Duke University
Math News

Welcome Back!

Your mathematics department continues to improve the quality of its majors, its faculty and its facilities.

The number of first and second majors and minors has increased to nearly 100 students and many sophomores will soon join this group. In the last two years, our majors have received many notable prizes and honors, including a Churchill fellowship, two Duke Faculty Scholarships, three B. M. Goldwater Scholarships, and a first and second place finish in the W. L. Putnam Mathematical Competition. A Duke team of three was designated as Outstanding in the 1998 Mathematical Contest in Modeling. The winning students presented their results at a mathematical conference in Toronto last July.

Nine distinguished teachers and researchers have joined the department. They are looking forward to working with the many talented Duke students in their classes. Professor William Pardon will continue to serve as department chair through the fall 1998 term. Professor John Harer, the chair from 1994 to 1997 will resume the chairmanship in the spring. After a distinguished three-year term as Director of Undergraduate Studies, associate professor Harold Layton is taking a sabbatical leave. Professor J. Thomas Beale will serve as DUS for the next two years. Check your email regularly for announcements and opportunities especially for math majors.

The University has been investing heavily in the physical plant throughout the campus. In the new multimedia classroom, room 120, instructors illustrate their lectures with mathematical programs such as *Maple* and *Matlab*. Easy access to the Internet allows for much experimentation. Many of the classes for math majors will be taught in that room.

The mathematics professors are here to serve you, the student, even as they pursue their own research projects. Our goal is to help you reach your maximum potential in mathematics. We welcome your input. Are there courses that you would like to see offered? Would you like to study a topic not in the regular curriculum? Do you want a mentor for a research project? Do let us know and we will see what can be arranged.

—*David Kraines, DMN Faculty Sponsor*

DUMU

About DUMU

The Duke University Math Union, or "DUMU" for short, is a club sponsored by the department for undergraduates. Our activities include social events, such as picnics, movies, frisbee games with the Society for Physics Students, and our high-school math contest. Additionally, we invite speakers for the entertaining and informative Undergraduate Lecture Series. If you are interested in hearing about DUMU events and are not already on our mailing list, contact Garrett at wgm2@acpub.duke.edu. Read on to find out about our current plans.

The High School Math Meet

DUMU is planning to host a contest on November 14 for high schools in North Carolina and nearby states, and we need problems and solutions for it. The more people who contribute, the more varied and interesting the contest will be. So, start thinking, and keep you eyes open for intriguing ideas. Math may be a tool and a subject, but it can also be a sport, a game, a kind of art, and thought-provoking fun.

The problems should be limited to precalculus and below, but that does not mean they cannot be creative. We need all levels of problems, from quick-and-easy puzzles to short dissertations. Humor in good taste is most welcome.

The format of the contest will be similar to the one used by the American Regions Math League.

If you come up with any promising problems, or are willing to help us type them up, contact Carl Miller at `cam9@acpub.duke.edu` or John Clyde at `jjc@acpub.duke.edu`. 🦟

Competitions

The following contests are open to all undergraduates. They take place on Saturdays and are held in a math classroom in the Physics Building. If you are interested in participating in one of these competitions, or if you would just like more information, contact David Kraines at `dkrain@math.duke.edu`.

- October 31. The Virginia Tech Regional Mathematics Contest is two and one half hours long. Knowledge of linear algebra and multivariable calculus is helpful. In the 1997 Virginia Tech Contest, of the 173 students from 32 institutions that participated, eight of the top fifteen were from Duke.

  For more information, see `http://www.math.vt.edu/events/index.html`.

- December 5. The W. L. Putnam Mathematical Competition is given in two sessions of three hours each. Success in this challenging competition requires ingenuity and mathematical rigor rather than advanced mathematical knowledge. The Duke team of Nathan Curtis '01, Andrew Dittmer '99, and Noam Shazeer '98 placed second in the December 1997 competition. A Duke team won the 1993 and 1996 Putnam contest!

  For more information, see `http://scuish.scu.edu/SCU/Departments/Math/putnam/`.

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*M*athematics is not a deductive science—that's a cliche. When you try to prove a theorem, you don't just list the hypotheses, and then start to reason. What you do is trial and error, experimentation, guesswork.

—Paul Halmos

Department News

Graduation of the Class of '98

Following the university-wide exercises last May, mathematics and physics majors, their families and friends, and a number of mathematics faculty gathered in the Levine Science Research Center Dining Room for a buffet luncheon, followed by a diploma ceremony. Most of our first and second majors reported definite post-graduation plans. At least twelve majors have entered graduate programs: three in mathematics, four in engineering, two in computer science, with the rest in physics, economics and other areas. Ten of our graduates have begun careers in financial services or consulting and two will start teaching at the high school level. 🦟

New Faculty

Here are the names and interests of the new faculty in the department:

- **Arlie Petters**, William and Sue Gross Associate Professor; Princeton; PhD MIT. *Singularities of differentiable maps, gravitational lensing*

- **Tom Witelski**, Assistant Professor; MIT; PhD Cal Tech. *Solution of nonlinear differential equations via perturbation methods and scientific computation; applications to industrial problems soil hydrology, mathematical biology and viscous fluid flow*

- **Stephen Shipman** Research Assistant Professor; PhD Arizona. *Singular limits of dynamical systems and asymptotic (WKB) analysis; limiting behavior of inverse problems*

- **Ramesh Sreekantan** Research Assistant Professor; PhD Chicago (on leave 98-99). *Number theory, arithmetic of algebraic cycles*

- **Dale Winter**, Teaching Assistant Professor; PhD Michigan. *Shock waves in general relativity; axially symmetric solutions in general relativity*

- **Walter Carlip**, Visiting Associate Professor; Ohio University; PhD Chicago. *Finite group theory, number theory; primality testing, recursive sequences*

- **Clyde Schoolfield**, Visiting Assistant Professor; PhD Johns Hopkins. *Probability theory and stochastic processes, group and representation theory, statistics and econometrics, mathematical finance; random walks on the octahedral group*

- **Kiril Skouibine**, PostDoc CAMCLSM; PhD Tulane. *Numerical analysis of reaction diffusion equations, mathematical biology, cardiac electro-physiology*

- **Eric Sharpe**, PostDoc CGTP; PhD Princeton (Physics). *String theory*

Department Receives Major Grant

A grant of $2.3 million grant from the Knowledge and Distributed Intelligence (KDI) program at the National Science Foundation will support the study of the intricate and little-understood complexities of how liquids flow through porous media such as geological formations.

"We are extremely gratified that the NSF has provided funding for this important basic research," said professor of mathematics John Trangenstein, principal investigator for the project. "This grant will enable a highly productive interdisciplinary collaboration among applied mathematicians, statisticians and engineers that will yield new insights into this important topic. The grant will also encourage the formation of such partnerships in the future to meet such major computational and modeling challenges."

Six principal investigators at Duke, including professor of mathematics William Allard, will work with 3 post-doctoral research associates and 5 graduate students to develop fundamental new modeling and computational methods as well as contribute to such practical applications as increasing the efficiency of oil production and using chemicals to remove pollutants from ground water. The huge computational demands

of such mathematical models will require construction of a new 32-processor computer dedicated to this project. This computer will also be available for student instruction.

For more information about this project, visit `http://www.math.duke.edu/faculty/trangenstein/kdi/index.html`.

News From The Graduate Program

Graduate Students
by Chad Schoen, Director of Graduate Studies

This autumn six new graduate students will begin working towards their Ph.D.'s in the math department. Their undergraduate school and expected interests are: Christian Benes from the University of Geneva (analysis), Ryan Deering from Duke University (applied math), Michael Kozdron from the University of British Columbia (probability theory), Colleen Mitchell from Duke University (mathematical biology), Amit Roy from SUNY at Plattsburgh (geometry), and Michael Silverstein from Cornell (mathematical physics).

Graduate Degrees

Charles Fargason, Mary Beth Fisher, Anna Georgieva and Kirsten Travers, were awarded doctorates in math during the past academic year. Fargason is a Management Consultant in Dallas, Fisher plans to work in pharmaceutics, Geogieva is a postdoctoral research fellow at Research Triangle Park, and Travers works in investment banking in New York. Andrew Barnes and Laura Taalman received Masters of Arts degrees.

Laura Taalman Rewarded for Excellence in Teaching

Laura Taalman recently received the 1997-1998 L. P. and Barbara Smith Award for Teaching Excellence. This award is presented annually to one or two graduate students who have demonstrated a long-term commitment to teaching and whose teaching has reached a consistent level of

excellence. The Smith award carries with it the explicit recognition by the Mathematics Department of Laura's fine teaching as well as a substantial monetary prize.

Professor William Pardon, Acting Chairman of the Mathematics Department, presented the award to fifth year graduate student, Laura Taalman, at the opening department meeting of the school year. According to Lewis Blake, Supervisor of First Year Instruction, Laura "has been one of the most hardworking and helpful teaching assistants that we have had." She has "put her heart and soul into making sure that the students learn. And, of course, her students love her and they learn math!"

The Smith teaching award was made possible by a generous donation from Captain L. P. Smith and Barbara Smith, who established the Smith Award in 1981. Captain Smith was Supervisor of Freshman Instruction in the Mathematics Department from 1973 until his retirement in 1982. The Smiths' goal was to reward those graduate students for their efforts to become fine teachers. The Smiths are now enjoying their retirement in the Seattle, Washington, area. 🦋

Food for Thought on Fridays

Every Friday afternoon, the math graduate students host an informal talk in which graduate students and faculty get a chance to share their ongoing research or some mathematical gem they have discovered. These talks are held every Friday afternoon at 4:00 in Room 120 Physics, preceded by tea at 3:30. Check the posted math calendar or `http://math.duke.edu/seminars/graduate.html` for the next speaker and title. No previous knowledge is assumed other than a solid undergraduate math experience; everyone is encouraged to attend. 🦋

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*S*ir, I have found you an argument. I am not obliged to find you an understanding.

—Samuel Johnson

Duke Math News Seeks Assistant Editor

Garrett Mitchener '99 is serving his fourth year as editor of *Duke Math News*. He eagerly seeks an assistant editor, a paid position, who would be willing to take full responsibility for the paper next year. Past issues of the Duke math news are available at `http://www.math.duke.edu/math_news`. Please contact David Kraines at `dkrain@math.duke.edu` if you are interested. 🦋

Math Horizons Now Available

The September issue of *Math Horizons*, an informative undergraduate math magazine, is available free, first-come first-serve, in Room 121 Physics. A few copies of previous issues are also available at that place and in room 226. 🦋

Vertices Seeks Writers

The undergraduate journal, *Vertices*, seeks students to write about math and science at Duke. This is an excellent way to learn more about your favorite professor and his or her research. Contact Mark Jackson `mgj2@duke.edu`. 🦋

Miller's Paper Wins Award

Johanna Miller '99 has won the Richard V. Andree award for the best paper written by an undergraduate and published in the Pi Mu Epsilon journal during 1998. Her paper, "Mauldin-Williams Graphs with Unique Dimension" written with C. Ryan Vinroot, explores generalizations of fractals. 🦋

Goldwater Scholarship

The prestigious Goldwater Scholarship is intended for sophomores and juniors planning careers in mathematics, engineering, and the natural sciences. It is worth up to $7,500 annually, covering tuition, fees, books, and room and

board. Fourteen math majors at Duke have won this award since 1989.

Preliminary applications are due to room 04 of the Allen Building by Monday, October 26. For more information, please see the Goldwater web site `http://www.act.org/goldwater` or Dean Mary Nijhout in room 04 of the Allen Building. ✿

I remember once going to see him when he was lying ill at Putney. I had ridden in taxi cab number 1729 and remarked that the number seemed to me rather a dull one, and that I hoped it was not an unfavorable omen. "No," he replied, "it is a very interesting number; it is the smallest number expressible as the sum of two cubes in two different ways."

—Godfrey H. Hardy
Said of a visit to Ramanujan

Notes from the DUS

As the new Director of Undergraduate Studies in the Mathematics Department, I want to welcome you all back! We have a very lively environment here for learning mathematics, and I will be looking for ways to make it better. I will be glad to have imaginative suggestions.

If you declared your major or minor in math before the school year started, you should have received the new edition of our *Handbook for Mathematics Majors and Minors*. If you have not received one, you can pick up a copy in the Mathematics Office, Room 121, from a shelf on the right as you enter the office. The *Handbook* is also available at the department's web site `http://www.math.duke.edu`, under the heading "The Undergraduate Program."

Registration for the spring semester begins on Wednesday, October 28. If your first major is math, you will have an advisor in the Mathematics Department. For those of you who recently declared a first major in math, I will soon be assigning you an advisor. If our records are right,

you received an e-mail from me about this. In this case you are welcome to tell me anything about your plans to help me make the assignment. If you are not a first major in math, your advisor is in another department, but you are welcome to talk to me about the math program if you wish.

Mathematics courses suitable for majors and minors and scheduled to be offered in the spring semester include: Math 114, 120S, 121, 126, 128S, 131 (two sections), 133, 135 (two sections), 139, 160, 196S, 201, 204, 206, and beyond. Math 196S will be a seminar in mathematical modeling in biology, taught by Professor Reed. Math 128S will be a seminar in number theory taught by Prof. Pardon. Details about several courses will be given in the course synopses.

The department has made a recent change in the major requirement (AB or BS) concerning Math 111. We now allow Math 111 to count for credit toward the major. However, Math 104 is a prerequisite for the major, and we strongly recommend to math majors that they take Math 131, if they wish, after taking Math 104, rather than taking Math 111. See the *Handbook* for detailed information.

Have a great semester!

—*Tom Beale*

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*T*he shortest path between two truths in the real domain passes through the complex domain.

—Jacques Hadamard

Problem Corner

Solutions from Last Issue

Solution to Problem 1:

(Solution and text of problem from `http://www.math.princeton.edu/~kkedlaya/competitions.html#putnam`.)

The centroid G of the triangle is collinear with H and O (Euler line), and the centroid lies two-thirds of the way from A to M. Therefore H is

also two-thirds of the way from A to F, so AF = 15. Since the triangles BFH and AFC are similar (they're right triangles and $\angle HBC = \pi/2 - \angle C = \angle CAF$), we have BF/FH = AF/FC, or $BF \cdot FC = FH \cdot AF = 75$. Now $BC^2 = (BF+FC)^2 = (BF-FC)^2 + 4BF \cdot FC$, but $BF - FC = BM + MF - (MC - MF) = 2MF = 22$, so

$$BC = \sqrt{22^2 + 4 \cdot 75} = \sqrt{784} = 28.$$

Solution to Problem 2:

(From *500 Math Challenges*, published by the MAA, problem 176.)

We know $p(a) = a$, $p(b) = b$, and $p(c) = c$. We can write $p(x) = (x - a)(x - b)(x - c)q(x) + r(x)$ where r has degree at most 2. (We are dividing by a cubic.) But, $r(a) = a$, $r(b) = b$, and $r(c) = c$ (just plug in...) so $r(x) - x$ is a quadratic that has at least three roots, and so must be identically zero. Thus $r(x) = x$.

New Problems

Problem 1: *Many Rectangles*

(By Michael Khoury, USAMO Team Member)

How many rectangles of any size can be formed by joining adjacent squares on an 8 by 8 chess board? How many of them are square?

Problem 2: *A Rising Sequence*

By Carl Miller '01

For a positive integer n, let $S_1, S_2, \ldots, S_n$ be a non-increasing sequence of positive integers such that $S_{(S_k)} \geq k$ for any k such that $1 \leq k \leq n$. (It is implied here that $S_{(S_k)}$ is defined for every such k, meaning $1 \leq S_k \leq n$.) Show that for some positive integer m,

$$\sum_{k=1}^{m} S_k - \sum_{k=m+1}^{n} S_k = m^2.$$