WASHINGTON AND LEE UNIVERSITY

Mathematics-Program Handbook
Fall 2011

Look up the word "mathematics" in a dictionary and you are not likely to find a good definition.

> **mathematics** (*Webster's Dictionary*) The science of numbers and their operations, interrelations, combinations, generalizations, and abstractions and of space configurations and their structure, measurement, transformations, and generalizations.
>
> **mathematics** (*American Heritage Dictionary*) The study of the measurement, properties, and relationships of quantities and sets, using numbers and symbols.

One common element in these two definitions is the mention of "relationships" or "interrelations." A relationship is a special kind of pattern—one of connection. Mathematicians explore patterns, and some of the tools they use in this endeavor are listed in the definitions above: numbers, transformations/functions, symbols, operations, and abstract structures. Thus, we assert the following is a better definition of mathematics.

> *Mathematics is the science of patterns: pattern recognition, pattern description, and pattern explanation—proof.*[1]

Patterns are discovered and investigated in response to problems—those concerning the "real world" (e.g., can quantum entanglement be used as a communications resource?) and those about mathematical objects themselves (e.g., are there infinitely many pairs of prime numbers differing by 2?). Thus, a reasonable alternate definition of mathematics is "The science of problem solving." However, we prefer a definition that focuses on patterns.

Because pattern analysis plays an important role in most analytical work, mathematical skills are widely applicable. The Department of Mathematics at Washington and Lee maintains a rigorous major program, which helps to prepare graduates for a wide variety of careers. Many work as analysts with consulting firms, as actuaries, as financial analysts, as teachers, as corporate analysts, and as software developers. Other graduates have pursued advanced degrees in mathematics, computer science, economics, engineering, law, and medicine.

People enjoy pattern analysis and problem solving. According to a study recently completed by Les Krantz, author of *Jobs Rated Almanac*, the three highest-rated[2] occupations in the U.S. are (1) mathematician, (2) actuary, and (3) statistician.

Do you enjoy pattern analysis and problem solving? Give some of the problems appearing pages 9 and 10 of this handbook a try!

The purpose of this handbook is to introduce students to the mathematics program at Washington and Lee: to describe the Mathematics Department's placement recommendations for new students, suggestions regarding the successful study of mathematics, objectives for its major program as well as for its courses that meet the University's Foundation and Distribution Requirements, and, finally, advice for majors on specific career options, graduate study, summer-research opportunities, and study-abroad experiences.

[1] This definition is one with which the well-known English mathematician G.H. Hardy would agree. Hardy writes in his *A Mathematician's Apology*, "A mathematician, like a painter or poet, is a maker of patterns." He continues, explaining that mathematical patterns are more permanent than those of painters or poets because mathematical patterns are made from ideas not just shapes and colors or mere words. It's interesting to note the extent to which Hardy's thoughts about mathematics are consistent with Einstein's. "Pure mathematics is, in its way, the poetry of logical ideas. One seeks the most general ideas of operation which will bring together in simple logical and unified form the largest possible circle of formal relationships. In this effort toward logical beauty, spiritual formulae are discovered necessary for the deeper penetration into the laws of nature."

[2] Criteria: environment, income, employment outlook, physical demands, and stress

Introductory Courses and Placement

A student's initial mathematics course at W&L is typically one of the following:

- Math 101, Calculus I: An introduction to the calculus of functions of one variable, including a study of limits, derivatives, extrema, integrals, and the fundamental theorem.
- Math 102, Calculus II: A continuation of Math 101, including techniques and applications of integration, transcendental functions, and infinite series.
- Math 121, Discrete Mathematics: A study of concepts fundamental to the analysis of finite mathematical structures and processes. These include logic and sets, algorithms, induction, the binomial theorem, and combinatorics.
- Math 221, Calculus III: Multivariable calculus, including motion in $\mathbb{R}^3$, parametric curves in $\mathbb{R}^n$, differential calculus of functions from $\mathbb{R}^n$ to $\mathbb{R}$ and to $\mathbb{R}^m$, multiple integrals, and Green's Theorem.

Math 101 and Math 121 satisfy W&L's Foundation Requirement in Mathematics/Computer Science while Math 102 and Math 221 satisfy the University's "SC" distribution requirement in science. Thus Math 101 and Math 121 should provide students with "a solid foundation in analytical, quantitative, and computational modes of thinking and problem solving, obtained through modeling of real-world problems in the precise language of mathematics." Courses, such as Math 102 and Math 221, satisfying the University's SC distribution requirement, are to "broaden and deepen students' knowledge of the natural or physical world or further develop their ability to gather, analyze, and interpret quantitative information."

Students intending to major in a physical or social science usually choose Math 101 over Math 121 (with an exception for Computer Science, whose major requires Math 121); other students should consider Math 121 as an alternative to Math 101. The Health Professions Advisory Committee at W&L suggests a first semester course of study that includes a mathematics course "at the level into which you test" (Math 101 or Math 102). Here's an interesting fact: In 2009, the mean scores of math and statistics majors taking the MCAT (Medical College Admission Test) exceeded mean scores of all other majors in the following categories: biological sciences, humanities, physical sciences, social sciences, and specialized health sciences.[3]

Placement in an initial mathematics course at W&L depends on a student's previous coursework as well as on his or her performance on any AP or IB tests taken. The Mathematics Department's case-by-case placement recommendations are presented below. After examining these recommendations, students should discuss their particular situation with their academic advisers. *Note well that the advanced-standing opportunities described below are available only in the fall term and open only to first-year students.*

- If you did NOT take a calculus course in high school and wish to take calculus at W&L, you should enroll in Math 101B (B is for a beginner in calculus) and do so fall term, as 101B is offered only in the fall. (The winter-term edition of Math 101 serves both true beginners in calculus as well as students with some previous calculus experience.) If you had some calculus in high school but still wish to enroll in Calculus I at W&L, you must enroll in Math 101A, D, E, or H). If you are not particularly interested in taking calculus, then you should consider enrolling in Discrete Mathematics, Math 121, or perhaps take Computer Science 101, 111, or 121.
- If you took an Advanced Placement (AP) Calculus Course (AB or BC) AND had your AP exam scores sent to W&L, then find your recommendation in the following list:

  AP Calculus AB:

  - Score 5: Receive 3 hours credit for Math 101.
    Fall Registration Recommendation: Either
    (1) Enroll in Math 102
    (2) Or enroll in Math 221A as an advanced-standing student. If you complete Math 221A with a grade of C or better, credit will be awarded for Math 102 as well.

[3]Source: Association of American Medical Colleges, DateTable 18.

If you are uncomfortable with the pace of Math 221A, you will have the option of switching to Math 102 through the first full week of class.

- Score 3, 4: Advanced Standing in Math 102.

  Fall Registration Recommendation: Enroll in Math 102. If you complete Math 102 with a grade of C or better, credit will be awarded for Math 101, as well. If you are uncomfortable with the pace of Math 102, you will have the option of switching to Math 101A, D, E, or H through the first full week of class.

- Score< 3: No credit.

  Fall Registration Recommendation: Math 101A, D, E, or H; or Math 121

AP Calculus BC:

- Score 5: 6 hours credit for Math 101 and 102.
  Fall Registration Recommendation: Math 221A
- Score 4: Advanced Standing in Math 221A or Math 102.
  Fall Registration Recommendation: Either
  (1) Enroll in Math 221A. If you complete Math 221A with a grade of C or better, credit will be awarded for Math 101 and 102, as well. If you are uncomfortable with the pace of Math 221A, you will have the option of switching to Math 102 through the first full week of class.
  (2) Or enroll in Math 102. If you complete Math 102 with a grade of C or better, credit will be awarded for Math 101, as well. If you are uncomfortable with the pace of Math 102, you will have the option of switching to Math 101A, D, E, or H through the first full week of class.
- Score 3: Advanced Standing in Math 102.

  Fall Registration Recommendation: Enroll in Math 102. If you complete Math 102 with a grade of C or better, credit will be awarded for Math 101, as well. If you are uncomfortable with the pace of Math 102, you will have the option of switching to Math 101A, D, E, or H through the first full week of class.

- Score< 3: No credit.

  Fall Registration Recommendation: Math 101A, D, E, or H; or Math 121

IB Math HL

- Score 5, 6, or 7: 6 hours credit for Math 101 and 102.

  Fall Registration Recommendation: Math 221A

- The remaining possibility is that you took a calculus course in high school, but took neither the AP nor IB examination. If you wish to take Calculus I at W&L, then you should enroll in Math 101A, D, E, or H (NOT 101B, a course for calculus beginners). However, if you feel quite confident of your calculus background, having a firm understanding of derivatives and their applications as well as integration, including fluency in the method of substitution, then you are invited and encouraged to TAKE THE MATH PLACEMENT EXAM, SUNDAY, SEPTEMBER 4, at 3 p.m. in Room 6 of Robinson Hall. If you do well on that exam, then you will be given the option of enrolling in Math 102 or Math 221A in the fall term. If you are placed in Math 102 or Math 221A and successfully complete the course with a grade of C or better, full credit will be awarded for any caclulus course(s) skipped; this option is available only in Fall term. If you are uncomfortable with the pace of the course into which you place, you will have the option of switching to a lower-level calculus course through the first full week of class.
- If you have questions about how any of this placement information applies to you, discuss it with your adviser, or e-mail the Head of the Mathematics Department, Paul Bourdon, bourdonp@wlu.edu.

In your initial course in mathematics (as well as any that may follow), you will, obviously, strive to be successful—to achieve mastery of course concepts, techniques, and applications.

Mastering Mathematics: Keys to Success

(1) *Enjoyment.* Students who enjoy mathematics are precisely those who seek to understand rather than to memorize. If you strive for understanding and solve problems based on general principles rather than memorized formulas, you will enjoy your mathematics courses. That enjoyment should extend to mathematics tests. Typically, if you have forgotten a fact or formula, you should be able to derive the needed fact or formula based on your understanding of it. Here's a simple example (that you might have encountered on a test in Elementary School):

What number does 2^0 *represent?*

Play a game. Pretend you are a fifth-grader who has studied exponential notation and learned (and understood) laws of exponents for positive integers raised to positive, integral powers. Then one day you walk into your classroom and see on the board "2^0". You think to yourself, "Whoa, I wonder what 2^0 means?" You reason, "It's gotta be a number." You assume that the laws of exponents that you've learned should continue to hold when the exponent is zero. Thus you scribble down something like, "$2^0 2^3 = 2^{0+3} = 2^3$." Thus 2^0 times 8 is 8 and you conclude, quite correctly, that 2^0 has be 1. A nice piece of detective work. Here's another, more-advanced, example. As many readers of this handbook will know, the fundamental tool that calculus provides for analyzing functions is called *the derivative*. Suppose on your first calculus test, you are asked to define the derivative of f at x. Sometimes students have trouble recording the definition of the derivative because they have simply tried to memorize it (and haven't really understood it). The definition of the derivative is typically derived as a solution to the problem of finding the slope of a line tangent to the graph of a function at a point on the graph. It is certainly easier to recall this source of the definition rather than the definition itself, and the definition is easily reconstructed from this source.

(2) *Approach homework assignments wisely.* Before beginning work on a set of homework problems, think about the material discussed in class, which the homework problems are meant to help you explore. Make sure you know and understand key ideas (perhaps embodied in theorems and definitions) as well as problem-solving techniques. The time and effort you invest in learning definitions, theorems, and techniques will always provide a payoff; however, if you spend several hours unsuccessfully trying to solve HW problems, then you've not used your study-time well. After you've spent some time (perhaps just 5-10 minutes) making sure you understand the relevant definitions and principles, then go ahead and get to work on the assigned HW problems. Try to solve the problems without looking at your notes or the exposition in the text. When you work a HW problem without relying on notes, you're re-enforcing your understanding of the principles you reviewed just before beginning work on the problem set. Also, when you take this approach each HW assignment becomes a practice test. If you have trouble completing a given HW problem, then certainly refer to your notes or the text for help. For certain problems, considering special cases or a simpler version of the given problem can be very helpful. From your work on special cases a pattern might emerge leading to a complete solution.

(3) *Seek help when you need it.* Take advantage of your instructor's office hours to clear up points of confusion. Consider visiting the "Math Center," which provide a supportive learning environment for those W&L students seeking help in lower-level mathematics courses, particularly calculus. The Center is located in Robinson Hall and open from 8 to 10 p.m. Sunday through Thursday evening, In upper-level courses, group work is often encouraged. Discussing problems and potential solutions with classmates can be very helpful (and fun as well).

(4) *Read your text actively with paper and pencil in hand.* Try to work through examples and proofs on your own and then see what the author or authors have to say. If you have trouble understanding a theorem or definition, try to understand what it is saying for specific examples. Also, it can be helpful to explore examples not satisfying a definition or

not satisfying the hypotheses of a theorem. Keep in mind that reading a mathematics text is not like reading a novel; e.g., some paragraphs might take ten or more minutes to digest.

The Mathematics Major

The Mathematics Department expects its majors will

- acquire critical-thinking and problem solving-skills necessary to mathematical investigations, from their beginning stages in which experimentation and pattern analysis are likely to play a role, to their final stages, in which mathematical discoveries are precisely formulated and formally proved to be correct;
- gain a deep familiarity with two of the principal areas of mathematics: modern analysis and modern algebra;
- experience mathematics as a creative art as well as a useful tool in modeling and exploring physical and social processes;
- be prepared to achieve success in mathematics-related careers or graduate study.

The course requirements of both the B.A. and B.S. major programs assure that the preceding goals are met. Each of these programs requires the completion of at least 10 mathematics courses, with 8 at the 300 level or above; thus, majors have broad exposure to mathematical thought and application. In Real Analysis (Math 311-312) and Abstract Algebra (321-322), students gain "deep familiarity" with modern analysis and algebra. Modeling of physical and/or social processes is an important feature of most mathematics courses, especially Multivariable Calculus (Math 221), Linear Algebra (Math 222), Statistics (Math 118, 218, 309, 310), and Differential Equations (Math 332-333). In addition, the B.A. and B.S. major programs include elective courses offered by other departments (e.g., physics, computer science, and economics) that have significant mathematical content. Finally, every mathematics-department course provides students with opportunities to experience the satisfaction derived from solving challenging problems through perseverance and creativity.

There is significant flexibility in the B.A. and B.S. programs, with each having at least five elective courses. The electives students choose depend on their interests as well as their post-graduation plans.

Students contemplating applying to a Ph.D. or a Master's program in mathematics should discuss their goals with a member of the mathematics department as soon as possible, in order to obtain individualized advice. In general, for such students the Department recommends completion of the following (in addition to courses explicitly required):

- Math 301: Fundamental Concepts of Mathematics
- Math 303: Complex Analysis
- Math 332-333: Ordinary and Partial Differential Equations
- Math 341: Geometric Topology
- Math 342: Modern Geometry

Also, most top graduate mathematics programs require applicants to take the GRE[4] General Test as well as the GRE Subject Test in Mathematics. Scores on these tests typically weigh heavily in admissions decisions. Students usually take the GRE Subject Test in Mathematics during the fall term of the senior year after an extensive summer program of preparation.

For majors interested in pursuing an advanced degree in statistics or biostatistics, the Department recommends completion of the following (in addition to courses explicitly required):

- Math 301: Fundamental Concepts of Mathematics
- Math 309-310: Mathematical Statistics I & II
- Math 332-333: Ordinary and Partial Differential Equations

For students intending to pursue professional training in medicine, law, or business, the mix of elective courses for the major should be driven primarily by student interests. However, the Department does recommend its advanced statistics courses, Math 309 and 310. We have already noted that mathematics majors usually perform quite well on the Medical College Admission Test. Math and

[4] Graduate Record Exam

physics majors are also top performers on the Law School Admission Test as well as the Graduate Management Admission Test (see, e.g., LSAT Data and GMAT Data).

For students who intend to enter the business world immediately after graduation from W&L, the Department trusts that the richness of sound fundamental training in pure mathematics, which is the focus of most of its courses, will equip its graduates with the analytical-reasoning and problem-solving skills they will need to build successful careers. This trust is confirmed by graduates of the Department in their responses to questions asking them to comment on any direct or indirect benefits they derived from majoring in mathematics. Here are some sample responses:

- "Tremendous value. Rational, logical thinking plays a major role in business decisions."
- "The training I received in mathematics made it possible for me to adapt to the extremely technical demands of the aerospace industry."
- "I am currently enrolled in the Chartered Financial Analyst Program, and my math background offers me a distinct advantage."
- "My job is as an analyst for a company that does a lot of work with the FAA in the area of traffic-flow management. We do a lot of modeling, which the mathematics training definitely helps with."
- "... provided a firm grounding in analysis."
- "... helps me think quantitatively and logically with rigor."

Many graduates of the Department who currently work in the corporate arena hold positions for which "analyst" is an apt description (e.g., actuarial analyst, financial analyst, research associate, securities analyst, technical analyst, operations manager, systems analyst). The only regret these students occasionally mention is that they wish they had taken the advanced-statistics sequence Math 309-310. Students contemplating careers in finance should strongly consider taking Accounting 201, 202, and 311 as well as some courses in finance such as Business 221.

The most popular career choice of mathematics majors at W&L is actuarial science. Actuaries are the leading professionals in finding ways to manage risk. For information about the actuarial profession, a good place to start is the "Be an Actuary" website (http://beanactuary.org). To become a fully-credentialed actuary, one must pass a sequence of exams and fulfill "VEE" requirements (Validation by Educational Experience). Actuarial professional organizations recommend that those considering a career as an actuary complete undergraduate coursework including:

- finance (Bus 221)
- microeconomics (Econ 101)
- macroeconomics (Econ 102)
- three semesters of calculus (Math 101, 102, 221)
- one semester of linear algebra (Math 222)
- two semesters of calculus-based probability and statistics (Math 309-310)
- business courses, such as marketing
- computer science courses
- communication courses, such as writing, technical writing, speech, or drama courses literature, history, art, political science, the humanities, and other liberal arts classes
- actuarial science courses, as available (Math 401)

For advice about preparing for careers in actuarial science, students should contact Professor Greg Dresden (Robinson Hall 2, dresdeng@wlu.edu).

Students considering teaching mathematics in grade school should visit W&L's Teacher Education website (http://teachereducation.wlu.edu) and should discuss licensure requirements with Professor Lenna Ojure. In Virginia, for certification to teach mathematics at the high-school level, students should major in mathematics and should have coursework distributed in each of the following areas: (a) Algebra: Math 222, Math 321-322, (b) Geometry: Math 342, (c) Analytic geometry: Math 101-102, (d) Probability and statistics: Math 118 and/or Math 309, (e) Discrete mathematics: Math 121 or Math 301, (f) Computer science: CSCI 111 or 121, (g) Calculus: Math 101, 102, and 221.

Students wishing to teach at the middle-school level in Virginia will need to have completed at least 21 credits in mathematics or mathematics-related courses (such as computer science or interdepartmental statistics). The Department's recommended courses are as follows:

(a) Calculus with Analytic Geometry: Math 101-102, (b) Introduction to Statistics: Math 118, (c) Multivariable Calculus: Math 221, (d) Linear Algebra: Math 222, (e) Fundamental Concepts: Math 301, (f) Real Analysis: Math 311-312, or Abstract Algebra: Math 321-322.

Students interested in teaching mathematics often consider the Math for America Program and the Teach for America Program.

The Mathematics Minor

The Mathematics Department recently created a minor program, which provides students a way to alert potential employers or graduate-admissions committees that they have completed significant coursework in mathematics. For a listing of all major and minor requirements for W&L's mathematics program, students should consult a current University Catalog.

Honors Program

An honors program in mathematics is offered to well-qualified majors. Minimum qualifications include achievement, through fall term of their junior year, of a GPA of 3.5 or higher, both in all coursework at W&L and in coursework within the Mathematics Department as well as within the Mathematics Major. Students who graduate with honors in mathematics must write a thesis during their senior year under the direction of a member of the Mathematics Department faculty. For further information about the honors program, students should see Professor Bourdon.

Summer-Research and Study-Abroad Opportunities

Each year, several of our majors engage in summer research, either at W&L (supported by the University's *Lee Scholars Program*) or at other universities (supported, e.g., by the National Science Foundation's *Research Experiences for Undergraduate's Program*). Since 1990, our students have written four software packages, developed five websites, published seven expository papers, and authored or co-authored twelve articles appearing in prestigious professional journals such as the *American Mathematical Monthly*, *Linear Algebra and its Applications*, *Physical Review A*, and the *Transactions of the American Mathematical Society*. An illustration from a student-authored paper (Emilie B. Wiesner, class of '00) appears below.

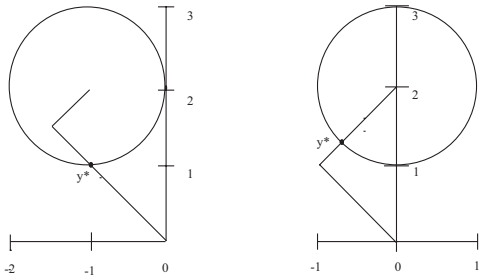


Fig. 1. y^* for $x_0 = (-1,2)$ and $x_0 = (0,2)$, respectively.

From: "Backward minimal points for bounded linear operators on finite dimensional vector spaces" (*Linear Algebra and its Applications* 338 (2001), 251-259)

Students wishing to explore summer-research opportunities can begin with the links provided below and then should discuss their interests with any member of the Mathematics Department.

- REU-Site Programs (Application deadlines: typically mid-February to early March)
- Opportunities at the National Security Agency: Mathematics Summer Employment Program, Director's Summer Program (Application deadline is October 31 for both programs)
- The Carleton Summer Mathematics Program for Women (Deadline: mid-February)
  G.W. University Summer Program for Women in Mathematics (Deadline: mid-February)
  EDGE Program for Women (Deadline: early March)
- Opportunities at NASA (Deadline: as early as mid-January)

A fall-term research opportunity that should be mentioned is one provided by Penn State University: its Mathematics Advanced Study Semester combines advanced coursework and research.

As for study-abroad opportunities, students of the Department frequently participate in the Budapest Semesters in Mathematics Program. See Professor Paul Humke for more information—in fact, he is the North American Director of the program. Another program that several students have enjoyed is one at St. Andrews in Scotland (ask Prof. Wayne Dymàček for details). Another option that students may consider is Mathematics in Moscow. These study-abroad programs are conducted during the academic year and students may choose to participate for one or two terms.

The Mathematics Faculty

It's well known that mathematics-department faculty are some of the friendliest folks on campus. You should certainly try to take advantage of the office hours that each professor has posted on his or her door. This is the perfect opportunity for you to get help on your homework, to clear up any questions you might have from the day's lecture, or to talk about any mathematical topic you have in mind.

The Department also maintains an open-door policy, in that if a faculty member is in his or her office with the door open, you should feel free to knock and ask a question. For more involved issues (that involve very difficult homework problems, for example), an appointment can be made for a later, in-depth discussion of the issue.

We all enjoy working on mathematics. You'll find here a list of our research areas. All of us, at one time or another, have worked with students on independent research projects or honors work, either during the summer or during the school year, and we all enjoy talking about our work. Given the wide variety of our research interests, there's sure to be something here for everyone.

Paul Bourdon (Ph.D., UNC at Chapel Hill) studies properties and applications of linear, harmonic, and analytic functions. He is currently investigating quantum operators, which are linear functions used to model the transmission of quantum information through noisy channels. He teaches Real and Complex Analysis, Ordinary and Partial Differential Equations, as well as Calculus I-III and Linear Algebra.

Katherine Crowley (Ph.D., Rice University) conducts research in Combinatorial Geometry and Topology and is especially interested in CAT(0) spaces and discrete Morse Theory. She teaches Calculus I-III, Fundamental Concepts, and Geometric Topology.

Gregory Dresden (Ph.D., UT at Austin) works in the areas of number theory and abstract algebra. Some of his recent papers cover topics (such as transcendental numbers, cyclotomic polynomials, and the Fibonacci sequence) that are accessible to undergraduates. His latest article discusses a new proof of the formula for the resultant of cyclotomic polynomials. Professor Dresden teaches actuary courses at W&L to prepare students for the actuary exams, as well as a cryptography and number theory course which involves a field trip to the NSA in Washington DC.

Wayne Dymàček (Ph.D., Virginia Tech) continues to work in various areas of combinatorics. Recently, with two students, he has counted the number of permutations with arithmetic progressions and investigated the realizability of $(\kappa, \lambda, \delta, \Delta)$-graphs. He also continues his work on Steinhaus graphs.

Michael Evans (Ph.D., Michigan State) is participating in the University's phased-retirement program and teaches in the fall term only. His fall term offerings often include classes in Real Analysis and Calculus I, II, and III. He maintains an active research program, presently exploring algorithmic means of approximating and characterizing various classes of functions of one or several real variables.

Nathan Feldman (Ph.D., UT at Knoxville) studies the dynamics of linear operators in infinite dimensional Hilbert spaces; this involves the chaotic behavior of infinite matrices and lies at the crossroads of analysis and infinite dimensional linear algebra. Professor Feldman regularly teaches calculus, statistics, linear algebra, differential equations, and analysis courses.

Carrie Finch (Ph.D., University of South Carolina) conducts research in Number Theory. She has recently determined the irreducibility of particular weighted sums of polynomials that have only cyclotomic factors, and is currently investigating consecutive integers that are simultaneously Sierpinski numbers and Riesel numbers.

Paul Humke (Ph.D., UW at Milwaukee) is a real analyst whose current research includes investigating interpolating approximations, dynamical systems and the geometry of attractors. He is the North

American Director of the Budapest Semesters in Mathematics Program and Editor-in-Chief of the research journal, *Real Analysis Exchange*. He teaches a wide range of courses at W&L including calculus, linear algebra, probability and statistics and real analysis.

Alan McRae (Ph.D., SUNY at Stony Brook) is currently investigating spacetime geometries as well as geometric probability. He has taught the following courses at W&L: Single and Multivariable Calculus, Introduction to Statistics, Special Topics in Contemporary Mathematics (Games & Gambling, History of Geometry, Paradoxes in Mathematics), Natural Science Seminar (Time Machines), Linear Algebra, Vector Analysis, Fundamental Concepts of Mathematics, Classical Geometry, Geometric Topology, Modern Geometry (Differential Geometry, Catastrophe Theory, Finite Geometry, Black Holes), and Directed Individual Study (History of Geometry, Mathematical Biology, Algebraic Geometry).

Jacob Siehler (Ph.D., Virginia Tech) has research interests centering around applications of category theory to questions in low-dimensional topology. He enjoys teaching discrete mathematics and topics in topology as well as the usual assortment of calculus courses, and maintains an active interest in computer programming and the computer algebra system *Mathematica.*

Jungmin Choi (Ph.D.'s, Unversity of Texas at Arlington and the University of Michigan) specializes in the mathematics of finance. Dr. Choi is a visiting professor in the Department and will teach Calculus I & II as well as a course in financial mathematics during the 2011–2012 academic year.

Andrew Oster (Ph.D., University of Utah) has research interests in Mathematical neuroscience and physiology, modeling, dynamical systems, pattern formation, visual processing, calcium dynamics, traveling waves, and neuronal bursting. Dr. Oster is a visiting professor in the Department and will teach Calculus I & II and possibly a seminar course in mathematical biology during the 2011–2012 academic year.

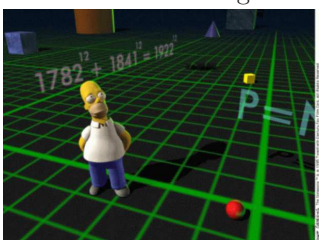
Social Events for Math Students

The Mathematics Department maintains an active social calendar. In the fall, we typically have a Math Career night with recent graduates on hand to talk about possible career paths for math majors. In the winter, we enjoy the almost-famous Math Movie night, with plenty of popcorn and drinks. Past screenings have included *Proof*, *A Beautiful Mind*, and *The Mean Policeman*. Spring term brings the Math Picnic, a nice opportunity for students and faculty to get together in a relaxed setting and enjoy a delicious meal. At the end of the year, graduating seniors and their families gather for a graduation reception. Finally, throughout the year we host visiting speakers, and these math talks are always preceeded by a brief reception with refreshments. Occasionally, students are invited to dinner with a visiting speaker.

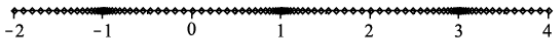
Robinson Hall has a special student-only math lounge. It's located on the second floor (next to Prof. Dymàček's office), and has a couple of computers, a table and some chairs, and a very comfortable couch that's perfect for the quick nap before class.

Fun Problems and Mathematics Contests

(1) Find a formula that generates terms in the sequence $1, 3, 6, 10, 15, \ldots$.
(2) Does every set of six people have three mutual acquaintances or three mutual strangers?
(3) Can Homer Simpson's equation $1782^{12} + 1841^{12} = 1922^{12}$ be correct?



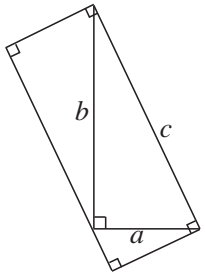
(4) Depicted below is the set $S := \{f(-3 + n/20) : n = 0, 1, 2, \ldots, 120\}$, where $f(x) = x - \frac{1}{\pi}\sin(\pi x) + 1$. Note points of S cluster tightly about -1, 1, and 3. Explain this behavior. How could you have predicted it?



(5) You have \$50,000 to invest in Mutual Funds A, B, C, D, and E. For each of the funds, you must invest in increments of \$5,000. Thus, for example, you might invest \$10,000 in each of the funds, or \$25,000 in A, \$5,000 in B, and \$20,000 in D (with no money invested in C or E). How many different investment distributions are possible?

(6) Albert and Bilbert are about to play a game in which hats—either rouge or puce—will be placed on their heads. Each will be able to see the color of his partner's hat, but not the color of his own. At the blow a whistle Albert and Bilbert will simultaneously make a guess as to the color of his own hat. Incorrect guesses will not be punished. A win consists of at least one correct guess. What strategy can Albert and Bilbert agree upon to secure a win?

(7) Use the diagram below as the basis for a proof of the Pythagorean Theorem.



If you enjoyed solving (or attempting to solve) these problems, then you should consider participating in the William Lowell Putnam Competition and the Virginia Tech Regional Mathematics Contest. Contact Professor Bourdon (Robinson Hall 32A, bourdonp@wlu.edu) for further information. In addition, Professor Feldman runs a Problem-of-the-Month contest, with problems posted on the Department's webpage.

Do I Need a Graphing Calculator?

Technology plays an integral role in the mathematics curriculum at Washington and Lee. Beginning in Math 221, Multivariable Calculus, the computer algebra system Maple is introduced via the Department's computer laboratory. It is used heavily in several subsequent courses, such as Math 332 (Ordinary Differential Equations) and Math 333 (Partial Differential Equations). It is in such courses that 3-D graphics, high-speed computation, and symbolic manipulation have much to offer. It is the strong feeling of the W&L mathematics faculty that the emphasis in its introductory-level calculus courses must be focused on calculus itself. This firm grounding enhances students' appreciation of both theoretical and computational aspects of advanced courses. Thus, perhaps unlike the calculus course you may have had in high school, Math 101 and Math 102 do NOT require a graphing calculator.