THE CURRICULUM

Williams College offers a course of study leading to the degree of Bachelor of Arts. The course requirements prescribe both the number of courses to be completed and the minimum grade level to be achieved; the curriculum also requires that each student explore several fields of knowledge and concentrate in one. The full requirements for the degree include meeting the minimum academic standards stated below, residing at the College, fulfilling the distribution requirement, completing a major, and completing the physical education requirement.

The academic year is divided into two regular semesters and a Winter Study Program. The student takes four courses in each semester and, during January, pursues a single program of study on a pass-fail basis.

The Winter Study Program, which began in 1967, is intended to provide students and faculty with a dramatically different educational experience in the January term. The differences are in the nature of the courses, the nature of the learning experience, and the change of educational pace and format from the fall and spring semesters. These differences apply to the faculty and students in several ways: faculty can try out courses with new subjects and techniques that might, if successful, be used later in the regular terms; they can explore subjects not amenable to inclusion in regular courses; and they can investigate fields outside their usual areas of expertise. In their academic work, which is graded Honors, Pass, Perfunctory Pass, or Fail, students can explore new fields at low risk, concentrate on one subject that requires a great deal of time, develop individual research projects, or work in a different milieu (as interns, for example, on or trips outside Williamstown). In addition, Winter Study offers students an opportunity for more independence and initiative in a less formal setting, more opportunity to participate in cultural events, and an occasion to get to know one another better.

REQUIREMENTS FOR THE BACHELOR OF ARTS DEGREE

Academic Requirement

To be eligible for the Bachelor of Arts degree a student must pass 32 regularly graded semester courses and receive grades of C minus or higher in at least 19 of those semester courses, pass four Winter Study Projects, fulfill the distribution requirement, complete all requirements for the major including an average of C minus or higher, and complete the physical education requirement. Beginning with the Class of 2006, students must also fulfill the quantitative/formal reasoning and writing requirements.

Distribution Requirement

The distribution requirement falls into four parts. (Parts 3 and 4 DO NOT apply to the Class of 2005.)

1) DIVISIONAL REQUIREMENT—designed to ensure that in their course of study at Williams, students take an appropriately diverse distribution of courses across the full range of the curriculum.

For the purposes of the requirement, courses are grouped into three divisions: Division I, Languages and the Arts; Division II, Social Studies; and Division III, Science and Mathematics. A full listing of the subjects in each division appears below.

Students must complete at least three graded semester courses in each division. Two in each division must be completed by the end of the sophomore year. No more than two of the courses used to satisfy the requirement may have the same course prefix.

Courses that fulfill the distribution requirement in Division I are designed to help students become better able to respond to the arts sensitively and intelligently by learning the language, whether verbal, visual, or musical, of a significant field of artistic expression. Students learn how to develop the capacity for critical discussion, to increase awareness of the esthetic and moral issues raised by works of art, and to grow in self-awareness and creativity.

Courses which fulfill the Division II requirement consider the institutions and social structures that human beings have created, whether knowingly or unknowingly, and which in turn markedly affect their lives. These courses are intended to help students recognize, analyze, and evaluate these human structures in order that they may better understand themselves and the social world in which they live.
A student may also fulfill the minimum requirements for a major by taking eight semester courses in the major field and two semester courses, approved by a major advisor, in associated fields. In nine departmental majors, such as Political Economy, a larger number of courses may be required.

2) A prescribed sequence of courses, supplemented by parallel courses, and including a major seminar, is required in some major fields. Other majors ask the student to plan a sequence of electives, including advanced work building on elementary courses in the field, and ending in one two-semester faculty-organized course or project in the senior year. All majors provide a systemic counseling to help students plan programs reflecting individual interests as well as disciplined or cumulative patterns of inquiry.

Courses in many major programs require prerequisite courses in related areas. A full description of detailed structure of each major is found under the heading of that major.

CONTRACT MAJOR

Students who wish to undertake the coherent study of an interdisciplinary subject not covered by a regularly offered major may propose to be contract majors. Procedures for arranging a contract major and for honors work in such a major are described in the section, “Courses of Instruction.” Students interested in this option should begin consulting with the Dean’s Office and with potential faculty advisors early in their sophomore year. A student completing a contract major may not do so in conjunction with a second major. For further details, see page 128.

TWO MAJORS

A student may complete two majors with the permission of both majors and the Committee on Academic Standing. Although a student may be granted permission to use a course from one major to fulfill a particular requirement in the other, the student nevertheless must take the minimum number of courses in each field without counting any course twice. A student may be a candidate for Honors in either or both the majors, but a course for Honors in one major may not be used for an Honors course in the other.

Physical Education Requirement

The Physical Education requirement provides students the opportunity of establishing and maintaining a general level of fitness and well-being; of developing abilities in carry-over activities; discovering and extending their own physical capabilities; and of developing skills in activities with survival implications, such as swimming, life saving, and water safety.

A swim test is required of all first-year students at the start of the academic year. Students who fail to complete the test must pass a basic swim course given in the Physical Education program during the first quarter of the year.

Students must complete four quarters of physical education by the end of the sophomore year. Students must enroll in at least two different activities in fulfilling the requirement.

Participation in a fall or spring intercollegiate sport is equivalent to two activity units and participation in a winter sport is equivalent to three units. A maximum of three credits may be attained while participating in intercollegiate sports with the exception of a two sport athlete who can fulfill the physical education requirement by totaling four units in two sports. Students may receive a maximum of two activity units for participation in a club sport; the remaining two units must come from the physical education activity program.

Residence Requirement

Students who begin college at Williams must spend a minimum of six semesters in residence. Williams. Students transferring to Williams from other institutions must spend a minimum of four semesters in residence at Williams, and those entering as sophomores are expected to spend six semesters in residence. Students are considered to be in residence if they are taking a program of study under the direction of the Williams College Faculty. Students must be in residence for both semesters of the final year.

The degree requirements must be completed within eight semesters, including any semesters for which a student receives credit while not in residence at Williams. Thus, semesters spent away on exchange or other approved programs at other colleges are included in the eight semesters. Similarly, if a student who is a student of the Class of 2007 or earlier, or the Committee on Academic Standing grants, degree credit base on Advanced Placement scores, then these semesters are also included in the limit of eight.
MATHMATICS AND STATISTICS (Div. III)

Chair, Professor EDWARD B. BURGER

Professors: ADAMS, O. BEAVER, BURGER, R. DE VEAUX*, GARRITY, V. HILL*, J. JOHN-SON**, MORGAN, SILVA, Associate Professor: LOEPP, Assistant Professors: BOTTIS, DEVA-DOSS**, KLEINBERG, PACELLI, STOICIU, TAPP, Visiting Professor: MERRIS, Visiting Assistant Professor: RAGSDALE, Visiting Lecturer: STEVENSON.

MAJOR

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.

Students are urged to consult with the department faculty on choosing courses appropriate to an individualized program of study.

REQUIREMENTS (nine courses plus colloquium)

Calculus (two courses)
Mathematics 104 Calculus II
Mathematics 105 or 106 Multivariable Calculus

Apart from unusual circumstances, students planning to major in mathematics should complete the calculus sequence (Mathematics 103, 104, 105/106) before the end of the sophomore year, at the latest.

Applied/Discrete Mathematics/Statistics (one course)
Mathematics 209 Differential Equations and Vector Calculus or
Mathematics 210 Mathematical Methods for Scientists (Same as Physics 210)
Mathematics 251 Discrete Mathematics or
Statistics 201 Statistics and Data Analysis or
Statistics 231 Statistical Design of Experiments or

A more advanced elective in discrete or applied mathematics or statistics, with prior departmental approval: Mathematics 305, 306, 315, 361, 375, 433, 452, or any Statistics course 300 or above with appropriate approval from another department as listed in the notes below.

Notes: Mathematics 251 is required in Computer Science, and Mathematics 209 is recommended in other sciences, but double majors should understand that no course may count toward both majors.

Core Courses (three courses)
Mathematics 211 Linear Algebra
Mathematics 301 Real Analysis or Mathematics 305 Applied Real Analysis
Mathematics 312 Abstract Algebra or Mathematics 315 Groups and Characters or Mathematics 317 Applied Abstract Algebra

Completion (three courses plus colloquium)

The Senior Major Course is any 400-level course taken in the senior year. In exceptional circumstances, with 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 three 300-level mathematics courses before enrolling in the Senior Major Course (if it is a statistics seminar, one of the 300-level courses may be replaced by Statistics 231).

Two electives from courses numbered 300 and above or Statistics 231.

Weekly participation as a senior in the Mathematics Colloquium, in which all senior majors present talks on mathematical or statistical topics of their choice.

NOTES

In some cases, an appropriate course from another department may be substituted for one of the electives, with prior permission of the Mathematics and Statistics department. In any case, at least eight courses must be taken in mathematics and statistics at Williams. These can, with prior permission, include

APPLIED MATHEMATICS OR OTHER SCIENCES

Students interested in applied mathematics or other sciences should consider Mathematics 209, 210, courses from outside Mathematics and Statistics, including possibilities such as Chemistry 301, 302, Computer Science 361, Economics 255, Physics 201, 202, Physics 210 or more advanced physics courses. Students interested in economics should consult the Economics Department.

BUSINESS AND FINANCE

Students interested in careers in business or finance should consider Mathematics 373, as well as courses in statistics and related areas such as Statistics 101, 201, 203, 381, 344, 346, 443. Since these courses address different needs, students should consult with the instructors to determine which seem to be most appropriate for individuals.

ENGINEERING

Students interested in engineering should consult the courses for applied mathematics immediately above, with Mathematics 209 and 305 especially recommended. Williams has exchange programs with several 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 IN MATHEMATICS

Students interested in continuing their study of mathematics in graduate school should take Mathematics 301 and 312. Mathematics 302 and 324 are strongly recommended. Many of the 400-level courses would be useful, particularly those that involve algebra and analysis. Honors theses are encouraged. Reading knowledge of a foreign language (French, German, or Russian) is helpful.

STATISTICS AND ACTUARIAL SCIENCE

Students interested in statistics or actuarial science should consult Mathematics 341, Statistics 201, actuarial exams given by the Society of Actuaries, which can constitute part of an honors program in actuarial science (see section on honors below).

TEACHING

Students interested in teaching mathematics at the elementary or secondary school level should consider Mathematics 285, 313, 325, 381, Statistics 201 and practice as a tutor or teaching assistant. Winter study courses that provide a teaching practicum are also highly recommended.

THE DEGREE WITH HONORS IN MATHEMATICS/STATISTICS

The degree with honors in Mathematics/Statistics is awarded to the student who has demonstrated outstanding intellectual achievement in a program of work which extends beyond the requirements of the major. The principal considerations for recommending a student for the degree with honors will be: Mas-tery of the fundamental material and skills, breadth and, particularly, depth of knowledge beyond the core material, and appropriate creativity in research.

An honors program normally consists of two semesters and a WSP (031) of independent research culminating in a thesis and a presentation. Under certain circumstances, the honors work can consist of coordinated independent study involving a regular course and one semester plus a WSP (030) of independent study culminating in a ‘thesis ‘and a presentation. At least one semester should be in addition to the major require-ments.

An honors program in actuarial studies requires significant achievement on four appropriate examinations of the Society of Actuaries and giving a second colloquium talk. Written work is a possible compo-nent. The highest honors will be reserved for the student who has displayed exceptional ability, achievement, and contribution. Such a student usually will have written a thesis, or pursued actuarial honors and written a thesis. An outstanding student who writes a thesis, or pursues actuarial honors and writes a paper,
Mathematics and Statistics

Prospective honors students are urged to consult with their departmental advisor at the time of registration in the spring of the sophomore or at the beginning of the junior year to arrange a program of study that could lead to the degree with honors. By the time of registration during spring of the junior year, the student must have requested a faculty advisor to be honors advisor and must have obtained the department's approval of formal admission to the honors program. Such approval depends on both the record and the promise of the applicant. It is conditional on continuous progress.

The recommendation for honors is usually announced at the end of the spring term. Participation in the honors program does not guarantee a recommendation for honors. The decision to re-endorse the honors program is based on both the scholarship of the student and the fulfillment of the honors program requirements. If the student completes the program during the fall or winter study, the decision may be announced at the beginning of the spring term, conditional on continuing merit.

ADVANCED PLACEMENT

The Mathematics and Statistics Department attempts to place each student who elects a mathematics course in that course best suited to the student's preparation and goals. The suggested placement in an appropriate calculus course is determined by the results of the Advanced Placement Examination (AB or BC) if the student took one, and any additional available information. A student who receives a 5, 4, or 3 on the BC examination is ordinarily placed in Mathematics 106. A student who receives a 4 or 5 on the AB examination is ordinarily placed in Mathematics 105. Students with different AP scores who take the Advanced Placement Examination are barred from Mathematics 103 unless they obtain permission from the instructor. A student who receives a 4 or 5 on the Statistics AP examination is ordinarily placed in Statistics 21. Students interested in mathematics who are not enrolled are encouraged to enroll in the most advanced course for which they are qualified. A student who wishes to enroll in a Mathematics course that he or she is not prepared for is encouraged to enroll in a Mathematics course that he or she is prepared for. The department reserves the right to refuse registration in any course for which the student is determined to be unprepared.

GENERAL REMARKS

Divisional Requirements

All courses may be used to satisfy this requirement.

Alternate Year Courses

Core courses Mathematics 301, 305, 312, and 315 are normally offered every year. Other 300-level courses may be offered in alternate years. Senior seminars (400-level courses) are normally offered every 2-4 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. Students with questions about the level at which courses are conducted are invited to consult members of the department.

Course Descriptions

Descriptions of the courses in Mathematics follow the descriptions of Mathematics courses. More detailed information on all of the offerings in the department is available in the Informal Guide to Mathematics Courses at Williams that can be obtained at the departmental office.

Courses Open on a Pass/Fail Basis

Students taking a mathematics or statistics course on a pass/fail basis must fulfill all the requirements of students taking the course on a graded basis.

With the permission of the department, any course offered by the department may be taken on a pass/fail basis. This may be done only by students majoring in mathematics or statistics and who are not majoring in the honors degree on this basis. However, with the permission of the department, courses taken in the department beyond those requirements may be taken on a pass/fail basis.

Graduate School Requirements

An increasing number of graduate and professional schools require mathematics and statistics as a prerequisite to admission or to obtaining 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.

MATH 102 (F) Pre calculus

This course prepares students for Mathematics 103, first semester calculus. The course begins with a brief review of algebra followed by a thorough treatment of algebraic, logarithmic, and trigonometric functions from a graphical, analytical, and applied point of view.

Format: lecture. Evaluation will be based primarily on homework, quizzes, and exams.

Prerequisites: placement by a Quantitative Studies Counselor. Enrolment limit: (expected: 15)

O. BEAVER

Tuition:

MATH 103 (FS) Calculus I (Q)

This course prepares students for Mathematics 103, first semester calculus. The course begins with a brief review of algebra followed by a thorough treatment of algebraic, logarithmic, and trigonometric functions from a graphical, analytical, and applied point of view.

Format: lecture. Evaluation will be based primarily on homework, quizzes, and exams.

Prerequisites: placement by a Quantitative Studies Counselor or permission of instructor. Enrolment limit: (expected: 15)

S. JOHNSON

Tuition:

MATH 104 (FS) Calculus II (Q)

This course prepares students for Mathematics 104, second semester calculus. The course begins with a brief review of algebra followed by a thorough treatment of algebraic, logarithmic, and trigonometric functions from a graphical, analytical, and applied point of view.

Format: lecture. Evaluation will be based primarily on homework, quizzes, and exams.

Prerequisites: Mathematics 103 or equivalent. Enrolment limit: (expected: 50-60)

Tuition:

First Semester: STEVENSON
Second Semester: O. BEAVER

MATH 105 (FS) 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. The course is designed to prepare students for graduate study in mathematics, science, economics, psychology, the social sciences.

Format: lecture. Evaluation will be based primarily on homework, quizzes, and exams.

Prerequisites: Mathematics 104 or equivalent. Enrolment limit: (expected: 50-70)

Tuition:

First Semester: STOICIOU, O. BEAVER
Second Semester: SILVA

MATH 106 (FS) 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. The course is designed to prepare students for graduate study in mathematics, science, economics, psychology, the social sciences.

Format: lecture. Evaluation will be based primarily on homework, quizzes, and exams.

Prerequisites: Mathematics 104 or equivalent. Enrolment limit: (expected: 50-70)

Tuition:

First Semester: ADAMS
Second Semester: TAPP

MATH 107 (FS) 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. The course is designed to prepare students for graduate study in mathematics, science, economics, psychology, the social sciences.

Format: lecture. Evaluation will be based primarily on homework, quizzes, and exams.

Prerequisites: Mathematics 104 or equivalent. Enrolment limit: (expected: 50-70)

Tuition:

First Semester: ADAMS
Second Semester: TAPP

MATH 108 (FS) 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. The course is designed to prepare students for graduate study in mathematics, science, economics, psychology, the social sciences.

Format: lecture. Evaluation will be based primarily on homework, quizzes, and exams.

Prerequisites: Mathematics 104 or equivalent. Enrolment limit: (expected: 50-70)

Tuition:

First Semester: ADAMS
Second Semester: TAPP
Mathematics and Statistics

Format: lecture. Evaluation will be based primarily on homework, quizzes, and/or exams. Prerequisites: BC 3 or higher or integral calculus with infinite series. No enrollment limit (expected: 45). Hour: 10:00-10:50 MWF; 11:00-11:50 MWF

MATH 175 Mathematical Politics: Voting, Power, and Conflict (Same as INTR 160) (Not offered 2005-2006; to be offered 2006-2007) (Q)

PACCELLI

MATH 180(F) 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 how we do things, and why are there so many different ways to solve problems? This course will explore these questions and develop a more rigorous understanding of mathematical ideas. Prerequisites: Math 100 or permission of instructor. Enrollment limit: 50 (expected: 50). Open to students who have taken mathematics courses other than Mathematics 100, 101, 102, 103, 120, 121, 201, 210, 210A, or 210B.

MATH 209(S) Differential Equations and Vector Calculus (Q)

Historically, much of mathematics has arisen from attempts to explain how functions change, and to understand the behavior of systems and the solutions of equations. In this course, we will explore these ideas and develop techniques for solving differential equations and vector calculus problems. Prerequisites: Math 105. No enrollment limit (expected: 31). Students may not normally get credit for both Mathematics 209 and Mathematics/Physics 210.

MATH 210(S) Mathematical Methods for Scientists (Same as Physics 210) (Q)

(See under Physics for full description.)

MATH 211(F) Linear Algebra (Q)

MATH 211(T) Mathematical Reasoning and Linear Algebra (Q)

MATH 212(F) Discrete Mathematics (Q)

As a complement to calculus, which is the study of continuous processes, this course focuses on the discrete, including finite sets and counting and proof techniques.

MATH 215 Introduction to Mathematical Proof and Argumentation (Q)

The fundamental focus of this tutorial is to develop mathematical language and proof techniques. Students will learn to write mathematical proofs in a general setting and apply them to various areas of mathematics. Prerequisites: Mathematics 104 or Mathematics 103 with Computer Science 134 or one year of high school calculus with permission of instructor. No enrollment limit (expected: 30). Hour: 10:00-10:50 MWF; 11:00-11:50 MWF

MATH 285 Teaching Mathematics (Q)

Under faculty supervision, student-teachers will prepare and conduct weekly extra sessions for middle school mathematics classes, using high-quality mathematics curricula. Prerequisites: Mathematics 104 or 103 with Computer Science 134 or one year of high school calculus with permission of instructor. Enrollment limit: 10 (expected: 10).

MATH 301(F) Real Analysis (Q)

Real analysis is the theory behind calculus. It is based on a precise understanding of the real number system and the properties of the real numbers. This course will focus on the theory of the real number system and its applications in calculus. Prerequisites: Mathematics 105 and 211, or permission of instructor. No enrollment limit (expected: 25). Hour: 8:00-8:50 MWF

MATH 302 Complex Analysis (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 305(S) Applied Real Analysis (Q)

MATH 306(F) Chaos and Fractals (Q)

This course is an introduction to chaotic dynamical systems. The topics will include bifurcations, the quadratic family, symbolic dynamics, chaos, dynamics of linear systems, and some complex dynamics. Prerequisites: Mathematics 105 and 211, or permission of instructor. No enrollment limit (expected: 25). Hour: 11:00-11:50 MWF

MATH 307 Methods in Mathematical Modeling and Operations Research (Q)

Operations research offers powerful mathematical tools for modeling, optimizing, and making decisions under uncertainty. The aim of the course is to introduce methods and show their applications to real-world problems. This course will focus on optimization techniques, including linear programming and integer programming. Students will learn to use optimization software packages and will develop skills in modeling and interpreting results. Prerequisites: Mathematics 211. No enrollment limit (expected: 15). Hour: 10:00-10:50 MWF

MATH 308 Topics in Algebra (Q)

MATH 309 Topics in Topology (Q)

MATH 310 Topics in Number Theory (Q)

MATH 311 Topics in Combinatorics (Q)

MATH 312 Topics in Graph Theory (Q)

MATH 313 Topics in Algebraic Geometry (Q)

MATH 314 Topics in Cryptography (Q)

MATH 315 Topics in Number Theory (Q)

MATH 316 Topics in Topology (Q)

MATH 317 Topics in Combinatorics (Q)

MATH 318 Topics in Graph Theory (Q)

MATH 319 Topics in Algebraic Geometry (Q)

MATH 320 Topics in Cryptography (Q)

MATH 321 Topics in Number Theory (Q)

MATH 322 Topics in Topology (Q)

MATH 323 Topics in Combinatorics (Q)

MATH 324 Topics in Graph Theory (Q)

MATH 325 Topics in Algebraic Geometry (Q)

MATH 326 Topics in Cryptography (Q)

MATH 327 Topics in Number Theory (Q)

MATH 328 Topics in Topology (Q)

MATH 329 Topics in Combinatorics (Q)

MATH 330 Topics in Graph Theory (Q)

MATH 331 Topics in Algebraic Geometry (Q)

MATH 332 Topics in Cryptography (Q)

MATH 333 Topics in Number Theory (Q)

MATH 334 Topics in Topology (Q)

MATH 335 Topics in Combinatorics (Q)

MATH 336 Topics in Graph Theory (Q)

MATH 337 Topics in Algebraic Geometry (Q)

MATH 338 Topics in Cryptography (Q)

MATH 339 Topics in Number Theory (Q)

MATH 340 Topics in Topology (Q)

MATH 341 Topics in Combinatorics (Q)

MATH 342 Topics in Graph Theory (Q)

MATH 343 Topics in Algebraic Geometry (Q)

MATH 344 Topics in Cryptography (Q)

MATH 345 Topics in Number Theory (Q)

MATH 346 Topics in Topology (Q)

MATH 347 Topics in Combinatorics (Q)

MATH 348 Topics in Graph Theory (Q)

MATH 349 Topics in Algebraic Geometry (Q)

MATH 350 Topics in Cryptography (Q)

MATH 351 Topics in Number Theory (Q)

MATH 352 Topics in Topology (Q)

MATH 353 Topics in Combinatorics (Q)

MATH 354 Topics in Graph Theory (Q)

MATH 355 Topics in Algebraic Geometry (Q)

MATH 356 Topics in Cryptography (Q)

MATH 357 Topics in Number Theory (Q)

MATH 358 Topics in Topology (Q)

MATH 359 Topics in Combinatorics (Q)

MATH 360 Topics in Graph Theory (Q)
MATH 323 Applied Topology (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math323.html)

MATH 324(F) Topology (Q) (www.williams.edu/Registrar/catalog/depts/math/math324.html)

MATH 327 Geodesic Surfaces (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math327.html)

MATH 327(T) Tilting Theory (Q) (www.williams.edu/Registrar/catalog/depts/math/math327.html)

MATH 335 Biological Modeling with Differential Equations (Same as Biology 235) (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math335.html)

MATH 341 Probability (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math341.html)

MATH 352 Combinatorics (Q) (www.williams.edu/Registrar/catalog/depts/math/math352.html)

MATH 361 Theory of Computation (Same as Computer Science 361) (Q) (See under Computer Science for full description.)

MATH 373 Investment Mathematics (Q) (www.williams.edu/Registrar/catalog/depts/math/math373.html)

MATH 375 Game Theory (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math375.html)

MATH 397, 398S, 497F, 498S Independent Study (www.williams.edu/Registrar/catalog/depts/math/math397S.html)

MATH 401 Functional Analysis with Applications to Mathematical Physics (Q) (www.williams.edu/Registrar/catalog/depts/math/math401.html)

This course does not count towards the major in Mathematics

MATH 321 Knot Theory (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math321.html)

MATH 322 Differential Geometry (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math322.html)

MATH 309, 251 or Statistics 201, or permission of instructor. Students cannot enroll in both Mathematics 313 and 313T.

MATH 314 Polynomial Arithmetic (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math314.html)

MATH 316 Protecting Information: Applications of Abstract Algebra and Quantum Physics (Same as Physics 316) (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math316.html)

MATH 317 Applied Abstract Algebra (Q) (www.williams.edu/Registrar/catalog/depts/math/math317.html)

MATH 319 Integrative Bioinformatics, Genomics, and Proteomics Lab (Same as Biology 319, Chemistry 319, Computer Science 319 and Physics 319) (Q) (See under Biology for full description.)

MATH 321 Knot Theory (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math321.html)

This course does not count towards the major in Mathematics

MATH 322 Differential Geometry (Not offered 2005-2006; to be offered 2006-2007) (Q) (www.williams.edu/Registrar/catalog/depts/math/math322.html)

Members of the Department
Mathematics and Statistics

Mathematics and Statistics

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 we will study their spectral properties. A special attention will be dedicated to various operators arising from mathematical physics—especially the Schrödinger operator.

Mathematical Literature: Mathematics 301 or permission of instructor. No enrollment limit (expected: 15).

MATH 402S Measure Theory and Probability (Q)
The study of measure theory and probability from an abstract (probabilistic) point of view. Applications of measure theory lie in probability, chemistry, physics as well as in economics. In this course, we will develop the basic concepts of measure theory and their applications in probability. Included will be the Lebesgue measure, measure kernels, measurable functions (random variables). Lebesgue integration, transformation, independence, convergence, and limit theorems. The material provides a good preparation for graduate study in mathematics, statistics and economics.
Pre-requisites: Mathematics 301 or permission of instructor.

MATH 403 Irrationality and Transcendence (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 404 Ergodic Theory (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 411S Combinatorial Algebra (Q)
Combinatorial algebra has applications ranging from algebraic geometry to coding theory. For example, one can use combinatorial algebra to design error-correcting codes. It is perhaps most used, however, to study curves and surfaces in different spaces. To understand these structures, one must study polynomial rings over fields. This course will be an introduction to combinatorial algebra. Possible topics include polynomial rings, localizations, primary decomposition, completions, and modules.

Pre-requisites: Mathematics 312 or permission of the instructor. No enrollment limit (expected: 15).

MATH 413 An Introduction to p-Adic Analysis (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 414 Galois Theory (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 415 Geometric Group Theory (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 416T Diophantine Analysis (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 417 Algebraic Error-Correcting Codes (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 418 Matrix Groups (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 421 Algebraic Geometry (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 425 Riemannian Geometry (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 426 Hyperbolic 3-Manifolds (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 433F Mathematical Modeling and Control Theory (Q)
Mathematical modeling is concerned with translating a natural phenomenon into a mathematical model. In this abstract form the underlying principles of the phenomenon can be carefully examined and tested. The behavior can be interpreted in terms of mathematical shapes. The models we will investigate include feedback phenomena, phase locked oscillators, multiple population dynamics, reaction-diffusion equations, shock waves, morpogenesis, and the spread of pollution, forest fires, and diseases. The natural phenomenon has some aspect we can control—such as how much pollution, electric charge, or chemotherapy agent we put in a river, circuit, or cancer patient. We will investigate how to operate with models in order to obtain a reliable and optimum input optimization of performance. We will

MATH 452 Combinatorics (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH 454 Graph Theory with Applications (Not offered 2005-2006; to be offered 2006-2007) (Q)

MATH W30 Senior Project

Taken by candidates for honors in Mathematics other than by thesis route.

MATH 493F-W314945 Senior Honors Thesis
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.

MATH 499(F)-Senior Colloquium
Meets every week for two hours both fall and spring. Senior majors must participate at least one hour each week. This colloquium is in addition to the regular four semester-courses taken by all students.

STATISTICS COURSES

STAT 101S Elementary Statistics and Data Analysis (Q)
It is nearly impossible to live in the world today without being inundated with data. Even the most popular newspapers have statistics to catch the eye of the passerby, and sports broadcasters overwhelm the listener with arcane statistics. How do we learn to recognize dishonest or even unethically distorted representations of quantitative information? How are we to reconcile two medical studies with seemingly contradictory conclusions? How many observations do we need in order to make a decision? It is the purpose of this course to develop an appreciation for and an understanding of the interpretation of data. We will become familiar with the standard tools of statistical inference such as the analysis of variance, and regression, as well as exploratory data techniques. Applications will come from the real world that we all live in.

Format: lecture. Evaluation will be based primarily on work on quizzes and exams.

Pre-requisites: Mathematics 100/101/102 (or demonstrated proficiency on a diagnostic test; see Mathematics 100). Students who have had calculus, and potential Mathematics majors should consider taking Statistics 201 instead. Enrollment limit: 50 (expected: 40). Not open for major credit to junior or senior Mathematics majors.

First Semester: CRAFT
Second Semester: CRAFT, KLINGENBERG

STAT 201(F)-Statistics and Data Analysis (Q)
Statistics can be viewed as the art (science?) of turning data into information. Real world decision-making, whether in business or government, 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 the t-test, analysis of variance and linear regression as well as exploratory and graphical data analysis techniques.

Format: lecture. Evaluation will be based primarily on quizzes and exams.

Pre-requisites: Mathematics 105 or equivalent. Students without any calculus background should consider Statistics 101 instead. Enrollment limit: 45 (expected: 35).

First Semester: BOYTS, KLINGENBERG
Second Semester: BOYTS, KLINGENBERG

STAT 231T Statistical Design of Experiments (Not offered 2005-2006; to be offered 2006-2007) (Q)

Statistical Design of Experiments (Not offered 2005-2006; to be offered 2006-2007) (Q)

Pre-requisites: Mathematics 301 or permission of instructor. No enrollment limit (expected: 12).

Format: lecture. Evaluation will be based primarily on performance of problem sets and exams.

First Semester: R. DEVEAUX
Second Semester: R. DEVEAUX

STAT 331 Statistical Design of Experiments (Not offered 2005-2006; to be offered 2006-2007) (Q)

Pre-requisites: Mathematics 301 or permission of instructor. No enrollment limit (expected: 12).

Format: lecture. Evaluation will be based primarily on performance of problem sets and exams.

First Semester: R. DEVEAUX
Second Semester: R. DEVEAUX

STAT 346(F) Regression and Forecasting (Q)
This course focuses on the building of empirical models through data in order to predict, explain, and interpret.
STAT 35T(F) Introduction to Biostatistics (Q)
This course discusses statistical methods and models useful in the biological sciences. It will briefly review methods of inference for continuous data and then cover topics in discrete data analysis such as logistic regression and exact inference for proportions. The second part of the course deals with the analysis of time-to-event or survival data. Topics covered include: prior distributions, posterior distributions, survival models, and hierarchical models. The course will be implemented using a statistical software package.
Format: lecture. Evaluation will be based primarily on homework assignments and projects.
Prerequisites: Statistics 101 or 201, and Mathematics 105 and 211, or permission of instructor.
Enrollment limit: 10 (expected: 10).
Hour: 9:00-9:50 MWF

MUSIC (Div. I)

Chair, Professor DAVID KECHLEY (First Semester)
Acting Chair, Associate Professor W. ANTHONY SHEPPARD (Second Semester)

Professors: BLOXAM**, E.D. BROWN, D. KECHLEY***, Associate Professor: W. A. SHEPPARD, Assistant Professors: E. GOLLIN, M. HIRSCH, PEREZ VELAZQUEZ. Visiting Assistant Professor: HOFFENBERG. Lynn B. Clay Asher in Residence and Director of Jazz Activities
Senior Lecturer in Music: JAFFE. Artist in Residence in Choral and Vocal Activities in Music: B. WELLS* Artist in Residence in Orchestral and Instrumental Activities in Music: PELDMAN. Artists in Residence in Music: STEVENSON (piano), KURKOWICK (violin). Ensemble Directors: BODNER (Sonic Winds, classical saxophone, Musician Skills Lab), M. JENKINS (Marching Band), J. KECHLEY (Flute Choir, flute), MARTULA (Clarinet Choir, clarinet), MENEGON (Jazz Combo, jazz bass), SUNDBERG (Brass Ensemble, trumpet), S. WALT (Woodwind Chamber, Music in Focus), A. THOMAS, (trumpet). Individual Instructors: AYAPON (African drumming), B. BAKER, J. HEBERT (flute), HOLMES (jazz), J. KIBLER (voice), J. LAWRENCE (piano), M. WALT (harpsichord, Musician Skills Lab), L. JENKINS (saxophone), E. LAWRENCE (guitar), A. PARKE (flute), J. TAYLOR (piano), J. KIBLER (cello), PHELEPS (guitar), ROGER (jazz vocal), KRISHNASWAMI (viola, viola), W. WRIGHT (piano).

MAJOR

Sequence Courses
Music 103, 104 Music Theory and Musicianship I
Music 201, 202 Music Theory and Musicianship II
Music 301, 302 Music in History I, Music in History II, and Music in History III

Elective Courses
An additional year or two semester courses in music, to be selected from the following:
Group A: any Music 106-Music 141 course, including direct supervision by instructor in supplement readings, assignments, papers, and other projects appropriate for the Music major.
Group B: Music 203T, 204T, 211, 212, 213, 245T, 301, 305, 306, 308, 326, 407, 408, 427, 428
Department strongly recommends that students elect at least one course from each group.
It is strongly recommended that prospective majors complete Music 103, 104, 201, 202, and 207 by the end of the sophomore year.

Performance and Concert Requirements
Music majors are encouraged to participate in departmental ensembles throughout their careers. The Music major is, i.e., for eight semesters. Majors are required to participate in departmental ensembles for at least 6 credit hours. The student must pass the requirement in an alternative way. Music majors are also expected to attend student-directed and departmental-sponsored concerts.

Foreign Language
Music majors are strongly urged to take courses in at least one foreign language while at Williams.

Musicianship Skills
Music majors are strongly urged to maintain, refine and improve their musician skills, such as sight singing, score reading, melodic and harmonic dictation, and keyboard proficiency, throughout their college years.

THE DEGREE WITH HONORS IN MUSIC
Three routes toward honors and highest honors are possible in the Music major:
a. Composition: A Composition thesis must include one major work completed during the senior year for a postgraduate audience and an additional 15-20 page discussion of the works performed by the composer. The student must pass a second major thesis title proposal and defend their work at an end-of-term concert.
b. Performance: A Performance thesis must include a selection of a work of at least 30 minutes duration performed by the student in a concert setting. The student must pass a second major thesis title proposal and defend their work at an end-of-term concert.
c. History, Theory, and Analysis, Ethnomusicology: A written History, Theoretical or Analytical, Ethnomusicological thesis between 65 and 80 pages in length and an oral presentation based on the thesis is required. A written thesis should offer new insights based on original research.

For the honors program, a student must have a minimum GPA in Music courses of 3.3 and a GPA in the Music major of 3.0. The student must also maintain a GPA of 3.0 in the Music major and a GPA of 3.0 in the overall average. A student who fails to meet the requirements will be denied the degree. The department's decision to award honors will be based on the quality of the thesis in performance.

LESSONS
Courses involving individual vocal or instrumental instruction involve extra fees which are subsidized by the Department. (See Music 251-258 and Studies in the Musical Art 325, 336, 427, 428). For further information contact the Department of Music.

Students considering a major in music should enroll in Music 103 and 104.

Descriptions of the following courses are listed numerically within the course listings.

THEORY AND MUSICIANSHIP
MUS 103 Music Theory and Musicianship I
MUS 104 Music Theory and Musicianship II
MUS 201 Music Theory and Musicianship II
MUS 202 Music Theory and Musicianship II
MUS 245 Music Analysis: Music with Text
MUS 301 An Introduction to Modal and Tonal Counterpoint
MUS 308 Orchestration and Instrumentation

COMPOSITION (See the first course number in the sequence for course description.)