course for which the student is overqualified.

For Example, a student starting in MATH 130 might take MATH 130 and 140 the first year, MATH 150 and MATH 200 the second year, MATH 250 and MATH 350 the third year, MATH 355 and a senior seminar the fourth year, plus the two required electives some time. Students are encouraged to consult freely with any math faculty about course selection and anything else.

CALCULUS PLACEMENT

Recommended placement for students who have taken an Advanced Placement Examination in Calculus (AB or BC) is:

BC 1, 2 or AB 2, 3 Math 140
AB 4 or 5 Math 150
BC 3, 4 or 5 Math 151

Consult with department faculty for any Calculus or Statistics placement questions. Students who have had calculus in high school, whether or not they took the Advanced Placement Examination, are barred from 130 unless they obtain permission from the instructor.

NOTES

Substitutions, Study Abroad, and Transfer Credit: In some cases, and with prior permission of the Mathematics and Statistics Department, appropriate courses from other institutions or a course from another Williams department may be substituted for electives. Programs like the “Budapest Semester in Mathematics” are recommended for majors who wish to focus on mathematics away. The department, though, normally accommodates students who select other study away programs. The department offers its core courses in both the fall and the spring to allow students to spend more easily a semester away. You can find general study away guidelines for Mathematics here.

Double Counting: No course may count towards two different majors.

Early Senior Seminar: In exceptional circumstances, with the prior permission of the department, a student may be allowed to satisfy the Senior Major Course requirement in the junior year, provided that the student has completed at least three 300-level mathematics courses before enrolling in the Senior Major Course.

Planning Courses: Core courses Mathematics 350, 351, 355, and Statistics 346 are normally offered every year. Most other 300-level topics are offered in alternate years. Topology, Complex Analysis, and second courses in real analysis and abstract algebra are normally offered at least every other year.

Each 400-level topic is normally offered every two to four years. Students should check with the department before planning far into the future.

Course Admission: Courses are normally open to all students meeting the prerequisites, subject to any course caps. Students with questions about the level at which courses are conducted are invited to consult department faculty.

THE DEGREE WITH HONORS IN MATHEMATICS

The degree with honors in Mathematics is awarded to the student who has demonstrated outstanding intellectual achievement in a program of study which extends beyond the requirements of the major. The principal considerations for recommending a student for the degree with honors will be: Mastery of core material and skills, breadth and, particularly, depth of knowledge beyond the core material, ability to pursue independent study of mathematics or statistics, originality in methods of investigation, and, where appropriate, creativity in research.

An honors program normally consists of two semesters (MATH/STAT 493 and 494) and a winter study (WSP 031) of independent research, culminating in a thesis and a presentation. Under certain circumstances, the honors work can consist of coordinated study involving a one semester (MATH/STAT 493 or 494) and a winter study (WSP 030) of independent research, culminating in a “minithesis” and a presentation. At least one semester should be in addition to the major requirements, and thesis courses do not count as 400-level senior seminars.

An honors program in actuarial studies requires significant achievement on four appropriate examinations of the Society of Actuaries.

Highest honors will be reserved for the rare student who has displayed exceptional ability, achievement or originality. Such a student usually will have written a thesis, or pursued actuarial honors and written a mini-thesis. An outstanding student who writes a mini-thesis, or pursues actuarial honors and writes a paper, might also be considered. In all cases, the award of honors and highest honors is the decision of the Department.

APPLIED MATHEMATICS TRACK

Students interested in applied mathematics, engineering, or other sciences should consider:

Mathematics 140 Calculus II
Mathematics 150 or 151 Multivariable Calculus
Statistics 201 Statistics and Data Analysis
Mathematics 250 Linear Algebra
Mathematics 351 Applied Real Analysis
Mathematics 355 Abstract Algebra
Some programming or numerical analysis (e.g. MATH 361, 318T, or anything if you’ve had CSCI 134)
Post-core Differential Equations/Numerical Methods
Senior seminar (e.g. Math Ecology MATH 410T or Mathematical Modeling MATH 433)

Other recommended courses: complex analysis, discrete mathematics (e.g. combinatorics or graph theory), operations research, optimization, probability, statistics, appropriate courses in Biology, Chemistry, Computer Science, Economics, Neuroscience, Physics, etc.

Williams has exchange and joint programs with good engineering schools. Interested students should consult the section on engineering near the beginning of the Bulletin and the Williams pre-engineering advisor for further information.

GRADUATE SCHOOL TRACK

Students interested in continuing their study of mathematics in graduate school should consider:

Mathematics 140 Calculus II
Mathematics 150 or 151 Multivariable Calculus
Mathematics 250 Linear Algebra
Mathematics 350 Real Analysis
Mathematics 355 Abstract Algebra
Complex Analysis
Topology
Some second semester analysis
Some second semester algebra
Some post-core geometry
Thesis
[Senior seminar can be waived in favor of harder post-core electives.]

Students headed for graduate school generally take more than this relatively small number of courses required for a liberal arts major. Reading knowledge of a foreign language (French, German, or Russian) can be helpful.

Students interested in continuing their study of statistics in graduate school should take STAT 201, 231, 346, a 400 level statistics course and MATH 350 and 341.

OTHER CAREER PATHS

Other Graduate and Professional Schools: An increasing number of graduate and professional schools require mathematics and statistics as a prerequisite to admission or to attaining their degree. Students interested in graduate or professional training in business, medicine, economics, or psychology are advised to find out the requirements in those fields early in their college careers.

Statistics and Actuarial Science: Students interested in statistics or actuarial science should consider Mathematics 341, Statistics courses, and Economics 255. Additionally, students should consider taking some number of the actuarial exams given by the Society of Actuaries, which can constitute part of an honors program in actuarial studies (see section on honors above).

Teaching: Students interested in teaching mathematics at the elementary or secondary school level should consider courses on teaching, number theory, geometry, statistics, and practice as a tutor or teaching assistant. Winter study courses that provide a teaching practicum are also highly recommended. Consult the Program in Teaching (Professor Susan Engel) and the Office of Career Counseling.

Business and Finance: Students interested in careers in business or finance should consider Mathematics 333 and Statistics courses. Since these courses address different needs, students should consult with the instructors to determine which seem to be most appropriate for individuals.

STATISTICS COURSE LISTINGS FOLLOW THE MATHEMATICS COURSE LISTINGS

There are three types of 300-level courses. There are the core courses: Real Analysis, MATH 350/351, and Abstract Algebra Math 355. There are the "precore" courses, which do not have the core courses as prerequisites and have numbers 300-349. Finally, there are those courses that have an Abstract Algebra or Real Analysis prerequisite, which are numbered 360-399.

MAJOR IN STATISTICS

The major in Statistics is designed to meet three goals: to introduce some of the central ideas of information and data science, to develop problem-solving ability by teaching students to combine creative thinking with rigorous reasoning, and to develop interdisciplinary skills by applying statistics to an application area of interest.

REQUIREMENTS (ten courses plus colloquium*)*

The major in Statistics consists of ten courses plus a colloquium requirement. The major includes courses in mathematics, computer science and statistics.

Mathematics (2 courses)

MATH 150 or 151 Multivariable Calculus or equivalent high school course
MATH 250 Linear Algebra

Except in unusual circumstances, students planning to major in statistics should complete the calculus sequence (MATH 130, 140, 150/151) before the spring of the sophomore year, at the latest. MATH 150 is a prerequisite for STAT 201 and MATH 250 is a prerequisite for STAT 346.

Computer Science (1 course)

CSCI 134 Intro to Computer Science or CSCI 135 Diving into the Deluge of Data or CSCI 136 Data Structures and Advanced Programming or some other course in the Computer Science Department with prior approval of the Math/Stat department.

Core Courses (4 Courses)

STAT 201 Statistics and Data Analysis or STAT 202 Introduction to Statistical Modeling
STAT 346 Regression and Forecasting
MATH 341/STAT 341 Probability
STAT 360 Inferential Statistics

Continuation (2 Courses)

Any two courses among the 300 or 400 level courses in the department with a STAT prefix.

Capstone Course (1 Course)

The capstone course is a 400-level STAT course taken in the senior year. Although the specific methodological emphasis of the course may vary from year to year, an in-depth project with both a written report and an oral presentation is typically part of the capstone course.

Colloquium Requirement

Participation in the Department Colloquium series, in which all senior majors present and attend talks on mathematical or statistical topics of their choice. Majors have to attend at least 20 colloquia in their senior year and present one themselves.

PLACEMENT

Students with an AP STAT score of 5 should consult the Department about proper placement in the introductory courses.

NOTES

Substitutions, Study Abroad, and Transfer Credit: In some cases, and with prior permission of the Mathematics and Statistics Department, appropriate courses from other institutions may be substituted for the application and continuation requirements, but at least eight courses must be taken from the Department of Mathematics and Statistics at Williams. These can, with prior permission, include courses taken away. Students with transfer credit should contact the department about special arrangements. You can find general study away guidelines for Statistics here.

Double Counting: No course may count towards two different majors.

Early Senior Capstone Course: In exceptional circumstances, with the prior permission of the department, a student may be allowed to satisfy the Senior Capstone Course requirement in the junior year, provided that the student has completed at least three 300-level statistics courses before enrolling in the capstone course.

Planning Courses: Core courses are normally offered every year. Other 300 and 400 level statistics courses are offered on an irregular basis. Students should check with the department before planning far into the future.

Course Admission: Courses are normally open to all students meeting the prerequisites, subject to any course caps. Students with questions about the level at which courses are conducted are invited to consult department faculty.

THE DEGREE WITH HONORS IN STATISTICS

The degree with honors in Statistics is awarded to the student who has demonstrated outstanding intellectual achievement in a program of study which extends beyond the requirements of the major. The principal considerations for recommending a student for the degree with honors will be: Mastery of core material and skills, breadth and, particularly, depth of knowledge beyond the core material, ability to pursue independent study of statistics, originality in methods of investigation, and, where appropriate, creativity in research.

An honors program normally consists of two semesters (STAT 493 and 494) and a winter study (WSP 031) of independent research, culminating in a thesis and a presentation. One of STAT 493 or STAT 494 can count as a continuation course, but not both. Neither counts as the 400-level senior capstone course.

An honors program in actuarial studies requires significant achievement on four appropriate examinations of the Society of Actuaries.

Highest honors will be reserved for the rare student who has displayed exceptional ability, achievement or originality. Such a student usually will have written a thesis or pursued actuarial honors. In all cases, the award of honors and highest honors is the decision of the Department.

MATH 102T(F) Foundations in Quantitative Skills

This course is designed to strengthen the student's foundation in quantitative reasoning in preparation for the science curriculum and QFR requirements. The material will cover topics at the college algebra/precalculus level with a particular emphasis on the computational and applied side of mathematics. We will use specialized software, including Excel and Mathematica. Prior experience with this software is not required. The course will be offered as a tutorial, with pairs of students meeting with the instructor to discuss various topics in mathematics and their implementation on the computer. Access to this course is limited to placement by a quantitative skills counselor.

Class Format: tutorial
Requirements/Evaluation: homework assignments and projects
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: access to the course is limited to placement by a quantitative skills counselor
Enrollment Preferences: students who need most help with the quantitative reasoning
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3

Fall 2016
TUT Section: T1 TBA Instructor: Mihai Stoiciu

MATH 113 The Beauty of Numbers (Q)

Have you ever wondered what keeps your credit card information safe everytime you buy something online? Number theory! Number Theory is one of the oldest branches of mathematics. In this course, we will discover the beauty and usefulness of numbers, from ancient Greece to modern cryptography. We will look for patterns, make conjectures, and learn how to prove these conjectures. Starting with nothing more than basic high school algebra, we will develop the logic and critical thinking skills required to realize and prove mathematical results. Topics to be covered include the meaning and content of proof, prime numbers, divisibility, rationality, modular arithmetic, Fermat's Last Theorem, the Golden ratio, Fibonacci numbers, coding theory, and unique factorization.

Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on projects, homework assignments, and exams
Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test) or permission of instructor
Enrollment Limit: 25
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Allison Pacelli

MATH 115 Mathematical Politics: Voting, Power, and Conflict (Q)

Crosslistings: MATH 115/INTR 160
Primary Crosslisting

Who should have won the 2000 Presidential Election? Do any two senators really have equal power in passing legislation? How can marital assets be divided fairly? While these questions are of interest to many social scientists, a mathematical perspective can offer a quantitative analysis of issues like these and more. In this course, we will discuss the advantages and disadvantages of various types of voting systems and show that, in fact, any such system is flawed. We will also examine a quantitative definition of power and the principles behind fair division. Along the way, we will enhance the critical reasoning skills necessary to tackle any type of problem mathematical or otherwise.

Class Format: lecture/discussion

Requirements/Evaluation: evaluation will be based primarily on projects, homework assignments, and exams
Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test) or permission of instructor
Enrollment Limit: 30
Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

MATH 120 The Art of Mathematical Thinking: An Introduction to the Beauty and Power of Mathematical Ideas (Q)
What is mathematics? How can it enrich and improve your life? What do mathematicians think about and how do they go about tackling challenging questions? Most people envision mathematicians as people who solve equations or perform arithmetic. In fact, mathematics is an artistic endeavor which requires both imagination and creativity. In this course, we will experience what this is all about by discovering various beautiful branches of mathematics while learning life lessons that will have a positive impact on our lives. There are two meta-goals for this course: (1) a better perspective into mathematics, and (2) sharper analytical reasoning to solve problems (both mathematical and nonmathematical).
Class Format: lecture/discussion
Requirements/Evaluation: evaluation will be based primarily on projects, homework assignments, and exams
Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test) or permission of instructor
Enrollment Limit: 30
Expected Class Size: 30
Dept. Notes: not open to students who have taken mathematics courses other than MATH 102,130, 170, STAT 101 without permission of the instructor
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

MATH 130(F,S) Calculus I (Q)
Calculus permits the computation of velocities and other instantaneous rates of change by a limiting process called differentiation. The same process also solves "max-min" problems: how to maximize profit or minimize pollution. A second limiting process, called integration, permits the computation of areas and accumulations of income or medicines. The Fundamental Theorem of Calculus provides a useful and surprising link between the two processes. Subtopics include trigonometry, exponential growth, and logarithms.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on exams, homework and quizzes
Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test); this is an introductory course for students who have not seen calculus before
Enrollment Limit: 50
Expected Class Size: 30
Dept. Notes: students who have previously taken a calculus course may not enroll in MATH 130 without the permission of instructor
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Lori Pedersen

LEC Section: 02 MWF 11:00 AM 11:50 AM Instructor: Lori Pedersen

Spring 2017
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Haydee Lindo

MATH 140(F,S) Calculus II (Q)
Mastery of calculus requires understanding how integration computes areas and business profit and acquiring a stock of techniques. Further methods solve equations involving derivatives ("differential equations") for population growth or pollution levels. Exponential and logarithmic functions and trigonometric and inverse functions play an important role. This course is the right starting point for students who have seen derivatives, but not necessarily integrals, before.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, quizzes, and/or exams
Prerequisites: MATH 130 or equivalent; students who have received the equivalent of advanced placement of AB 4, BC 3 or higher may not enroll in MATH 140 without the permission of instructor
Enrollment Limit: none
Expected Class Size: 30
Dept. Notes: students who have higher advanced placement must enroll in MATH 150 or above
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Leo Goldmakher

LEC Section: 02 MWF 11:00 AM 11:50 AM Instructor: Leo Goldmakher

Spring 2017
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Lori Pedersen

MATH 150(F,S) Multivariable Calculus (Q)

Applications of calculus in mathematics, science, economics, psychology, the social sciences, involve several variables. This course extends calculus to several variables: vectors, partial derivatives, multiple integrals. There is also a unit on infinite series, sometimes with applications to differential equations.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, quizzes, and/or exams
Prerequisites: MATH 140 or equivalent, such as satisfactory performance on an Advanced Placement Examination
Enrollment Limit: 50
Expected Class Size: 50
Dept. Notes: this course is the right starting point for students who have seen differentiation and integration before; students with the equivalent of advanced placement of AB 4, BC 3 or above should enroll in MATH 150
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Stewart Johnson

LEC Section: 02 MWF 10:00 AM 10:50 AM Instructor: Stewart Johnson

LEC Section: 03 MWF 11:00 AM 11:50 AM Instructor: Stewart Johnson

Spring 2017
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Diana Davis

LEC Section: 02 MWF 11:00 AM 11:50 AM Instructor: Diana Davis

MATH 151(F) Multivariable Calculus (Q)
Applications of calculus in mathematics, science, economics, psychology, the social sciences, involve several variables. This course extends calculus to several variables: vectors, partial derivatives and multiple integrals. The goal of the course is Stokes Theorem, a deep and profound generalization of the Fundamental Theorem of Calculus. The difference between this course and MATH 150 is that MATH 150 covers infinite series instead of Stokes Theorem. Students with the equivalent of BC 3 or higher should enroll in MATH 151, as well as students who have taken the equivalent of an integral calculus and who have already been exposed to infinite series. For further clarification as to whether MATH 150 or MATH 151 is appropriate, please consult a member of the math/stat department.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, quizzes, and/or exams
Prerequisites: AP BC 3 or higher or integral calculus with infinite series
Enrollment Limit: 50
Expected Class Size: 50
Dept. Notes: MATH 151 satisfies any MATH 150 prerequisite; credit will not be given for both MATH 150 and MATH 151
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Ralph Morrison

LEC Section: 02 MWF 10:00 AM 10:50 AM Instructor: Ralph Morrison

LEC Section: 03 MWF 11:00 AM 11:50 AM Instructor: Ralph Morrison

MATH 200(F,S) Discrete Mathematics (Q)
Course Description: In contrast to calculus, which is the study of continuous processes, this course examines the structure and properties of finite sets. Topics to be covered include mathematical logic, elementary number theory, mathematical induction, set theory, functions, relations, elementary combinatorics and probability, graphs and trees, and algorithms. Emphasis will be given on the methods and styles of mathematical proofs, in order to prepare the students for more advanced math courses.
Class Format: lecture/discussion
Requirements/Evaluation: evaluation will be based primarily on homework and exams
Prerequisites: MATH 140, or MATH 130 with CSCI 134 or 135, or one year of high school calculus with permission of instructor
Enrollment Limit: none
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Peyam Tabrizian

Spring 2017
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Peyam Tabrizian

MATH 209 Differential Equations (Q)
Historically, much beautiful mathematics has arisen from attempts to explain physical, chemical, biological and economic processes. A few ingenious techniques solve a surprisingly large fraction of the associated ordinary and partial differential equations, and geometric methods give insight to many more. The mystical Pythagorean fascination with ratios and harmonics is vindicated and applied in

Fourier series and integrals. We will explore the methods, abstract structures, and modeling applications of ordinary and partial differential equations and Fourier analysis.
Class Format: lecture/discussion
Requirements/Evaluation: evaluation will be based on problem sets, hour tests, and a final exam
Prerequisites: MATH 150; students may not normally get credit for both MATH 209 and MATH/PHYS 210
Enrollment Limit: 50
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: MTSC Related Courses

Not Offered Academic Year 2017
LEC Instructor: Julie Blackwood

MATH 210(S) Mathematical Methods for Scientists (Q)
Crosslistings: PHYS 210/MATH 210
Secondary Crosslisting
This course covers a variety of mathematical methods used in the sciences, focusing particularly on the solution of ordinary and partial differential equations. In addition to calling attention to certain special equations that arise frequently in the study of waves and diffusion, we develop general techniques such as looking for series solutions and, in the case of nonlinear equations, using phase portraits and linearizing around fixed points. We study some simple numerical techniques for solving differential equations. A series of optional sessions in Mathematica will be offered for students who are not already familiar with this computational tool.
Class Format: lecture, three hours per week
Requirements/Evaluation: evaluation will be based on weekly problem sets and several in-class exams, all of which have a substantial quantitative component
Prerequisites: MATH 150 or 151 and familiarity with Newtonian mechanics at the level of PHYS 131
Enrollment Limit: 50
Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: MTSC Related Courses

Spring 2017
LEC Section: 01 TR 09:55 AM 11:10 AM Instructor: Frederick Strauch

MATH 250(F,S) Linear Algebra (Q)
Many social, political, economic, biological, and physical phenomena can be described, at least approximately, by linear relations. In the study of systems of linear equations one may ask: When does a solution exist? When is it unique? How does one find it? How can one interpret it geometrically? This course develops the theoretical structure underlying answers to these and other questions and includes the study of matrices, vector spaces, linear independence and bases, linear transformations, determinants and inner products. Course work is balanced between theoretical and computational, with attention to improving mathematical style and sophistication.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework and exams
Prerequisites: MATH 150/151 or MATH 200
Enrollment Limit: 45
Expected Class Size: 35
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: COGS Related Courses

Fall 2016
LEC Section: 01 MWF 11:00 AM 11:50 AM Instructor: Allison Pacelli

LEC Section: 02 MWF 12:00 PM 12:50 PM Instructor: Allison Pacelli

Spring 2017
LEC Section: 01 TR 08:30 AM 09:45 AM Instructor: Pamela Harris

LEC Section: 02 TR 09:55 AM 11:10 AM Instructor: Pamela Harris

MATH 285T Mathematics Education (Q)
This course will be a study of mathematics education, from the practical aspects of teaching to numerous ideas in current research. This is an exciting time in mathematics education. The new common core state standards have sparked a level of interest and debate not often seen in the field. In this course, we will look at a wide range of issues in math education, from content knowledge to the role of creativity in a math class to philosophies of teaching.
In addition to weekly tutorial meetings that focus on some of the key questions in math education, we will also meet weekly as a group to discuss the mechanics of teaching. Each student will also be responsible for teaching bi-weekly extra sessions for MATH 200 at which they will make presentations, field questions, and offer guidance on homework questions. Students will also attend the MATH 200 lecture, and do some grading for the course.
Anyone interested in this course should contact Prof Pacelli early in the fall semester if possible.
Class Format: tutorial/teaching

Requirements/Evaluation: evaluation will be based primarily on written work, oral presentations, teaching performance, and a final project
Extra Info: may not be taken on a pass/fail basis
Prerequisites: MATH 250 and MATH 200 or permission of instructor
Enrollment Preferences: those with an interest in teaching, and if over-enrolled, admission will be based on answers to a questionnaire
Enrollment Limit: 6
Expected Class Size: 6
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: TEAC Related Courses

Not Offered Academic Year 2017
TUT Instructor: Allison Pacelli

MATH 293T(F) Undergraduate Research Topics in Representation Theory (Q)
Central to the study of the representation theory of Lie algebras is the computation of weight multiplicities by using Kostant's weight multiplicity formula. This formula is an alternating sum over a finite group, and involves a partition function. In this tutorial, we will address questions regarding the number of terms contributing nontrivially to the sum and develop closed formulas for the value of the partition function. Techniques used include generating functions and counting arguments, which are at the heart of combinatorics and are accessible to undergraduate students.
Class Format: tutorial
Requirements/Evaluation: written assignments, oral presentations
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: permission of instructor
Enrollment Preferences: programming experience, students with interests in the intersection of combinatorics and abstract algebra
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
TUT Section: T1 TBA Instructor: Pamela Harris

MATH 300 Measuring Truth
Crosslistings: MATH 300/HSCI 300/REL 301/SOC 300
Primary Crosslisting
We will examine specific case studies of measuring truth—the emergence of science and technology in American colleges and universities; the prevalence of scientific methods in social science and humanities; the ways alternative methodologies in the humanities critique and historicize scientific approaches to reaching truth; and the possible tension between scientific modes of thinking and the aims of the liberal arts.
Class Format: seminar
Requirements/Evaluation: five 2-page papers and a final 15-page paper
Extra Info: may not be taken on a pass/fail basis
Prerequisites: any 200-level course
Enrollment Preferences: at the discretion of the instructors
Enrollment Limit: 20
Expected Class Size: 20
Distribution Notes: meets Division 3 requirement if registration under MATH; meets division 2 if registration under AFR, HSCIREL or SOC
Distributional Requirements: Division 3
Other Attributes: SCST Related Courses

Not Offered Academic Year 2017

MATH 309(S) Differential Equations (Q)
Historically, much beautiful mathematics has arisen from attempts to explain physical, chemical and biological processes. A few ingenious techniques solve a surprisingly large fraction of the associated ordinary and partial differential equations, and geometric methods give insight to many more. We will study techniques for solving first-order nonlinear equations, nth-order linear equations, systems, and partial differential equations. Topics include series solutions, the Laplace transform, stability, phase plane analysis, the matrix exponential, and separation of variables.
Class Format: lecture
Requirements/Evaluation: problem sets and exams
Prerequisites: MATH 250, students may not normally get credit for both MATH 309 and MATH 209 or MATH/PHYS 210
Enrollment Limit: 40
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 MWF 11:00 AM 11:50 AM Instructor: Alejandro Sarria

MATH 311(F) Chaos and Dynamical Systems (Q)
Dynamical systems model the motion over time of objects from populations to pendulums. Often they are governed by ordinary differential equations and arise in physics, engineering, biology, and other areas. We will study one and two dimensional flows, fixed points and stability, bifurcations, oscillators, linear systems, linearization, and chaos in one dimensional dynamics.
Class Format: lecture
Requirements/Evaluation: problem sets and exams
Prerequisites: MATH 209, 210, or 250
Enrollment Limit: 40
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Alejandro Sarria

MATH 313(S) Introduction to Number Theory (Q)
The study of numbers dates back thousands of years, and is fundamental in mathematics. In this course, we will investigate both classical and modern questions about numbers. In particular, we will explore the integers, and examine issues involving primes, divisibility, and congruences. We will also look at the ideas of number and prime in more general settings, and consider fascinating questions that are simple to understand, but can be quite difficult to answer.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on performance on homework, projects, and examinations
Prerequisites: MATH 250 or permission of instructor
Enrollment Limit: 50
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Steven Miller

MATH 316(S) Protecting Information: Applications of Abstract Algebra and Quantum Physics (Q)
Crosslistings: MATH 316/PHYS 316
Primary Crosslisting
Living in the information age, we find ourselves depending more and more on codes that protect messages against either noise or eavesdropping. This course examines some of the most important codes currently being used to protect information, including linear codes, which in addition to being mathematically elegant are the most practical codes for error correction, and the RSA public key cryptographic scheme, popular nowadays for internet applications. We also study the standard AES system as well as an increasingly popular cryptographic strategy based on elliptic curves. Looking ahead by a decade or more, we show how a quantum computer could crack the RSA scheme in short order, and how quantum cryptographic devices will achieve security through the inherent unpredictability of quantum events.
Class Format: lecture
Requirements/Evaluation: evaluation will be based on homework sets and exams
Prerequisites: PHYS/MATH 210 or MATH 250 (possibly concurrent) or permission of instructors;
Enrollment Preferences: discretion of the instructors
Enrollment Limit: 50
Expected Class Size: 35
Dept. Notes: students not satisfying the course prerequisites but who have completed MATH 200 or MATH 209 are particularly encouraged to ask to be admitted
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructors:Susan Loepp, William Wootters

MATH 318T(F) Numerical Problem Solving (Q)
In the last twenty years computers have profoundly changed the work in numerical mathematics (in areas from linear algebra and calculus to differential equations and probability). The main goal of this tutorial is to learn how to use computers to do quantitative science. We will explore concepts and ideas in mathematics and science using numerical methods and computer programming. We will use specialized software, including Mathematica and Matlab.
Class Format: tutorial
Requirements/Evaluation: evaluation will be based on homework, classwork, and exams
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: MATH 150/151 and MATH 250 or permission of instructor
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
TUT Section: T1 TBA Instructor: Mihai Stoiciu

MATH 319(F) Integrative Bioinformatics, Genomics, and Proteomics Lab (Q)

Crosslistings: BIOL 319/MATH 319/CHEM 319/PHYS 319/CSCI 319
Secondary Crosslisting
What can computational biology teach us about cancer? In this capstone experience for the Genomics, Proteomics, and Bioinformatics program, computational analysis and wet-lab investigations will inform each other, as students majoring in biology, chemistry, computer science, mathematics/statistics, and physics contribute their own expertise to explore how ever-growing gene and protein data-sets can provide key insights into human disease. In this course, we will take advantage of one well-studied system, the highly conserved Ras-related family of proteins, which play a central role in numerous fundamental processes within the cell. The course will integrate bioinformatics and molecular biology, using database searching, alignments and pattern matching, phylogenetics, and recombinant DNA techniques to reconstruct the evolution of gene families by focusing on the gene duplication events and gene rearrangements that have occurred over the course of eukaryotic speciation. By utilizing high through-put approaches to investigate genes involved in the MAPK signal transduction pathway in human colon cancer cell lines, students will uncover regulatory mechanisms that are aberrantly altered by siRNA knockdown of putative regulatory components. This functional genomic strategy will be coupled with independent projects using phosphorylation-state specific antisera to test our hypotheses. Proteomic analysis will introduce the students to de novo structural prediction and threading algorithms, as well as data-mining approaches and Bayesian modeling of protein network dynamics in single cells. Flow cytometry and mass spectrometry will be used to study networks of interacting proteins in colon tumor cells.
Class Format: two afternoons of lab, with one hour of lecture, per week
Requirements/Evaluation: lab participation, several short homework assignments, one lab report, a programming project, and a grant proposal
Prerequisites: BIOL 202; students who have not taken BIOL 202 but have taken BIOL 101 and CSCI 315 or PHYS 315, may enroll with permission of instructor. No prior computer programming experience is required.
Enrollment Preferences: seniors, then juniors, then sophomores
Enrollment Limit: 12
Expected Class Size: 12
Dept. Notes: does not satisfy the distribution requirement in the Biology major
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: BGNP Core Courses, BIMO Interdepartmental Electives

Fall 2016
LEC Section: 01 W 12:25 PM 01:00 PM Instructor: Lois Banta

LAB Section: 02 WR 01:00 PM 04:00 PM Instructor: Lois Banta

LAB Section: 03 Cancelled

MATH 321 Knot Theory (Q)
Take a piece of string, tie a knot in it, and glue the ends together. The result is a knotted circle, known as a knot. For the last 100 years, mathematicians have studied knots, asking such questions as, "Given a nasty tangled knot, how do you tell if it can be untangled without cutting it open?" Some of the most interesting advances in knot theory have occurred in the last ten years.This course is an introduction to the theory of knots. Among other topics, we will cover methods of knot tabulation, surfaces applied to knots, polynomials associated to knots, and relationships between knot theory and chemistry and physics. In addition to learning the theory, we will look at open problems in the field.
Class Format: lecture
Requirements/Evaluation: evaluation will be based on problem sets, midterms, a paper and a final exam
Prerequisites: MATH 250 or permission of instructor
Enrollment Limit: 30
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Colin Adams

MATH 322 Introduction to Complex Analysis (Q)
The complex numbers are amazingly useful in mathematics, physics, engineering, and elsewhere. We'll learn the meaning of complex multiplication and exponentiation, as in Euler's famous e^{iπ}= -1. We'll study complex functions and their power series, learn how to integrate in the complex plane, including residue calculus, and how to map one domain to another (conformal mapping). We'll see the easiest proof of the Fundamental Theorem of Algebra, which says that every algebraic equation has a solution as long as you allow complex numbers.
Class Format: tutorial
Requirements/Evaluation: evaluation will be based primarily on homework, classwork, and exams
Extra Info: may not be taken on a pass/fail basis
Prerequisites: MATH 150
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

MATH 323 Applied Topology (Q)
In topology, one studies properties of an object that are preserved under rubber-like deformations, where one is allowed to twist and pull, but one cannot tear or glue. Hence a sphere is considered the same as a cube, but distinct from the surface of a doughnut. In recent years, topology has found applications in chemistry (knotted DNA molecules), economics (stability theory), Geographic

Information Systems, cosmology (the shape of the Universe), medicine (heart failure), robotics and electric circuit design, just to name some of the fields that have been impacted. In this course, we will learn the basics of topology, including point-set topology, geometric topology and algebraic topology, but all with the purpose of applying the theory to a broad array of fields.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on problem sets and exams
Prerequisites: MATH 250 or permission of instructor
Enrollment Preferences: none
Enrollment Limit: 40
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Colin Adams

MATH 325 Set Theory (Q)
Set theory is the traditional foundational language for all of mathematics. We will be discussing the Zermelo-Fraenkel axioms, including the Axiom of Choice and the Continuum Hypothesis, basic independence results and, if time permitsGoedel's Incompleteness Theorem. At one time, these issues tore at the foundations of mathematics. They are still vital for understanding the nature of mathematical truth.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on performance on homework and exams
Prerequisites: MATH 150 or MATH 151, and MATH 250
Enrollment Limit: none
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Thomas Garrity

MATH 326 Differential Geometry (Q)
Differential Geometry is the study of curvature. In turn, curvature is the heart of geometry. The goal of this course is to start the study of curvature, concentrating on the curvature of curves and of surfaces, leading to the deep Gauss-Bonnet Theorem, which links curvature with topology.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on problem sets, midterms and a final exam
Prerequisites: MATH 250
Enrollment Limit: none
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Thomas Garrity

MATH 327 Computational Geometry (Q)
The subject of computational geometry started just 25 years ago, and this course is designed to introduce its fundamental ideas. Our goal is to explore "visualization" and "shape" in real world problems. We focus on both theoretic ideas (such as visibility, polyhedra, Voronoi diagrams, triangulations, motion) as well as applications (such as cartography, origami, robotics, surface meshing, rigidity). This is a beautiful subject with a tremendous amount of active research and numerous unsolved problems, relating powerful ideas from mathematics and computer science.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on problem sets and exams
Extra Info: may not be taken on a pass/fail basis
Prerequisites: MATH 200 or MATH 250 or CSCI 256
Enrollment Preferences: preference given to upperclassmen
Enrollment Limit: none
Expected Class Size: 20
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC

MATH 331(S) The little Questions (Q)
Using math competitions such as the Putnam Exam as a springboard, in this class we follow the dictum of the Ross Program and "think deeply of simple things". The two main goals of this course are to prepare students for competitive math competitions, and to get a sense of the mathematical landscape encompassing elementary number theory, combinatorics, graph theory, and group theory (among others). While elementary frequently is not synonymous with easy, we will see many beautiful proofs and "a-ha" moments in the course of our investigations. Students will be encouraged to explore these topics at levels compatible with their backgrounds.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, classwork, and exams

Prerequisites: MATH 250 or permission of instructor
Enrollment Preferences: members or alternates of the Putnam team, Mathematics, Physics or Computer Science majors
Enrollment Limit: 30
Expected Class Size: 25
Dept. Notes: http://web.williams.edu/Mathematics/sjmiller/public_html/331/
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Steven Miller

MATH 333 Investment Mathematics (Q)
Over the years financial instruments have grown from stocks and bonds to numerous derivatives, such as options to buy and sell at future dates under certain conditions. The 1997 Nobel Prize in Economics was awarded to Robert Merton and Myron Schloles for their Black-Scholes model of the value of financial instruments. This course will study deterministic and random models, futures, options, the Black-Scholes Equation, and additional topics.
Class Format: lecture/discussion
Requirements/Evaluation: evaluation will be based on homework, classwork, and exams
Prerequisites: MATH 250 or permission of instructor
Enrollment Limit: 25
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

MATH 334 Graph Theory (Q)
Investigation of the structure and properties of graphs with emphasis both on certain classes of graphs such as multi-partite, planar, and perfect graphs and on application to various optimization problems such as minimum colorings of graphs, maximum matchings in graphs, network flows, etc.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on problem sets and exams
Prerequisites: MATH 250
Enrollment Preferences: Math majors
Enrollment Limit: 35
Expected Class Size: 20
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

MATH 335 Game Theory (Q)
Game theory is the study of interacting decision makers involved in a conflict of interest. We investigate outcomes, dynamics, and strategies as players rationally pursue objective goals and interact according to specific rules. Game theory has been used to illuminate political, ethical, economical, social, psychological, and evolutionary phenomenon. We will examine concepts of equilibrium, stable strategies, imperfect information, repetition, cooperation, utility, and decision.
Class Format: lecture
Requirements/Evaluation: evaluation will be based on problem sets and exams
Prerequisites: two MATH/STAT courses at the 200 or higher level, or permission of instructor
Enrollment Limit: none
Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Stewart Johnson

MATH 337 Phylogenetics (Q)
Phylogenetics is the analysis and construction of information trees based on shared characteristics. The foundational problem asks, given some data from objects, how can a tree be constructed which shows the proper relationships between the objects? This is a beautiful subject with a tremendous amount of cutting-edge research, relating powerful ideas from statistics, computer science, biology, and mathematics, having a wide range of applications, from literature, to linguistics, to visual graphics. This course is designed to introduce fundamental ideas of this subject from a mathematical viewpoint, touching and expanding upon the interests of the enrolled students.
Class Format: tutorial
Requirements/Evaluation: evaluation will be based on exams, participation, and projects
Extra Info: may not be taken on a pass/fail basis
Prerequisites: BIOL 202 or CSCI 256 or MATH 250 or permission of instructor
Enrollment Preferences: at the discretion of the instructor
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: BGNP Related Courses

MATH 341(F) Probability (Q)
While probability began with a study of games, it has grown to become a discipline with numerous applications throughout mathematics and the sciences. Drawing on gaming examples for motivation, this course will present axiomatic and mathematical aspects of

probability. Included will be discussions of random variables, expectation, independence, laws of large numbers, and the Central Limit Theorem. Many interesting and important applications will also be presented, potentially including some from coding theory, number theory and nuclear physics.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, classwork, and exams
Prerequisites: MATH 250 or MATH 200 or permission of instructor
Enrollment Limit: 40
Expected Class Size: 20
Dept. Notes: http://web.williams.edu/Mathematics/sjmiller/public_html/341/
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01   MWF 10:00 AM 10:50 AM Instructor: Steven Miller

MATH 347T Origami (Q)
Origami is the art and study of folding and unfolding. Although ancient in origin, there has been a tremendous resurgence of interest recently, resulting in stunning sculptures and marvelously intricate pop-up books. The applications of origami have grown as well, from NASA's James Webb space telescope to cutting-edge protein folding models. This is a beautiful subject with a tremendous amount of active research, relating powerful ideas from studio art, computer science, and mathematics.
This tutorial is designed to introduce the foundations of origami design from a mathematical viewpoint: 1D linkages, 2D crease patterns and cut-theorems, 3D unfolding polyhedra. No experience in paper folding is necessary.
Class Format: tutorial
Requirements/Evaluation: primarily based on participation, presentations, and projects
Extra Info: may not be taken on a pass/fail basis
Prerequisites: MATH 200 or MATH 250 or CSCI 256 or permission of instructor
Enrollment Preferences: at the discretion of the instructor
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
TUT   Instructor: Satyan Devadoss

MATH 350(F,S) Real Analysis (Q)
Real analysis is the theory behind calculus. It is based on a precise understanding of the real numbers, elementary topology, and limits. Topologically, nice sets are either closed (contain their limit points) or open (complement closed). You also need limits to define continuity, derivatives, integrals, and to understand sequences of functions.
Class Format: lecture/discussion
Requirements/Evaluation: evaluation will be based on homework, classwork, and exams
Prerequisites: MATH 150 or MATH 151 and MATH 250, or permission of instructor
Enrollment Limit: 40
Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01   MWF 11:00 AM 11:50 AM Instructor: Cesar Silva

Spring 2017
LEC Section: 01   MWF 09:00 AM 09:50 AM Instructor: Stewart Johnson

MATH 351(F) Applied Real Analysis (Q)
Real analysis or the theory of calculus—derivatives, integrals, continuity, convergence—starts with a deeper understanding of real numbers and limits. Applications in the calculus of variations or "infinite-dimensional calculus" include geodesics, harmonic functions, minimal surfaces, Hamilton's action and Lagrange's equations, optimal economic strategies, nonEuclidean geometry, and general relativity.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on exams, homework and quizzes
Prerequisites: MATH 150 and MATH 250, or permission of instructor
Enrollment Limit: 50
Expected Class Size: 20
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01   MWF 09:00 AM 09:50 AM Instructor: Diana Davis

MATH 355(F,S) Abstract Algebra (Q)
Algebra gives us tools to solve equations. The integers, the rationals, and the real numbers have special properties which make algebra work according to the circumstances. In this course, we generalize algebraic processes and the sets upon which they operate in order to better understand, theoretically, when equations can and cannot be solved. We define and study abstract algebraic structures such

as groups, rings, and fields, as well as the concepts of factor group, quotient ring, homomorphism, isomorphism, and various types of field extensions. This course introduces students to abstract rigorous mathematics.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on problem sets and exams
Prerequisites: MATH 250 or permission of instructor
Enrollment Limit: 30
Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Susan Loepp

Spring 2017
LEC Section: 01 MWF 11:00 AM 11:50 AM Instructor: Allison Pacelli

LEC Section: 02 MWF 12:00 PM 12:50 PM Instructor: Allison Pacelli

MATH 361(F) Theory of Computation (Q)
Crosslistings: CSCI 361/MATH 361
Secondary Crosslisting
This course introduces a formal framework for investigating both the computability and complexity of problems. We study several models of computation including finite automata, regular languages, context-free grammars, and Turing machines. These models provide a mathematical basis for the study of computability theory—the examination of what problems can be solved and what problems cannot be solved—and the study of complexity theory—the examination of how efficiently problems can be solved. Topics include the halting problem and the P versus NP problem.
Class Format: lecture
Requirements/Evaluation: evaluation will be based on problem sets, a midterm examination, and a final examination
Prerequisites: CSCI 256 or both a 300-level MATH course and permission of instructor
Enrollment Preferences: current or expected Computer Science majors
Enrollment Limit: 40
Expected Class Size: 40
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: COGS Interdepartmental Electives

Fall 2016
LEC Section: 01 MWF 12:00 PM 12:50 PM Instructor: Thomas Murtagh

MATH 367 Homological Algebra (Q)
Though a relatively young subfield of mathematics, Homological Algebra has earned its place by supplying powerful tools to solve questions in the much older fields of Commutative Algebra, Algebraic Geometry and Representation Theory. This class will introduce theorems and tools of Homological Algebra, grounding its results in applications to polynomial rings and their quotients. We will focus on some early groundbreaking results and learn some of Homological Algebra's most-used constructions. Possible topics include tensor products, chain complexes, homology, Ext, Tor and Hilbert's Syzygy Theorem.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework and exams
Extra Info: may not be taken on a pass/fail basis
Prerequisites: Math 355
Enrollment Preferences: junior and senior math majors
Enrollment Limit: 20
Expected Class Size: 12
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Haydee Lindo

MATH 369 Analysis and Number Theory (Q)
Crosslistings: MATH 369/MATH 406
Primary Crosslisting
Gauss said "Mathematics is the queen of the sciences and number theory the queen of mathematics"; in this class we shall meet some of her subjects. We will discuss many of the most important questions in analytic and additive number theory, with an emphasis on techniques and open problems. Topics will range from Goldbach's Problem and the Circle Method to the Riemann Zeta Function and Random Matrix Theory.
Other topics will be chosen by student interest, coming from sum and difference sets, Poissonian behavior, Benford's law, the dynamics of the 3x+1 map as well as suggestions from the class. We will occasionally assume some advanced results for our investigations, though we will always try to supply heuristics and motivate the material. No number theory background is assumed, and we will discuss whatever material we need from probability, statistics or Fourier analysis. For more information, see http://www.math.brown.edu/~sjmiller/williams/406.
Class Format: tutorial
Requirements/Evaluation: evaluation will be based on scholarship, discussions, homework, examinations, papers and presentations

Extra Info: may not be taken on a pass/fail basis, not available for the fifth course option
Prerequisites: for those taking 369T: at least one of MATH 350, 351, 355; for those taking 406T: one of MATH 350 or 351 and MATH 355
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

MATH 372(S) Complex Analysis (Q)
The calculus of complex-valued functions turns out to have unexpected simplicity and power. As an example of simplicity, every complex-differentiable function is automatically infinitely differentiable. As examples of power, the so-called "residue calculus" permits the computation of "impossible" integrals, and "conformal mapping" reduces physical problems on very general domains to problems on the round disc. The easiest proof of the Fundamental Theorem of Algebra, not to mention the first proof of the Prime Number Theorem, used complex analysis. We will discuss these and other topics as time permits (such as the Riemann Mapping Theorem, Special Functions, and the Central Limit Theorem).
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, classwork, and exams
Prerequisites: MATH 350 or MATH 351
Enrollment Limit: 40
Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 TR 08:30 AM 09:45 AM Instructor: Alejandro Sarria

MATH 374T(F) Topology (Q)
Topology is the study of when one geometric object can be continuously deformed and twisted into another object. Determining when two objects are topologically the same is incredibly difficult and is still the subject of a tremendous amount of research, including recent work on the Poincaré Conjecture, one of the million-dollar millennium-prize problems. The main part of the course on point-set topology establishes a framework based on "open sets" for studying continuity and compactness in very general spaces. The second part on homotopy theory develops refined methods for determining when objects are the same. We will prove for example that you cannot twist a basketball into a doughnut.
Class Format: tutorial
Requirements/Evaluation: homework, tutorials, and exams
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: MATH 350 or 351; not open to students who have taken MATH 323
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
TUT Section: T1 TBA Instructor: Cesar Silva

MATH 377(F) Operations Research (Q) (W)
Crosslistings: MATH 377/STAT 377
Primary Crosslisting
In the first N math classes of your career, you can be misled as to what the world is truly like. How? You're given exact problems and told to find exact solutions. The real world is sadly far more complicated. Frequently we cannot exactly solve problems; moreover, the problems we try to solve are themselves merely approximations to the world! We are forced to develop techniques to approximate not just solutions, but even the statement of the problem. Additionally, we often need the solutions quickly. Operations Research, which was born as a discipline during the tumultuous events of World War II, deals with efficiently finding optimal solutions. In this course we build analytic and programming techniques to efficiently tackle many problems. We will review many algorithms from earlier in your mathematical or CS career, with special attention now given to analyzing their run-time and seeing how they can be improved; students will be implementing many of these algorithms on computer systems of their choice. The culmination of the course is a development of linear programming and an exploration of what it can do and what are its limitations. For those wishing to take this as a Stats course, the final project must have a substantial implementation computation (respectively, statistics) component approved by the instructor.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, classwork, projects, presentations and exams; at least 20 pages of writing
Prerequisites: MATH 350 or 351 and permission of instructor
Enrollment Preferences: Computer Science, Mathematics and Statistics majors
Enrollment Limit: 40
Expected Class Size: 25
Dept. Notes: http://web.williams.edu/Mathematics/sjmiller/public_html/317/
Distributional Requirements: Division 3, Quantitative/Formal Reasoning, Writing Intensive

Fall 2016
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Steven Miller

MATH 378(S) Computational Algebraic Geometry (Q)

Algebraic Geometry has been at the heart of mathematics for at least two hundred years. While starting with a humble study of circles, it has influenced a tremendous amount of modern mathematics, ranging from number theory to robotics. Algebraic Geometry uses tools from almost all areas of mathematics to study shapes defined by polynomials; in this course, we will build up both theoretical and computational machinery to help in this endeavor. We will study Bezout's Theorem for plane curves, and the geometry of more general affine and projective varieties.
Class Format: lecture
Requirements/Evaluation: evaluation will be based on homework, exams, and final project
Extra Info: may not be taken on a pass/fail basis
Prerequisites: MATH 355
Enrollment Preferences: instructor decision
Enrollment Limit: 40
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 TR 09:55 AM 11:10 AM Instructor: Ralph Morrison

MATH 379(F) Asymptotic Analysis in Differential Equations
Asymptotic Analysis is a fascinating subfield of differential equations in which interesting and unexpected phenomena can occur. Roughly speaking, the problem is this: Given a differential equation depending on a parameter epsilon, what happens to the solutions to the equation as we let epsilon go to 0? After an extensive survey of examples, we will cover asymptotic evaluation of integrals, such as stationary phase and Laplace's method, multiple scales, WKB approximations, averaging methods, matched asymptotic expansions, and boundary layers. If time permits, we will also discuss bifurcation theory and the Nash-Moser Inverse Function Theorem.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework and exams
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: MATH 350 or MATH 351
Enrollment Limit: 25
Expected Class Size: 15
Distributional Requirements: Division 3

Fall 2016
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Peyam Tabrizian

MATH 382 Harmonic Analysis (Q)
Harmonic Analysis is a diverse field which includes Fourier Analysis, one of the major tools of modern mathematics. Applications range from mathematical topics such as partial differential equations and number theory to more applied ones such as signal processing and medical imaging. The course will begin with an introduction to the Fourier Transform and will cover a wide variety of topics including singular integral operators, maximal operators and wavelets as the semester progresses. Along the way applications from partial differential equations and ergodic theory will arise with a highlight being the almost everywhere convergence of Fourier series.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on exams, homework, quizzes and a project
Prerequisites: MATH 350 or MATH 351 or permission of the instructor
Enrollment Preferences: lottery
Enrollment Limit: 30
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Eyvindur Palsson

MATH 389 Advanced Analysis (Q)
This course further develops and explores topics and concepts from real analysis, with special emphasis on introducing students to subject matter and techniques that are useful for graduate study in mathematics or an allied field. Material will be drawn, based on student interest, from many areas, including analytic number theory, Fourier series and harmonic analysis, generating functions, differential equations and special functions, integral operators, equidistribution theory and probability, random matrix theory and probabilistic methods. This will be an intense, fast paced class which will give a flavor for graduate school. In addition to standard homework problems, students will also write reviews for MathSciNet, referee papers for journals, write programs in SAGE or Mathematica to investigate and conjecture, and read classic and current research papers.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, classwork, and exams
Prerequisites: MATH 350 or 351 and one additional 300-level MATH course, or permission of instructor
Enrollment Preferences: students interested in graduate school in mathematics or an allied discipline
Enrollment Limit: 30
Expected Class Size: 15
Dept. Notes: http://web.williams.edu/Mathematics/sjmiller/public_html/389/
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017

LEC	Instructor: Steven Miller

MATH 394 Galois Theory (Q)
Some equations — such as x^5 - 1 = 0 — are easy to solve. Others — such as x^5 - x - 1 = 0 — are very hard, if not impossible (using standard mathematical operations). Galois discovered a deep connection between field theory and group theory that led to a criterion for checking whether or not a given polynomial can be easily solved. His discovery also led to many other breakthroughs, for example proving the impossibility of squaring the circle or trisecting a typical angle using compass and straightedge. From these not-so-humble beginnings, Galois theory has become a fundamental tool in modern mathematics, from topology to number theory. In this course we will develop the theory and explore its applications to other areas of math.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on written homeworks, oral presentations, and exams
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: MATH 355
Enrollment Preferences: discretion of the instructor
Enrollment Limit: 15
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC	Instructor: Leo Goldmakher

MATH 397(F) Independent Study: Mathematics
Directed 300-level independent study in Mathematics.
Class Format: independent study
Prerequisites: permission of department
Distributional Requirements: Division 3

Fall 2016
IND Section: 01	Cancelled

MATH 398(S) Independent Study: Mathematics
Directed 300-levelindependent study in Mathematics.
Class Format: independent study
Prerequisites: permission of department
Distributional Requirements: Division 3

Spring 2017
IND Section: 01	Cancelled

MATH 401 Functional Analysis (Q)
Functional analysis can be viewed as linear algebra on infinite-dimensional spaces. It is a central topic in Mathematics, which brings together and extends ideas from analysis, algebra, and geometry. Functional analysis also provides the rigorous mathematical background for several areas of theoretical physics (especially quantum mechanics). We will introduce infinite-dimensional spaces (Banach and Hilbert spaces) and study their properties. These spaces are often spaces of functions (for example, the space of square-integrable functions). We will consider linear operators on Hilbert spaces and investigate their spectral properties. A special attention will be dedicated to various operators arising from mathematical physics, especially the Schrodinger operator.
Class Format: lecture
Requirements/Evaluation: weekly problem sets, two midterm exams, final exam
Prerequisites: MATH 350 or 351 or permission of instructor
Enrollment Preferences: Mathematics and Physics majors; seniors
Enrollment Limit: 40
Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC	Instructor: Mihai Stoiciu

MATH 402(S) Measure Theory and Probability (Q)
The study of measure theory arose from the study of stochastic (probabilistic) systems. Applications of measure theory lie in biology, chemistry, physics as well as in economics. In this course, we develop the abstract concepts of measure theory and ground them in probability spaces. Included will be Lebesgue and Borel measures, measurable functions (random variables). Lebesgue integration, distributions, independence, convergence and limit theorems. This material provides good preparation for graduate studies in mathematics, statistics and economics.
Class Format: lecture/discussion
Requirements/Evaluation: evaluation will be based primarily on performance on homework assignments and exams
Prerequisites: MATH 350 or MATH 351 or permission of instructor
Enrollment Limit: 40
Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 MR 02:35 PM 03:50 PM Instructor: Mihai Stoiciu

MATH 403 Measure and Ergodic Theory (Q)
An introduction to measure theory and ergodic theory. Measure theory is a generalization of the notion of length and area, has been used in the study of stochastic (probabilistic) systems. The course covers the construction of Lebesque and Borel measures, measurable functions, and Lebesque integration. Ergodic theory studies the probabilistic behavior of dynamical systems as they evolve through time, and is based on measure theory. The course will cover basic notions, such as ergodic transformations, weak mixing, mixing, and Bernoulli transformations, and transformations admitting and not admitting an invariant measure. There will be an emphasis on specific examples such as group rotations, the binary odometer transformations, and rank-one constructions. The Ergodic Theorem will also be covered, and will be used to illustrate notions and theorems from measure theory.
Class Format: lecture
Requirements/Evaluation: homework and exams
Prerequisites: MATH 350 or MATH 351 or permission of instructor
Enrollment Preferences: Mathematics majors
Enrollment Limit: 25
Expected Class Size: 15-20
Dept. Notes: senior major course
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Cesar Silva

MATH 406T Analysis and Number Theory (Q)
Crosslistings: MATH 369/MATH 406
Secondary Crosslisting
Gauss said "Mathematics is the queen of the sciences and number theory the queen of mathematics"; in this class we shall meet some of her subjects. We will discuss many of the most important questions in analytic and additive number theory, with an emphasis on techniques and open problems. Topics will range from Goldbach's Problem and the Circle Method to the Riemann Zeta Function and Random Matrix Theory.
Other topics will be chosen by student interest, coming from sum and difference sets, Poissonian behavior, Benford's law, the dynamics of the 3x+1 map as well as suggestions from the class. We will occasionally assume some advanced results for our investigations, though we will always try to supply heuristics and motivate the material. No number theory background is assumed, and we will discuss whatever material we need from probability, statistics or Fourier analysis. For more information, see http://www.math.brown.edu/~sjmiller/williams/406.
Class Format: tutorial
Requirements/Evaluation: evaluation will be based on scholarship, discussions, homework, examinations, papers and presentations
Extra Info: may not be taken on a pass/fail basis, not available for the fifth course option
Prerequisites: for those taking 369T: at least one of MATH 350, 351, 355; for those taking 406T: one of MATH 350 or 351 and MATH 355
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
TUT Instructor: Steven Miller

MATH 410T Mathematical Ecology (Q)
Crosslistings: MATH 410/BIOL 214
Primary Crosslisting
Using mathematics to study natural phenomena has become ubiquitous over the past couple of decades. In this tutorial, we will study mathematical models comprised of both deterministic and stochastic differential equations that are developed to understand ecological dynamics and, in many cases, evaluate the dynamical consequences of policy decisions. We will learn how to understand these models through both standard analytic techniques such as stability and bifurcation analysis as well as through simulation using computer programs such as MATLAB. Possible topics include fisheries management, disease ecology, control of invasive species, and predicting critical transitions in ecological systems.
Class Format: tutorial
Requirements/Evaluation: written and programming assignments, oral presentations, and exams
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: MATH 250 or permission of instructor; Math 209 preferred
Enrollment Preferences: programming experience, students with interests in the intersection of math and biology
Enrollment Limit: 10
Expected Class Size: 10
Dept. Notes: Does not satisfy the distribution requirement in the Biology major
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: ENVI Natural World Electives, ENVS Group EB-A Electives, ENVS Methods Courses, PHLH Methods in Public Health

Not Offered Academic Year 2017
TUT Instructor: Julie Blackwood

MATH 411(S) Commutative Algebra (Q)
Commutative Algebra is an essential area of mathematics that provides indispensable tools to many areas, including Number Theory and Algebraic Geometry. This course will introduce you to the fundamental concepts for the study of commutative rings, with a special focus on the notion of "prime ideals," and how they generalize the well-known notion of primality in the set of integers. Possible topics include Noetherian rings, primary decomposition, localizations and quotients, height, dimension, basic module theory, and the Krull Altitude Theorem.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework and exams
Prerequisites: MATH 355 or permission of instructor
Enrollment Limit: 30
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Cory Colbert

MATH 416 Advanced Applied Linear Algebra (Q)
In the first N math classes of your career, it's possible to get an incomplete picture as to what the real world is truly like. How? You're often given exact problems and told to find exact solutions. The real world is sadly far more complicated. Frequently we cannot exactly solve problems; moreover, the problems we try to solve are themselves merely approximations to the world. We're forced to develop techniques to approximate not just solutions, but even the statement of the problem. In this course we discuss some powerful methods from advanced linear algebra and their applications to the real world, specifically linear programming (and, if time permits, random matrix theory). Linear programming is used to attack a variety of problems, from applied ones such as the traveling salesman problem, determining schedules for major league sports (or a movie theater, or an airline) to designing efficient diets to feed the world, to pure ones such as Hales' proof of the Kepler conjecture.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, possible presentations and write-ups, exams and scholarship
Prerequisites: MATH 250 and MATH 350 (programming experience is desirable, but not necessary)
Enrollment Limit: 40
Expected Class Size: 35
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Steven Miller

MATH 419 Algebraic Number Theory (Q)
We all know that integers can be factored into prime numbers and that this factorization is essentially unique. In more general settings, it often still makes sense to factor numbers into "primes," but the factorization is not necessarily unique! This surprising fact was the downfall of Lamé's attempted proof of Fermat's Last Theorem in 1847. Although a valid proof was not discovered until over 150 years later, this error gave rise to a new branch of mathematics: algebraic number theory. In this course, we will study factorization and other number-theoretic notions in more abstract algebraic settings, and we will see a beautiful interplay between groups, rings, and fields.
Class Format: lecture/seminar
Requirements/Evaluation: evaluation will be based primarily on homework assignments and exams
Prerequisites: MATH 355, or permission of instructor
Enrollment Limit: 40
Expected Class Size: 20
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Allison Pacelli

MATH 420T Analytic Number Theory (Q)
How many primes are smaller than x? How many divisors does an integer n have? How many different numbers appear in the N x N multiplication table? Over the course of the past 150 years, tremendous progress has been made towards resolving these and similar questions in number theory, relying on tools and methods from analysis. The goal of this tutorial is to explain and motivate the ubiquitous appearance of analysis in modern number theory—a surprising fact, given that analysis is concerned with continuous functions, while number theory is concerned with discrete objects (integers, primes, divisors, etc). Topics to be covered include: asymptotic analysis, partial and Euler-Maclaurin summation, counting divisors and Dirichlet's hyperbola method, the randomness of prime factorization and the Erdos-Kac theorem, the partition function and the saddle point method, the prime number theorem and the Riemann zeta function, primes in arithmetic progressions and Dirichlet L-functions, the Goldbach conjecture and the circle method, gaps between primes, and other topics as time and interest allow.
Class Format: tutorial
Requirements/Evaluation: tutorial format (problem sets and presentations)
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: MATH 350 or MATH 351, MATH 372 (may be taken concurrently), familiarity with modular arithmetic

Enrollment Preferences: Mathematics majors
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
TUT Instructor: Leo Goldmakher

MATH 424(F) Geometry, Surfaces and Billiards
Mathematical billiards is the study of a ball bouncing around in a table—a rectangle in the popular pub game, but any shape of table for us, including triangles and ellipses. The geometry of billiards is elegant, and is related to surfaces, fractals, and even continued fractions. We will study many types of billiards and surfaces, and take time to explore some beautiful examples and ideas.
Class Format: lecture
Requirements/Evaluation: based on work in class, problem sets, an exam and a project.
Extra Info: not available for the fifth course option
Prerequisites: MATH 350/351 and MATH 355
Enrollment Limit: 25
Expected Class Size: 15
Distributional Requirements: Division 3

Fall 2016
LEC Section: 01 MWF 11:00 AM 11:50 AM Instructor: Diana Davis

MATH 427 Tiling Theory (Q)
Since humankind first utilized stones and bricks to tile the floors of their abodes, tiling has been an area of interest. Practitioners include artists, engineers, designers, architects, crystallographers, scientists and mathematicians. This course will be an investigation into the mathematical theory of tiling. The course will focus on tilings of the plane, including topics such as the symmetry groups of tilings, the topology of tilings, the ergodic theory of tilings, the classification of tilings and the aperiodic Penrose tilings. We will also look at tilings in higher dimensions, including "knotted tilings".
Class Format: lecture
Requirements/Evaluation: problem assignments, exams and a presentation/paper
Extra Info: may not be taken on a pass/fail basis
Prerequisites: MATH 250 and MATH 355
Enrollment Preferences: seniors, because it is a 400-level course required for graduation
Enrollment Limit: 30
Expected Class Size: 20
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Colin Adams

MATH 431(F) Nonlinear Waves, Solitons (Q)
Waves arise in scientific and engineering disciplines such as acoustics, optics, fluid/solid mechanics, electromagnetism and quantum mechanics. Although linear waves are well understood, the study of nonlinear wave phenomena remains an active field of research and a source of inspiration and challenge for several areas of mathematics. We discuss traveling waves, shallow water models, wave steepening, solitons and blowup. Additional topics may include shocks, weak solutions and conservation laws.
Class Format: lecture
Requirements/Evaluation: problem sets, exams, and final project
Prerequisites: MATH 209/210 and MATH 350/351, or permission of the instructor
Enrollment Limit: 40
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 TF 02:35 PM 03:50 PM Instructor: Alejandro Sarria

MATH 433 Mathematical Modeling (Q)
Mathematical modeling is concerned with translating a natural phenomenon into a mathematical form. In this abstract form the underlying principles of the phenomenon can be carefully examined and real-world behavior can be interpreted in terms of mathematical shapes. The models we investigate include feedback phenomena, phase locked oscillators, multiple population dynamics, reaction-diffusion equations, shock waves, and the spread of pollution, forest fires, and diseases. We will employ tools from the fields of differential equations and dynamical systems. The course is intended for students in the mathematical, physical, and chemical sciences, as well as for students who are seriously interested in the mathematical aspects of physiology, economics, geology, biology, and environmental studies.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on performance of problem sets and exams
Prerequisites: MATH 209/PHYS 210 and MATH 350 or 351, or permission of the instructor
Enrollment Preferences: senior Mathematics majors
Enrollment Limit: 50

Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: COGS Related Courses

Not Offered Academic Year 2017
LEC Instructor: Julie Blackwood

MATH 434 Applied Dynamics and Optimal Control (Q)
We seek to understand how dynamical systems evolve, how that evolution depends on the various parameters of the system, and how we might manipulate those parameters to optimize an outcome. We will explore the language of dynamics by deepening our understanding of differential and difference equations, study parameter dependence and bifurcations, and explore optimal control through Pontryagin's maximum principle and Hamilton-Jacobi-Bellman equations. These tools have broad application in ecology, economics, finance, and engineering, and we will draw on basic models from these fields to motivate our study.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on exams and homework assignments
Prerequisites: MATH 209 or PHYS 210, and MATH 350 or 351, or permission of the instructor
Enrollment Limit: 40
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017

MATH 437 Electricity and Magnetism for Mathematicians (Q)
Maxwell's equations are four simple formulas, linking electricity and magnetism, that are among the most profound equations ever discovered. These equations led to the prediction of radio waves, to the realization that a description of light is also contained in these equations and to the discovery of the special theory of relativity. In fact, almost all current descriptions of the fundamental laws of the universe are deep generalizations of Maxwell's equations. Perhaps even more surprising is that these equations and their generalizations have led to some of the most important mathematical discoveries (where there is no obvious physics) of the last 25 years. For example, much of the math world was shocked at how these physics generalizations became one of the main tools in geometry from the 1980s until today. It seems that the mathematics behind Maxwell is endless. This will be an introduction to Maxwell's equations, from the perspective of a mathematician.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on performance on homework and exams
Prerequisites: MATH 350 or MATH 351, and MATH 355, or permission of instructor; not open to students who have taken MATH 337; no physics background required
Enrollment Limit: none
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Thomas Garrity

MATH 453(S) Introduction to the Theory of Partial Differential Equations (Q)
The study of Partial Differential Equations (PDE) is a very prominent branch of modern analysis with many real-life applications. Unlike previous courses you may have taken, in this senior seminar we will set the applications-part aside, and instead study PDE from a rigorous point of view, using tools from mathematical analysis. We will start by examining properties of three classical PDE: Laplace's equation, the heat equation, and the wave equation. Then, we will move on with an introduction to Sobolev spaces and see how to use them to study general second-order elliptic equations. Finally, we will end with first-order PDE and the method of characteristics and, if time permits, we will also cover the theory of Hamilton-Jacobi equations and conservation laws. My hope is that, by the end of the course, you will not only have a deeper understanding of PDE, but also a newfound appreciation of mathematical analysis.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework and exams
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: MATH 350 or MATH 351
Enrollment Limit: 25
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 MWF 11:00 AM 11:50 AM Instructor: Peyam Tabrizian

MATH 456(F) Representation Theory (Q)
Representation theory has applications in fields such as physics (via models for elementary particles), engineering (considering symmetries of structures), and even in voting theory (voting for committees in agreeable societies). This course will introduce the concepts and techniques of the representation theory of finite groups, and will focus on the representation theory of the symmetric group. We will undertake this study through a variety of perspectives, including general representation theory, combinatorial algorithms, and symmetric functions.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, in class presentations, and exams

Extra Info: may not be taken on a pass/fail basis
Prerequisites: MATH 355
Enrollment Preferences: junior and senior Math majors
Enrollment Limit: 40
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 TR 08:30 AM 09:45 AM Instructor: Pamela Harris

MATH 475 Methods in Mathematical Fluid Dynamics (Q)
Crosslistings: MATH 475/PHYS 475
Primary Crosslisting
The mathematical study of fluids is an exciting field with applications in areas such as engineering, physics and biology. The applied nature of the subject has led to important developments in aerodynamics and hydrodynamics. From ocean currents and exploding supernovae to weather prediction and even traffic flow, several partial differential equations (pde) have been proposed as models to study fluid phenomena. This course is designed to both, introduce students to some of the techniques used in mathematical fluid dynamics and lay down a foundation for future research in this and other related areas. Briefly, we start with the method of characteristics, a useful tool in the study of pde. Symmetry and geometrical arguments, special solutions, energy methods, particle trajectories, and techniques from ordinary differential equations (ode) are also discussed. A special focus will be on models from hydrodynamics. These include the KdV and the Camasss Holm equations (and generalizations thereof), and the Euler equations of ideal fluids. Mainly, we will be concerned with models whose solutions depend on time and one spatial variable, although depending on student interest and time, we may also investigate higher-dimensional models.
Class Format: lecture
Requirements/Evaluation: problem sets and final project
Extra Info: may not be taken on a pass/fail basis
Prerequisites: MATH 151, MATH 250, and MATH 350 or 351; some background in pde/ode would be helpful but not required
Enrollment Preferences: senior Mathematics majors
Enrollment Limit: 40
Expected Class Size: 25
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Alejandro Sarria

MATH 478 On Expressing Numbers (Q)
The real numbers are overall mysterious. Attempts even to describe different real numbers can quickly lead to deep, open questions in mathematics. For example, writing numbers via their decimal expansions leads to the result that a number is rational precisely when the decimal expansion is eventually periodic. There is an entirely different method for describing real numbers: continued fractions, which go back thousands of years. Here every real number can be captured by a sequence of integers (just like for the decimal expansion) but now eventually periodicity corresponds to the number being a square root. The mathematics of continued fractions, and especially their higher dimensional generalizations, lead to a great deal of mathematics. We will be using tools from linear algebra, functional analysis, dynamical systems, ergodic theory and algebraic number theory to explore the best way to express a real number.
Class Format: lecture
Requirements/Evaluation: exams and homework
Prerequisites: MATH 350 or MATH 351, and MATH 355
Enrollment Preferences: Seniors
Enrollment Limit: none
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Thomas Garrity

MATH 479 Additive Combinatorics (Q) (W)
Lying at the interface of combinatorics, ergodic theory, harmonic analysis, number theory, and probability, Additive Combinatorics is an exciting field which has experienced tremendous growth in recent years. Very roughly, it is an attempt to classify subsets of a given field which are almost a subspace. We will discuss a variety of topics, including sum-product theorems, the structure of sets of small doubling (e.g. the Freiman-Ruzsa theorem), long arithmetic progressions (e.g. Roth's theorem), structured subsets of sumsets, and applications to computer science (e.g. to pseudorandomess). Depending on time and interest, we may also discuss higher-order Fourier analysis, the polynomial method, and the ergodic approach to Szemeredi's theorem.
Class Format: lecture
Requirements/Evaluation: regular problem sets, as well as a final project
Prerequisites: MATH 250, MATH 350, MATH 355
Enrollment Preferences: students who have previously taken number theory
Enrollment Limit: 19
Expected Class Size: 8
Distributional Requirements: Division 3, Quantitative/Formal Reasoning, Writing Intensive

Not Offered Academic Year 2017
LEC Instructor: Leo Goldmakher

MATH 493(F) Senior Honors Thesis: Mathematics
Mathematics senior honors thesis. Each student carries out an individual research project under the direction of a faculty member that culminates in a thesis. See description under *The Degree with Honors in Mathematics*.
Class Format: independent study
Extra Info: this is part of a full-year thesis (493-494)
Distributional Requirements: Division 3

Fall 2016
HON Section: 01 Cancelled

MATH 494(S) Senior Honors Thesis: Mathematics
Mathematics senior honors thesis. Each student carries out an individual research project under the direction of a faculty member that culminates in a thesis. See description under *The Degree with Honors in Mathematics*.
Class Format: independent study
Extra Info: this is part of a full-year thesis (493-494)
Distributional Requirements: Division 3

Spring 2017
HON Section: 01 Cancelled

MATH 497(F) Independent Study: Mathematics
Directed 400-level independent study in Mathematics.
Class Format: independent study
Prerequisites: permission of department
Distributional Requirements: Division 3

Fall 2016
IND Section: 01 Cancelled

MATH 498(S) Independent Study: Mathematics
Directed 400-level independent study in Mathematics.
Class Format: independent study
Prerequisites: permission of department
Distributional Requirements: Division 3

Spring 2017
IND Section: 01 Cancelled

MATH 499(F,S) Senior Colloquium
Mathematics senior colloquium. Meets every week for two hours both fall and spring. Senior majors must participate at least one hour a week. This colloquium is in addition to the regular four semester-courses taken by all students.
Class Format: colloquium
Distributional Requirements: Non-divisional

Fall 2016
LEC Section: 01 Cancelled

Spring 2017
LEC Section: 01 Cancelled

STAT 101(F,S) Elementary Statistics and Data Analysis (Q)
It is impossible to be an informed citizen in the world today without an understanding of data and information. Whether opinion polls, unemployment rates, salary differences between men and women, the efficacy of vaccines or consumer webdata, we need to be able to separate the signal from the noise. We will learn the statistical methods used to analyze and interpret data from a wide variety of sources. The goal of the course is to help reach conclusions and make informed decisions based on data.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on performances on quizzes and exams
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test)
Enrollment Limit: 50
Expected Class Size: 40
Dept. Notes: students who have had calculus, and potential majors in science, economics or mathematics should consider taking Statistics 201 instead
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: BGNP Recommended Courses, COGS Related Courses, PHLH Statistics Courses

Fall 2016
LEC Section: 01 MWF 08:00 AM 08:50 AM Instructor: Laurie Tupper

LEC Section: 02 MWF 10:00 AM 10:50 AM Instructor: Laurie Tupper

Spring 2017
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Laurie Tupper

STAT 201(F,S) Statistics and Data Analysis (Q)
Statistics can be viewed as the art and science of turning data into information. Real world decision-making, whether in business or science is often based on data and the perceived information it contains. Sherlock Holmes, when prematurely asked the merits of a case by Dr. Watson, snapped back, "Data, data, data! I can't make bricks without clay." In this course, we will study the basic methods by which statisticians attempt to extract information from data. These will include many of the standard tools of statistical inference such as hypothesis testing, confidence intervals, and linear regression as well as exploratory and graphical data analysis techniques. This is an accelerated introductory statistics course that involves computational programming and incorporates modern statistical techniques.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on performance on quizzes and exams
Prerequisites: MATH 150 or equivalent; students without any calculus background should consider STAT 101 instead
Enrollment Limit: 40
Expected Class Size: 40
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: BGNP Recommended Courses, COGS Related Courses, ENVS Methods Courses, PHLH Statistics Courses

Fall 2016
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Daniel Turek

LEC Section: 02 TR 08:30 AM 09:45 AM Instructor: Bernhard Klingenberg

Spring 2017
LEC Section: 01 TR 08:30 AM 09:45 AM Instructor: Bernhard Klingenberg

LEC Section: 02 MWF 09:00 AM 09:50 AM Instructor: Daniel Turek

LEC Section: 03 MWF 11:00 AM 11:50 AM Instructor: Daniel Turek

STAT 202(F) Introduction to Statistical Modeling (Q)
Data come from a variety of sources sometimes from planned experiments or designed surveys, but also arise by much less organized means. In this course we'll explore the kinds of models and predictions that we can make from both kinds of data as well as design aspects of collecting data. We'll focus on model building, especially multiple regression, and talk about its potential as well as its limits to answer questions about the world. We'll emphasize applications over theory and analyze real data sets throughout the course.
Class Format: lecture
Requirements/Evaluation: evaluation will be based on homework, exams and projects
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: AP Statistics 5; STAT 101 or 201 or permission of instructor
Enrollment Limit: 35
Expected Class Size: 20
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: PHLH Statistics Courses

Fall 2016
LEC Section: 01 TF 02:35 PM 03:50 PM Instructor: Richard De Veaux

STAT 231T Statistical Design of Experiments (Q)
What does statistics have to do with designing and carrying out experiments? The answer is, surprisingly perhaps, a great deal. In this course, we will study how to design an experiment with the fewest number of observations possible to achieve a certain power. We will also learn how to analyze and present the resulting data and draw conclusions. After reviewing basic statistical theory and two sample comparisons, we cover one and two-way ANOVA and (fractional) factorial designs extensively. The culmination of the course will be a project where each student designs, carries out, analyzes, and presents an experiment of interest to him or her. Throughout the course, we will use the free statistical software program R to carry out the statistical analysis.
Class Format: tutorial
Requirements/Evaluation: evaluation will be based primarily on performance on exams, homework and the final project
Extra Info: may not be taken on a pass/fail basis
Prerequisites: a previous introductory course in statistics and no fear of simple computer programming and calculus
Enrollment Limit: 10
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: BGNP Related Courses, COGS Related Courses, ENVS Methods Courses, PHLH Statistics Courses

Not Offered Academic Year 2017

TUT Instructor: Andrey Glubokov

STAT 346(F,S) Regression and Forecasting (Q)
This course focuses on the building of empirical models through data in order to predict, explain, and interpret scientific phenomena. Regression modeling is the standard method for analyzing continuous response data and their relationship with explanatory variables. This course provides both theoretical and practical training in statistical modeling with particular emphasis on simple linear and multiple regression, using R to develop and diagnose models. The course covers the theory of multiple regression and diagnostics from a linear algebra perspective with emphasis on the practical application of the methods to real data sets. The data sets will be taken from a wide variety of disciplines.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on performance on exams, homework, and a project
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: STAT 101 or 201, and MATH 150 and 250; or permission of instructor
Enrollment Limit: 22
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 TF 01:10 PM 02:25 PM Instructor: Richard De Veaux

Spring 2017
LEC Section: 01 TF 01:10 PM 02:25 PM Instructor: Richard De Veaux

STAT 355 Multivariate Statistical Analysis (Q)
To better understand complex processes, we study how variables are related to one another, and how they work in combination. Therefore, we want to make inferences about more than one variable at time? Elementary statistical methods might not apply. In this course, we study the tools and the intuition that are necessary to analyze and describe such data sets. Topics covered will include data visualization techniques for high dimensional data sets, parametric and non-parametric techniques to estimate joint distributions, techniques for combining variables, as well as classification and clustering algorithms.
Class Format: lecture
Requirements/Evaluation: evaluation will be based on homework and exams
Prerequisites: STAT 201 and MATH 250
Enrollment Limit: 25
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Brianna Heggeseth

STAT 356(S) Time Series Analysis (Q)
Time series—data collected over time—crop up in applications from economics to engineering to transit. But because the observations are generally not independent, we need special methods to investigate them. This course will include exploratory methods and modeling for time series, including smoothing, ARIMA and state space models, and a foray into the frequency domain. We will emphasize applications to a variety of real data.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on projects, homework, and exams
Prerequisites: STAT 346 (may be taken concurrently) or permission of instructor
Enrollment Limit: 30
Expected Class Size: 20
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Laurie Tupper

STAT 360(S) Statistical Inference (Q)
How do we estimate unknown parameters and express the uncertainty we have in our estimate? Is there an estimator that works best? Many topics from Stat 201 such as random variables, the central limit theorem, point and interval estimation and hypotheses testing will be revisited and put on a more rigorous mathematical footing. The focus is on maximum likelihood estimators and their properties. Bayesian and computer intensive resampling techniques (e.g., the bootstrap) will also be considered.
Class Format: lecture
Requirements/Evaluation: evaluation will be based on problem sets and exams
Extra Info: may not be taken on a pass/fail basis
Prerequisites: MATH 250, STAT 201, STAT 341
Enrollment Limit: 30
Expected Class Size: 30
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 TR 11:20 AM 12:35 PM Instructor: Bernhard Klingenberg

STAT 365(F) Bayesian Statistics (Q)
The Bayesian approach to statistical inference represents a reversal of traditional (or frequentist) inference, in which data are viewed as being fixed and model parameters as unknown quantities. Interest and application of Bayesian methods have exploded in recent decades, being facilitated by recent advances in computational power. We begin with an introduction to Bayes' Theorem, the theoretical underpinning of Bayesian statistics which dates back to the 1700's, and the concepts of prior and posterior distributions, conjugacy, and closed-form Bayesian inference. Building on this, we introduce modern computational approaches to Bayesian inference, including Markov chain Monte Carlo (MCMC), Metropolis-Hastings sampling, and the theory underlying these simple and powerful methods. Students will become comfortable with modern software tools for MCMC using a variety of applied hierarchical modeling examples, and will use R for all statistical computing.
Class Format: lecture
Requirements/Evaluation: evaluation will be based on homework and exams
Prerequisites: STAT 201 and MATH 150 and 250, or permission of instructor
Enrollment Preferences: juniors and seniors, Statistics majors
Enrollment Limit: 30
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Fall 2016
LEC Section: 01 MWF 11:00 AM 11:50 AM Instructor: Daniel Turek

STAT 372 Longitudinal Data Analysis: Modeling Change over Time (Q)
This course explores modern statistical methods for drawing scientific inferences from longitudinal data, i.e., data collected repeatedly on experimental units over time. The independence assumption made for most classical statistical methods does not hold with this data structure because we have multiple measurements on each individual. Topics will include linear and generalized linear models for correlated data, including marginal and random effect models, as well as computational issues and methods for fitting these models. We will consider many applications in the social and biological sciences.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on performance on exams, homework, and a project
Extra Info: may not be taken on a pass/fail basis
Prerequisites: STAT 201 and STAT 346
Enrollment Preferences: junior and senior Statistics majors
Enrollment Limit: 30
Expected Class Size: 20
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: PHLH Statistics Courses

Not Offered Academic Year 2017
LEC Instructor: Brianna Heggeseth

STAT 377(F) Operations Research (Q) (W)
Crosslistings: MATH 377/STAT 377
Secondary Crosslisting
In the first N math classes of your career, you can be misled as to what the world is truly like. How? You're given exact problems and told to find exact solutions. The real world is sadly far more complicated. Frequently we cannot exactly solve problems; moreover, the problems we try to solve are themselves merely approximations to the world! We are forced to develop techniques to approximate not just solutions, but even the statement of the problem. Additionally, we often need the solutions quickly. Operations Research, which was born as a discipline during the tumultuous events of World War II, deals with efficiently finding optimal solutions. In this course we build analytic and programming techniques to efficiently tackle many problems. We will review many algorithms from earlier in your mathematical or CS career, with special attention now given to analyzing their run-time and seeing how they can be improved; students will be implementing many of these algorithms on computer systems of their choice. The culmination of the course is a development of linear programming and an exploration of what it can do and what are its limitations. For those wishing to take this as a Stats course, the final project must have a substantial implementation computation (respectively, statistics) component approved by the instructor.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, classwork, projects, presentations and exams; at least 20 pages of writing
Prerequisites: MATH 350 or 351 and permission of instructor
Enrollment Preferences: Computer Science, Mathematics and Statistics majors
Enrollment Limit: 40
Expected Class Size: 25
Dept. Notes: http://web.williams.edu/Mathematics/sjmiller/public_html/317/
Distributional Requirements: Division 3, Quantitative/Formal Reasoning, Writing Intensive

Fall 2016
LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Steven Miller

STAT 397(F) Independent Study: Statistics
Directed independent study in Statistics.
Class Format: independent study

Prerequisites: permission of department
Distributional Requirements: Division 3

Fall 2016
IND Section: 01 Cancelled

STAT 398(S) Independent Study: Statistics
Directed independent study in Statistics.
Class Format: independent study
Prerequisites: permission of department
Distributional Requirements: Division 3

Spring 2017
IND Section: 01 Cancelled

STAT 440(F) Categorical Data Analysis (Q)
This course focuses on methods for analyzing categorical response data. In contrast to continuous data, categorical data consist of observations classified into two or more categories. Traditional tools of statistical data analysis are not designed to handle such data and pose inappropriate assumptions. We will develop methods specifically designed to address the discrete nature of the observations and consider many applications in the social and biological sciences as well as in medicine, engineering and economics. All methods can be viewed as extensions of traditional regression models and ANOVA.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on performance on exams, homework, and a project
Prerequisites: STAT 346 and STAT 360
Enrollment Limit: 18
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning
Other Attributes: PHLH Statistics Courses

Fall 2016
LEC Section: 01 TR 11:20 AM 12:35 PM Instructor: Bernhard Klingenberg

STAT 442(S) Computational Statistics and Data Mining (Q)
In both science and industry today, the ability to collect and store data can outpace our ability to analyze it. Traditional techniques in statistics are often unable to cope with the size and complexity of today's data bases and data warehouses. New methodologies in Statistics have recently been developed, designed to address these inadequacies, emphasizing visualization, exploration and empirical model building at the expense of traditional hypothesis testing. In this course we will examine these new techniques and apply them to a variety of real data sets.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homeworks and projects
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: STAT 346 or permission of instructor
Enrollment Preferences: seniors and Statistics Majors
Enrollment Limit: 18
Expected Class Size: 10
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Spring 2017
LEC Section: 01 TF 02:35 PM 03:50 PM Instructor: Richard De Veaux

STAT 462 Modern Nonparametric Statistics (Q)
Many statistical procedures and tools are based on a set of assumptions, such as normality. But, what if some or all of these assumptions are not valid? This question leads to the consideration of distribution-free analysis, an active and fascinating field in modern statistics called nonparametric statistics. In this course we aim to make inference for population characteristics while making as few assumptions as possible. Besides the classical rank or randomization-based teststhis course especially focuses on various modern nonparametric inferential techniques, such as nonparametric density estimation, nonparametric regression, selection of smoothing parameter (cross validation and unbiased risk estimation), bootstrap and jackknife, and Minimax theory. Throughout the semester we will examine these new methodologies and apply them on simulated and real data sets using R.
Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, exams, and a final presentation and project
Extra Info: may not be taken on a pass/fail basis
Prerequisites: STAT 201 and STAT 360, or permission of instructor
Enrollment Preferences: those who have taken STAT 346
Enrollment Limit: 30
Expected Class Size: 15
Distributional Requirements: Division 3, Quantitative/Formal Reasoning

Not Offered Academic Year 2017
LEC Instructor: Wendy Wang

STAT 493(F) Senior Thesis: Statistics
Each student carries out an individual research project under the direction of a faculty member that culminates in a thesis. See description under *The Degree with Honors in Mathematics.*
Class Format: independent study
Distributional Requirements: Division 3

Fall 2016
HON Section: 01 Cancelled

STAT 494(S) Senior Thesis: Statistics
Each student carries out an individual research project under the direction of a faculty member that culminates in a thesis. See description under *The Degree with Honors in Mathematics.*
Class Format: independent study
Distributional Requirements: Division 3

Spring 2017
HON Section: 01 Cancelled

STAT 497(F) Independent Study: Statistics
Directed independent study in Statistics.
Class Format: independent study
Prerequisites: permission of department
Distributional Requirements: Division 3

Fall 2016
IND Section: 01 Cancelled

STAT 498(S) Independent Study: Statistics
Directed independent study in Statistics.
Class Format: independent study
Prerequisites: permission of department
Distributional Requirements: Division 3

Spring 2017
IND Section: 01 Cancelled