2004 - 2005 Graduation Requirements:

Williams

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, or on 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.

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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 the students recognize, analyze, and evaluate these human structures in order that they may better understand themselves and the social world in which they live.

Asia, Latin America, Oceania, or the Caribbean. Students are urged to complete this course, which may also be used to fulfill any of the other requirements, by the end of the sophomore year.

An *asterisk* following a course title indicates that the course may be used to meet the Peoples and Cultures Distribution Requirement. A list of courses offered in 2005-2006 which meet the requirement is on page 314.

3) ***QUANTITATIVE/FORMAL REASONING REQUIREMENT***—intended to help students become adept at reasoning mathematically and abstractly. The ability to apply a formal method to reach conclusions, to use numbers comfortably, and to employ the research tools necessary to analyze data lessen barriers to carrying out professional and economic roles. Prior to their senior year, all students must satisfactorily complete a Quantitative/Formal Reasoning (QFR) course—those marked with a "(Q)." Students requiring extra assistance (as assessed during First Days) are normally placed into Mathematics 100/101/102, which is to be taken before fulfilling the QFR requirement.

The hallmarks of a QFR course are the representation of facts in a language of mathematical symbols and the use of formal rules to obtain a determinate answer. Primary evaluation in these courses is based on multistep mathematical, statistical, or logical inference (as opposed to descriptive answers). A list of courses offered in 2005-2006 which meet the requirement is on page 317.

4) ***WRITING REQUIREMENT***—All students are required to take two writing-intensive courses: one by the end of the sophomore year and one by the end of the junior year. Students will benefit most from writing-intensive courses by taking them early in their college careers and are therefore strongly encouraged to complete the requirement by the end of the sophomore year. Courses designated as "writing intensive"—those marked with a "(W)"—stress the process of learning to write effectively. Such courses include a substantial amount of writing (a minimum of 20 pages), usually divided into several discrete assignments. Instructors pay close attention to matters of style and argumentation. Enrollments are limited to 19. A list of courses offered in 2005-2006 which meet the requirement is on page 322. One of the W courses may be an independent study that meets the writing intensive criteria.

Major Requirement

The Major Requirement is designed to assure that all Williams undergraduates will have the experience of disciplined and cumulative study, carried on over an extended period of time, in some important field of intellectual inquiry. Juniors are required to declare a major and the selection is normally made at the time of registration in the spring of the sophomore year.

MAJOR FIELDS

Majors are offered in the following fields:

American Studies
Anthropology
Art
Asian Studies
Astronomy
Astrophysics
Biology
Chemistry
Chinese
Classics (Greek, Latin)
Comparative Literature
Computer Science
Economics
English
French
Geosciences
German
History
Japanese
Literary Studies
Mathematics
Music
Philosophy
Physics
Political Economy
Political Science
Psychology
Religion
Russian
Sociology
Spanish
Theatre
Women's and Gender Studies

GENERAL STRUCTURE OF MAJORS

1) A student ordinarily must elect at least nine semester courses in his or her major field. A particular major may also require an additional course and/or one Winter Study Project during the junior or senior year.

Williams 2005

A student may also fulfill the minimum requirements for a major by taking eight semester cours in the major field and two semester courses, approved by a major advisor, in associated fields. In inte 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 maj seminar, is required in some major fields. Other majors ask the student to plan a sequence of electi courses, including advanced work building on elementary courses in the field, and ending in a one- two- semester faculty-organized course or project in the senior year. All majors provide a system counseling to help students plan programs reflecting individual interests as well as disciplined ar cumulative patterns of inquiry.

Courses in many major programs require prerequisite courses in related areas. A full description of tl 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 reg larly offered major may propose to be contract majors. Procedures for arranging a contract major and f honors work in such a major are described in the section, "Courses of Instruction." Students interested this option should begin consulting with the Dean's Office and with potential faculty advisors early in tl sophomore year. A student completing a contract major may not do so in conjunction with a second majc For further details, see page 128.

TWO MAJORS

A student may complete two majors with the permission of both majors and the Committee on Ac demic Standing. Although a student may be granted permission to use a course from one major to fulfill particular requirement in the other, the student nevertheless must take the minimum number of courses 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 mai taining 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 wi 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 fa to complete the test must pass a basic swim course given in the Physical Education program during tl first quarter of the year.

Students must complete four quarters of physical education by the end of the sophomore year. St dents 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 a winter sport is equivalent to three units. A maximum of three credits may be attained while participatir in intercollegiate sports with the exception of a two sport athlete who can fulfill the physical educatic requirement by totaling four units in two sports. Students may receive a maximum of two activity units f participation in a club sport; the remaining two units must come from the physical education activity pr gram.

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 fo semesters in residence at Williams, and those entering as sophomores are expected to spend six s mesters in residence. Students are considered to be in residence if they are taking a program of stud under the direction of the Williams College Faculty. Students must be in residence for both semeste of the final year.

The degree requirements must be completed within eight semesters, including any semesters for whic a student receives credit while not in residence at Williams. Thus, semesters spent away on exchange other approved programs at other colleges are included in the eight semesters. Similarly, if a student fro the Class of 2007 or earlier requests, and the Committee on Academic Standing grants, degree credit base on Advanced Placement scores, then these semesters are also included in the limit of eight.

Related Courses:
Biology 101 The Cell
Chemistry 016 Glass and Glassblowing
Chemistry 156 Organic Chemistry
and Chemistry 251 Organic Chemistry
Chemistry 155 Current Topics in Chemistry
or Chemistry 256 Foundations of Physical and Inorganic Chemistry
Chemistry 335 Inorganic/Organometallic Chemistry
Chemistry 361 Physical Chemistry: Structure and Dynamics
Chemistry/Environmental Studies 364 Instrumental Methods of Analysis
Chemistry 366 Physical Chemistry: Thermodynamics
Geosciences 202 Mineralogy and Geochemistry
Mathematics 209 Differential Equations and Vector Calculus
Mathematics 315 Groups and Characters
Physics 015 Electronics
Physics 201 Electricity and Magnetism
Physics 202 Waves and Optics
Physics/Mathematics 210 Mathematical Methods for Scientists
Physics 301 Quantum Physics
Physics 405T Electromagnetic Theory
Physics 411T Classical Mechanics
Physics 451 Solid State Physics

MATHEMATICS AND STATISTICS (Div. III)

Chair, Professor EDWARD B. BURGER

Professors: ADAMS, O. BEAVER, BURGER, R. DE VEAUX*, GARRITY, V. HILL*, S. JOHNSON***, MORGAN, SILVA. Associate Professor: LOEPP. Assistant Professors: BOTTS, DEVADOSS*, KLINGENBERG, PACELLI, STOICIU, TAPP. Visiting Professor: MERRIS. Visiting Assistant Professor: CRAFT. 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
Except in 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 or an appropriate course 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 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 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 courses taken away. Students with transfer credit should contact the department about special arrangements.

APPLIED MATHEMATICS OR OTHER SCIENCES

Students interested in applied mathematics or other sciences should consider Mathematics 209, 210, 251, 305, 306, 315, 323, 342, 354, 361, 433, or Statistics 201, 231, 346, 442, and additional appropriate courses from outside Mathematics and Statistics, including possibilities such as Chemistry 301, Computer Science 256, Computer Science 361, Economics 255, Physics 201, Physics 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, 231, 331, 344, 346, 442, 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 consider the courses for applied mathematics immediately above, with Mathematics 209 and 305 especially recommended. 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 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 ones 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 consider Mathematics 341, Statistics 201, 231, 331, 346, 442 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 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 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 and a 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 regular course and one semester plus a WSP (030) of independent study, culminating in a "minithesis" and a presentation. At least one semester should be in addition to the major requirements.

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 component.

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 minithesis. An outstanding student who writes a minithesis, or pursues actuarial honors and writes a paper, might also be considered.

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 member 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 continuing 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 is based not only on successful completion of the honors program but also on the merit of the student's overall record in mathematics. 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 3, 4, or 5 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. A student who receives a 1 or 2 on the BC examination or a 2 or 3 on the AB examination is ordinarily placed in Mathematics 104. Students who have had calculus in high school, whether or not they took 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 231. Students interested in statistics should consult the department for placement. In any event, students registering for mathematics and statistics courses are urged to consult with members of the department concerning appropriate courses and placement. In general, students are encouraged to enroll in the most advanced course for which they are qualified: it is much easier to drop back than to jump forward. The department reserves the right to refuse registration in any course for which the student is determined to be *over*-prepared.

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 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. 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 Statistics 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 meet all the requirements set for 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. Permission will not be given to mathematics majors to meet any of the requirements of the major or 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 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.

MATHEMATICS COURSES

NOTE: STATISTICS COURSE LISTINGS FOLLOW THE MATHEMATICS COURSE LISTINGS.

MATH 101(F) Mathematical Analysis with Descriptive Statistics

This course is intended to develop quantitative skills for non-science majors. We will cover basic algebra from an applied point of view, including working with formulas and solving for unknowns. We will investigate a variety of ways to model real-world problems. For example, how many handshakes away are you from the president and how is that related to a transportation network? We will look at the mathematics of equity, including a look at voting theories. We will cover basic finance, including loans and annuities. Finally, we will also cover descriptive statistics, including data analysis, computing with mean/median/variance, data display and contingency tables.

Format: lecture and computer lab. Evaluation will be based primarily on homework, quizzes and/or exams, and computer projects.

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

Hour: 9:00-9:50 MWF — O. BEAVER

MATH 102(F) Precalculus

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/or exams.

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

Hour: 9:00-9:50 MWF — S. JOHNSON

MATH 103(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. This is an introductory course for students who have not seen calculus before. Students who have previously taken a calculus course may not enroll in Mathematics 103 without the permission of instructor.

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

Prerequisites: Mathematics 101 (or demonstrated proficiency on a diagnostic test; see Mathematics 101). *No enrollment limit (expected: 50-60).*

Hour: 10:00-10:50 MWF, 12:00-12:50 MWF, 11:20-12:35 TR — First Semester: STEVENSON; Second Semester: O. BEAVER

MATH 104(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. Students who have received the equivalent of advanced placement of AB 4 or BC 3 may not enroll in Mathematics 104 without the permission of instructor. Students who have higher advanced placement must enroll in Mathematics 105 or above.

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

Prerequisites: Mathematics 103 *or* equivalent. *No enrollment limit (expected: 50-70).*

Hour: 8:00-8:50 MWF, 10:00-10:50 MWF, 11:00-11:50 MWF — First Semester: STOICIU, O. BEAVER

9:00-9:50 MWF, 10:00-10:50 MWF — Second Semester: SILVA

MATH 105(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. 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 Mathematics 105.

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

Prerequisites: Mathematics 104 *or* equivalent, such as satisfactory performance on an Advanced Placement Examination. *No enrollment limit (expected: 45).*

Hour: 9:00-9:50 MWF, 10:00-10:50 MWF, 11:00-11:50 MWF — First Semester: ADAMS

8:00-8:50 MWF, 9:00-9:50 MWF — Second Semester: TAPP

MATH 106(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 Mathematics 105 is that Mathematics 105 covers infinite series instead of Stokes Theorem. Students with the equivalent of BC 3 or higher should enroll in Mathematics 106, 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 or not Mathematics 105 or Mathematics 106 is appropriate, please consult a member of the math/stat department. Mathematics 106 satisfies any Mathematics 105 prerequisite. Credit will not be given for both Mathematics 105 *and* Mathematics 106.

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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 GARRITY

MATH 175 Mathematical Politics: Voting, Power, and Conflict (Same as INTR 160) ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math175.html) PACELLI

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 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).
Format: lecture/discussion. Evaluation will be based primarily on projects, homework assignments, and exams.
Prerequisites: Mathematics 100/101/102 (or demonstrated proficiency on a diagnostic test—see Mathematics 100) or permission of instructor. *Enrollment limit: 50 (expected: 50). Not open to students who have taken mathematics courses other than Mathematics 100, 101, 102, 103, 170, Statistics 101 without permission of the instructor.*
Hour: 9:00-9:50 MWF Lab: 2:35-3:25 T, 2:10-3 W BURGER

MATH 209(S) Differential Equations and Vector Calculus (Q)
Historically, much beautiful mathematics has arisen from attempts to explain heat flow, chemical reactions, biological processes, or magnetic fields. A few ingenious techniques solve a surprisingly large fraction of the associated ordinary and partial differential equations. The mystical Pythagorean fascination with ratios and harmonics is vindicated and applied in Fourier series and integrals. Integrating vectorfields over surfaces applies equally to blood flow, gravity, and differential geometry.
Format: lecture/discussion. Evaluation will be based on problem sets, hour tests, and a final exam.
Prerequisites: Mathematics 105. *No enrollment limit (expected: 31). Students may not normally get credit for both Mathematics 209 and Mathematics/Physics 210.*
Hour: 10:00-10:50 MWF GARRITY

MATH 210(S) Mathematical Methods for Scientists (Same as Physics 210) (Q)
(See under Physics for full description.)

MATH 211(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.
Format: lecture. Evaluation will be based primarily on homework and exams.
Prerequisites: Mathematics 105 *or* 209 *or* 210 *or* 251, *or* Statistics 201. *No enrollment limit (expected: 35-70).*
Hour: 8:00-8:50 MWF, 9:00-9:50 MWF First Semester: LOEPP
9:00-9:50 MWF, 10:00-10:50 MWF Second Semester: STOICIU

MATH 211T(F) Mathematical Reasoning and Linear Algebra (Q)
This tutorial aims to develop students' problem-solving and proof-writing techniques in mathematics through the use of linear algebra. It is also an introduction to linear algebra, with an emphasis on its conceptual development and the beauty of its mathematical structure. There will be weekly assignments requiring clearly written proofs of theorems and facts in linear algebra, and expecting the level of independent study of a tutorial. The topics to be covered are matrices, vector spaces, linear independence, linear transformations, orthonormal bases, inner product spaces, and some applications such as fractals and linear regression.
Note: This course fulfills the same requirements as Mathematics 211 but credit will not be given for both Mathematics 211T and Mathematics 211.
Format: tutorial. Evaluation will be based on presentations, problem assignments and exams.
Prerequisites: Mathematics 105 or 251 or equivalent; permission of instructor is required for all students. *Enrollment limit:10 (expected: 10).*
Tutorial meetings to be arranged. SILVA

MATH 251(F,S) 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 structures, their properties and applications. Topics will include [illegible] theory, infinity, graph theory, logic, counting, recursion, and functions. The course serves as an introduction not only to these and other topics but also to the methods and styles of mathematical proof.
Format: lecture/discussion. Evaluation will be based primarily on homework, classwork, and exams.
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: 20).*
Hour: 10:00-10:50 MWF First Semester: TAP
11:20-12:35 TR Second Semester: MORGAN

MATH 251T(F) Introduction to Mathematical Proof and Argumentation (Q)
The fundamental focus of this tutorial is for students to acquire the ability to create and clearly express mathematical arguments through an exploration of topics from discrete mathematics. Students will learn various mathematical proof techniques while discovering such areas as logic, number theory, infinity, geometry, graph theory, and probability. Our goal is not only to gain an understanding and appreciation of interesting and important areas of mathematics but also to develop and critically analyze original mathematical ideas and argumentation. Note: this course fulfills the same requirements as does Mathematics 251 but credit will not be given for both Mathematics 251T and Mathematics 251.
Format: tutorial. Evaluation will be based primarily on performance on written work, oral presentations and examinations.
Prerequisites: Mathematics 104 or Mathematics 103 with Computer Science 134 or one year of high school calculus with permission of instructor. *Enrollment limit: 10 (expected: 10).*
Tutorial meetings to be arranged. PACELLI

MATH 285T(F) Teaching Mathematics (Q)
Under faculty supervision, student-teachers will prepare and conduct scheduled weekly extra sessions for Mathematics 180, for smaller, assigned groups of students. For these sessions they will prepare presentations, assign and grade homework, and answer questions on the course material and on the homework. They will be available to their students outside of class, attend and assist at Mathematics 180 lectures (3 hours a week), and visit and evaluate each other's sessions. There is a weekly meeting, for an hour or two, including organizational matters, deeper study of the mathematics discussed, and practice teaching skills. There will be assigned readings, discussion, drills, and weekly homework or papers.
Format: tutorial/teaching. Evaluation will be based on the overall teaching activity, responsibility, participation in the tutorial and other meetings, homework and papers.
Prerequisites: permission of instructor early in the previous Spring. *Enrollment limit: 6 (expected: 4).*
Hour: 9:00-9:50 MWF Lab: 2:35-3:25 T, 2:10-3 W BURGER

MATH 301(F) 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.
Format: lecture/discussion. Evaluation will be based on homework, classwork, and exams.
Prerequisites: Mathematics 105 and 211, or permission of instructor. *No enrollment limit (expected: 35)*
Hour: 8:00-8:50 MWF TAP

MATH 302 Complex Analysis ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math302.html)

MATH 305(S) 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.
Format: lecture. Evaluation will be based primarily on homework, classwork, and exams.
Prerequisites: Mathematics 105 and 211, or permission of instructor. *No enrollment limit (expected: 25)*
Hour: 11:00-11:50 MWF MORGAN

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.
Format: lecture. Evaluation will be based on performance on homework and exams.
Prerequisites: Mathematics 211. *No enrollment limit (expected: 15).*
Hour: 10:00-10:50 MWF SILVA

MATH 307(S) 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. Departing from the deterministic realm, we will discuss dynamic programming, statistical machine learning, and epidemiological modeling. Applications will be drawn largely from cancer treat-

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Format: lecture. Evaluation will be based on performance on homework and exams.
Prerequisites: Mathematics 211. *No enrollment limit (expected: 20).*
Hour: 11:20-12:35 TR — CRAFT

MATH 312(S) Abstract Algebra (Q)
Algebra gives us the tools to solve equations. Sets such as the integers or real numbers have special properties which make algebra work or not 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 the abstract algebraic structures called groups, rings and fields, as well as the concepts of factor group, quotient ring, homomorphism, isomorphism, and various types of field extensions.
Format: lecture. Evaluation will be based primarily on problem sets and exams.
Prerequisites: Mathematics 211 and one or more of the following: Mathematics 209, 251 *or* Statistics 201, *or* permission of instructor. *No enrollment limit (expected: 25).*
Hour: 10:00-10:50 MWF, 11:00-11:50 MWF — PACELLI

MATH 313(F) 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.
Evaluation will be based primarily on performance on homework, projects, and exams.
Prerequisites: Mathematics 211 or 251, or permission of instructor. *Students cannot enroll in both Mathematics 313 and 313T.*
Hour: 12:00-12:50 MWF — PACELLI

MATH 313T(S) Explorations in Number Theory and Geometry (Q)
The main goal of this tutorial is for students to discover some beautiful topics of number theory and their connections with geometry. Here we will explore how the rational numbers sit within the real number line and how geometric observations lead to number theoretic insights. We will also introduce elliptic curves and consider the fundamental algebraic issues surrounding them. Our objective is not only to develop an understanding and appreciation of interesting areas of number theory but also to create and critically analyze original mathematical ideas.
Format: Tutorial. Evaluation will be based primarily on performance on written work, oral presentations, and examinations.
Prerequisites: permission of instructor (no number theory background required). *Enrollment limit: 10 (expected: 10). Students cannot enroll in both Mathematics 313 and 313T.*
Tutorial meetings to be arranged. — BURGER

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

MATH 315 Groups and Characters *(Not offered 2005-2006; to be offered 2006-2007)* **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math315.html) — V. HILL

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) — WOOTTERS and LOEPP

MATH 317(F) Applied Abstract Algebra (Q)
The abstract algebraic structures called groups, rings and fields have proven to have surprisingly many applications. For example, groups have been used to build secure cryptosystems and to study the symmetry of molecules. We will study the abstract properties of groups, rings and fields and then study several applications of this theory. Possible topics include cryptography, puzzles, error correcting codes, computer software applications, symmetry, tiling, networks, and grobner bases.
Evaluation will be based primarily on homework and exams.
Prerequisites: Mathematics 211 and one or more of the following: Mathematics 209, 251 or Statistics 201 or permission of the instructor.
Hour: 10:00-10:50 MWF — LOEPP

MATH 319(F) 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.)
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) — DEVADOSS

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

MATH 323 Applied Topology *(Not offered 2005-2006; to be offered 2006-2007)* **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math323.html) — ADA

MATH 324T(F) Topology (Q)
Topology is the study of when one geometric object can be continuously deformed and twisted into an er object. Determining when two objects are topologically the same is incredibly difficult and is still subject of a tremendous amount of research, including current work on the Poincare Conjecture, one of million-dollar millennium-prize problems. The first part of the course on "Point-set Topology" establis a framework based on "open sets" for studying continuity and compactness in very general spaces. second part on "Homotopy Theory" develops refined methods for determining when objects are the sa We will prove for example that you cannot twist a basketball into a doughnut.
Format: lecture/discussion. Evaluation will be based on homework, classwork, and exams. Prerequisi Mathematics 301, or permission of instructor and Mathematics 305 or 312. Not open to students who h taken Mathematics 323. *Enrollment limit: 10 (expected 10).*
Tutorial meetings to be arranged. — MORG

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

MATH 327T(S) Tiling Theory (Q)
Since humankind first utilized stones and bricks to create floors, tiling has been a part of civilization. Pra tioners include artists, engineers, designers, architects, crystallographers, scientists and mathematici This course will be an investigation into the mathematical theory of tiling. We will focus on tilings of plane, including topics such as the symmetry groups of tilings, the topology of tilings, the ergodic theory tilings, the classification of tilings and the aperiodic Penrose tilings. We will be able to see how algebra be utilized to solve a variety of tiling problems. We will also look at knotted tilings in higher dimensions addition to several books on the subject, we will work from current research papers.
Format: tutorial. Evaluation will be based on presentations, problem assignments and exams.
Prerequisite: Mathematics 211, and Mathematics 312 or Mathematics 315. *Enrollment limit: 10 (pected:10).*
Tutorial meetings to be arranged. — ADA

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

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

MATH 352(S) Combinatorics (Q)
An advanced course in discrete mathematics (see Mathematics 251) with emphasis on counting and fi structures. Counting techniques will include generalized binomial coefficients, inclusion/exclusion, ge ating functions, partitions and Stirling numbers, and Polya counting. Structures studied will be drawn fr graphs and digraphs, networks, designs, posets and lattices, possibly with applications to the physical social sciences. The theory will be developed with an emphasis on problem solving and independent w Evaluation will be based primarily on performance on problem sets and exams.
Prerequisites: Mathematics 211. *No enrollment limit (expected: 20).*
Hour: 9:00-9:50 MWF — MER

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

MATH 373(F) Investment Mathematics (Q)
Over the years financial instruments have grown from stocks and bonds to numerous derivatives, such options to buy and sell at future dates under certain conditions. The 1997 Nobel Prize in Economics awarded to Robert Merton and Myron Schloles for their Black-Scholes model of the value of finan instruments. This course will study deterministic and random models, futures, options, the Black-Scho Equation, and additional topics.
Format: lecture/discussion. Evaluation will be based on homework, classwork, and exams.
Prerequisites: Mathematics 211 or permission of instructor. *No enrollment limit (expected: 20).*
Hour: 11:00-11:50 MWF — MORG

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

MATH 397(F), 398(S), 497(F), 498(S) Independent Study
Directed independent study in Mathematics.
Prerequisites: permission of the department.
— Members of the Departm

MATH 401(F) Functional Analysis with Applications to Mathematical Physics (Q)
Functional analysis can be viewed as linear algebra on infinite dimensional spaces. It is a beautiful a classical area of mathematics and it also provides the rigorous mathematical background for some areas

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.
Format: lecture. Evaluation will be based on homeworks and exams.
Prerequisites: Mathematics 301 or 305 or permission of instructor. *No enrollment limit (expected: 15).*
Hour: 9:00-9:50 MWF — 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.
Evaluation will be based primarily on performance on homework assignments and exams.
Prerequisites: Mathematics 301 or 305 or permission of instructor.
Hour: 9:55-11:10 TR — O. BEAVER

MATH 403 Irrationality and Transcendence ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math403.html) — BURGER

MATH 404T Ergodic Theory ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math404.html) — SILVA

MATH 411(S) Commutative Algebra (Q)
Commutative algebra has applications ranging from algebraic geometry to coding theory. For example, one can use commutative algebra to create error correcting codes. It is perhaps most often 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 commutative algebra. Possible topics include polynomial rings, localizations, primary decomposition, completions, and modules.
Evaluation will be based primarily on homework and exams.
Prerequisites: Mathematics 312 or 317 or permission of the instructor. *No enrollment limit (expected: 15).*
Hour: 9:00-9:50 MWF — LOEPP

MATH 413 An Introduction to *p*-Adic Analysis ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math413.html) — BURGER

MATH 414 Galois Theory ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math414.html) — PACELLI

MATH 415 Geometric Group Theory ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math415.html) — DEVADOSS

MATH 416T Diophantine Analysis ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math416.html) — BURGER

MATH 417 Algebraic Error-Correcting Codes ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math417.html) — LOEPP

MATH 418 Matrix Groups ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math418.html) — TAPP

MATH 421 Algebraic Geometry ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math421.html) — GARRITY

MATH 425 Riemannian Geometry ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math425.html) — MORGAN

MATH 426 Hyperbolic 3-Manifolds ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math426.html) — ADAMS

MATH 433(F) Mathematical Modeling and Control Theory (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, morphogenesis, and the spread of pollution, forest fires, and diseases. Often the natural phenomenon has some aspect we can control—such as how much pollution, electric charge, or chemotherapeutic agent we put into a river, circuit, or cancer patient. We will investigate how to operate such controls in order to achieve a specific goal or optimize some interpretation of performance. We will employ tools from the fields of differential equations and dynamical systems. The course is intended fo students in the mathematical, physical, and chemical sciences, as well as for students who are seriousl interested in the mathematical aspects of physiology, economics, geology, biology, and environmenta studies.
Format: lecture. Evaluation will be based primarily on performance of problem sets and exams.
Prerequisites: Mathematics 209 or Physics 210 *and* Mathematics 301 or 305 or permission of instructo *No enrollment limit (expected: 12).*
Hour: 10:00-10:50 MWF — S. JOHNSO

MATH 452 Combinatorics ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math452.html)

MATH 454 Graph Theory with Applications ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/math/math454.html)

MATH W30 Senior Project
Taken by candidates for honors in Mathematics other than by thesis route.

MATH 493(F)-W31-494(S) 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.*

MATH 499(F,S) 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.
Members of the Departmen

STATISTICS COURSES

STAT 101(F,S) 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 feature 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 unintentionally 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 including the t-test, 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 performances on quizzes and exams.
Prerequisites: 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.*
Hour: 8:30-9:45 TR, 11:20-12:35 TR — First Semester: CRAFT
8:30-9:45 TR, 8:00-8:50 MWF — Second Semester: CRAFT, KLINGENBERG

STAT 201(F,S) 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 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 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 performance on quizzes and exams.
Prerequisites: Mathematics 105 or equivalent. Students without any calculus background should consider Statistics 101 instead. *Enrollment limit: 45 (expected: 45).*
Hour: 10:00-10:50 MWF, 12:00-12:50 MWF — First Semester: BOTTS, KLINGENBERG
10:00-10:50 MWF, 12:00-12:50 MWF — Second Semester: BOTTS, KLINGENBERG

STAT 231T Statistical Design of Experiments ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/stat/stat231.html) — R. DEVEAUX

STAT 331 Statistical Design of Experiments ***(Not offered 2005-2006; to be offered 2006-2007)*** **(Q)**
(www.williams.edu/Registrar/catalog/depts/stat/stat331.html) — R. DEVEAUX

STAT 346(S) Regression and Forecasting (Q)
This course focuses on the building of empirical models through data in order to predict, explain, and inter-

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Through no fault of its own, regression analysis has perhaps the most used of all data analysis methods. We will study both the mathematics of regression analysis and its applications, including a discussion of the limits to such analyses. The applications will range from predicting the quality of a vintage of Bordeaux wine from the weather to forecasting stock prices, and will come from a broad range of disciplines.
Format: lecture. Evaluation will be based primarily on performance on the project, homework, and exams.
Prerequisites: Statistics 101 or 201, and Mathematics 105 and 211; or permission of instructor. *No enrollment limit (expected: 10).*
Hour: 9:00-9:50 MWF BOTTS

STAT 358T(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 include discussion and modeling of the hazard and survivor function through the Kaplan-Meier method and through the proportional hazard model. All methods will be implemented using a statistical software package.
Format: tutorial. Evaluation will be based primarily on performance on written work, oral presentations, and projects.
Prerequisites: Statistics 201 or permission of instructor. *Enrollment limit:10 (expected:10).*
Tutorial meetings to be arranged. KLINGENBERG

STAT 421 Introduction to Categorical Data Analysis *(Not offered 2005-2006; to be offered 2006-2007)* (Q)
(www.williams.edu/Registrar/catalog/depts/stat/stat421.html)

STAT 441(F) Bayesian Statistics (Q)
The probability of an event can be defined in two ways: (1) the long-run frequency of the event, or (2) the belief that the event will occur. Classical statistical inference is built on the first definition given above, while Bayesian statistical inference is built on the second. This course will introduce the student to methods in Bayesian statistics. Topics covered include: prior distributions, posterior distributions, conjugacy, and Bayesian inference in single-parameter, multi-parameter, and hierarchical models. The computational issues associated with each of these topics will also be discussed.
Format: lecture. Evaluation will be based on homework, exams, and a final project.
Prerequisite: Statistics 201, or permission of instructor. *No enrollment limit (expected:15).*
Hour: 8:00-8:50 MWF BOTTS

STAT 442 Computational Statistics and Data Mining *(Not offered 2005-2006; to be offered 2006-2007)* (Q)
(www.williams.edu/Registrar/catalog/depts/stat/stat442.html) R. DEVEAUX

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. Lyell B. Clay Artist in Residence and Director of Jazz Activities/Senior Lecturer in Music: JAFFE. Artist in Residence in Choral and Vocal Activities/Lecturer in Music: B. WELLS*. Artist in Residence in Orchestral and Instrumental Activities/Lecturer in Music: FELDMAN. Artists in Residence: STEVENSON (piano), KURKOWICZ (violin). Ensemble Directors: BODNER (Symphonic Winds, classical saxophone, Musicianship 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, bassoon). Individual Instructors: AGYAPON (African drumming), ATHERTON, (trombone, low brass), L. BAKER (bass), HEBERT (flute), HOLMES (jazz drums, jazz trumpet), C. JENKINS (oboe), K. KIBLER (voice), EDWIN LAWRENCE (piano, organ, harpsichord, Musicianship Skills Lab), ERIK LAWRENCE (jazz saxophone), MORSE (harp), NAZARENKO (jazz piano), PANDOLFI (horn), PARKE (cello), PHELPS (guitar), ROIGER (jazz vocal), RYER-PARKE (voice), KRISHNASWAMI (violin, viola), M. WALT (voice), WRIGHT (piano).

MAJOR
Sequence Courses
Music 103, 104 Music Theory and Musicianship I
Music 201, 202 Music Theory and Musicianship II
Music 207, 208, 209 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 supplementa readings, assignments, papers, and other projects appropriate for the Music major.
Group B: Music 203T, 204T, 211, 212, 213, 245T, 301, 305, 306, 308, 325, 326, 407, 408, 427, 42
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 t end of the sophomore year.

Performance and Concert Requirements
Music majors are encouraged to participate in departmental ensembles throughout their careers at W liams; i.e., for eight semesters. Majors are required to participate in departmental ensembles for at least fc semesters. The student must petition to meet this requirement in an alternative way. Music majors are al expected to attend departmentally-sponsored concerts.

Foreign Languages
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 musicianship skills, such as sigl singing, score reading, melodic and harmonic dictation, and keyboard proficiency, throughout their enti Williams career.

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 portfolio of smaller works completed during the junior and senior years, and a 10- to 15-page discu sion of the student's work.
b. *Performance:* A Performance thesis must include an honors recital given during the spring of t senior year and a 15- to 20-page discussion of a selection of the works performed. The studen general performance career will also be considered in determining honors.
c. *History, Theory and Analysis, or Ethnomusicology:* A written Historical, Theoretical/Analytical, Ethnomusicological thesis between 65 and 80 pages in length and an oral presentation based on t thesis is required. A written thesis should offer new insights based on original research.

To be admitted to the honors program, a student must have at least a 3.3 GPA in Music courses (th GPA must be maintained in order to receive honors), and have demonstrated ability and experien through coursework and performance in the proposed thesis area. A 1- to 2-page application to the honc program, written in consultation with a faculty member, must be made to the chair of Music before during spring registration in the junior year.
Honors candidates must enroll in Music 493(F)-W31-494(S) during their senior year. A student who highly qualified for honors work, but who, for compelling reasons, is unable to pursue a year-long proje may petition the department for permission to pursue a thesis over one semester and the winter study ter If granted, the standards for evaluating the thesis in such exceptional cases would be identical to those th apply to year-long honors projects. Final submission of the thesis must be made to the Music Departme by April 15 of the senior year. The department's decision to award honors will be based on the quality the thesis.

LESSONS
Courses involving individual vocal or instrumental instruction involve extra fees which are subsidize by the department. (See Music 251-258 and Studies in the Musical Art 325, 326, 427, 428). For furth 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 I
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 Counterpart
MUS 308 Orchestration and Instrumentation

COMPOSITION *(See the first course number in the sequence for course description.)*
MUS 203T, 204T Composition I and II