Math Matters

The Cornell Mathematics Department Newsletter
VOLUME 3, NUMBER 2 December 1995

MER Workshop on Curricular Reform in Mathematics

The Mathematics Department hosted the MER Conference workshop on campus November 16-19, 1995. Faculty in the department sat on panels throughout the four day conference, which focused on the issues, content and implications of curricular reform efforts in Mathematics.

Panel One, "Putting curricular reform in context" was held on Friday, November 17th. Panelists included Joe Adney of Michigan State, Bob Davis of Rutgers, Carole LaCampagne of the U.S. Department of Education, and Joe Rosenstein, also of Rutgers. The panel considered and delineated the motivations and goals behind curricular reform efforts, past and present, and how the theoretical framework relates to the experience. It also examined what could be learned by delving into the past, and what should be common to and different about curricular reform at the elementary, middle grades, high school and undergraduate levels.

"Curricular reform as the process of translating frameworks into real programs" was the title of the second panel. The purpose of the presentation was to help others experience the kinds of thinking and decision making that are involved in developing and implementing new curricula. Questions raised were: What is the relationship between content and pedagogy? How can teachers be prepared to teach new curricula? What drives the decisions about content and pedagogy? The panel also previewed what the implications of kindergarten through 12th grade reform may be for undergraduate education. Panel members included Rick Billstein and James Hirstein of the University of Montana, Betty Phillips of Michigan State and Phil Wagreich of the University of Illinois at Chicago.

Saturday's first panel was "Curricular reform within a mathematics department." The panel, which was organized and moderated by **Tom Rishel**, senior lecturer and director of undergraduate teaching at Cornell, highlighted how the Cornell Mathematics Department addresses the needs of the non-major by developing alternative courses to the standard calculus curriculum. Panelists included Cornell's **Allen Back**, **Leon Harkleroad** and **Gene Hwang**.

The final presentation was entitled "Curricular reform in the undergraduate environment." Panelists Jerry Bona of the University of Texas at Austin, Rishel, James Turner of Florida A&M, and Ros Welchman of CUNY Brooklyn addressed the following questions: What are the implications of K-12 curricular reform for undergraduate mathematics? What are the implications for undergraduate curricular reform for K-12 mathematics, teacher preparation, etc.? Is curricular reform needed at the undergraduate level? What's driving curricular reform: pressure from administration, changing demographics, new developments in mathematics, etc.? Is there such a thing as curricular reform across the undergraduate level or is curricular reform a course by course process? How can faculty development be handled? What are the implications for the valuation of teaching, including recognition and rewards?

Local speakers who also did afternoon workshops were Professor **David Henderson** on "Experimental Geometry"; **Allen Back**, director of the Math Lab, and **Birgit Speh**, professor of Mathematics, held a computer presentation on calculus; and **Tom and Mary Ann Rishel** spoke on "Writing and Mathematics." Rishel's panel also included former Cornell undergraduate **Justin Collins** '95 and current undergraduate **Alison Klugherz** '96.

Other Cornell participants included: visitors **Carolyn DeSilva, Atul Roy** and **Bob Schneider.** Associate Dean **Peter Kahn** and Professor **Bob Connelly** gave welcoming talks.

The Mathematics Department on the World Wide Web

The Mathematics department is going on-line! Currently, the instructional computing lab has its own webpage, which is located at *http://mathlab.cit.cornell.edu*. While still under construction, the page includes local materials on the Mathlab, some pointers to departmental information, and links to other mathematical resources from external sites.

The text for the page reads as follows:

The Mathlab focuses on undergraduate and visualization oriented aspects of mathematical computing. It serves as an electronic classroom, laboratory, and site for undergraduate research. It also serves as an experimentation and production center for materials aiding undergraduate instruction. The department page, also under construction, is located at *http://math.cornell.edu/*

Local Mathlab Materials

Quick Reference to the Lab
Multivariable Calculus in the Lab - A collection of Maple worksheet (images) for multivariable calculus.
PDE Learning Programs (Macintosh)
Visualization - A guide to some local visualization resources.
Programming - A guide to some programming environments in the lab.
User Seminar Series Announcement
Support Notes
What's New?

Local Math Department Information

Most local department information is currently being provided by the **Department of Mathematics** Gopher **Server**.

Department Information:
Current Math Seminars
Seminar Listings
Directory
Math Library Hours
Directions to Cornell
Math Club Home Page
Department WWW Server

Local System Information:
Computer Facilities
E-Mail Info
Dialup Access
Tex Usage

External Pointers and Information:
Other Cornell Servers
CUinfo
College of Arts and Sciences
Cornell Online Catalog
Center For Applied Math
Cornell Theory Center
Computer Science
Operations Research
Physics Department
University-Wide Course Web Server
More complete list

Mathematical Organizations and Institutes
AMS
MAA
SIAM
MSRI
Geometry Center
Institute for Advanced Study
DIMACS
NSF Division of Mathematical Sciences
Other

Preprint Servers and Electronic Journals

Mathematical Software Resources

Other Math Departments

Tex Information

Math Education

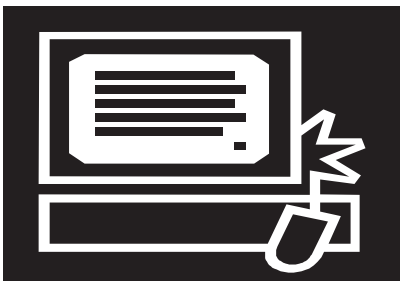
Workstation Usage Help

World Wide Web Help

Miscellaneous Sources

Feedback on these pages to:
mathlab@math.cornell.edu

The page was last updated on October 6th. Further access will soon be available on the department, the Math Club, and the Mathematics library.



Recently Published Faculty Books

Keith Dennis and Benson Farb, *Noncommutative Algebra*. Springer-Verlag, 1993.

Noncommutative Algebra, suitable for a one-semester graduate course, is an introduction to the theory of noncommutative algebra. It is based on lecture notes written by Professor Dennis for Math 532 and was greatly influenced by K. Brown, S. Chase and S. Sen. Co-author Benson Farb (Ph.D. 1994, Princeton University) received his B.A. from Cornell University in 1989 and was that year's winner of the Kieval Prize.

The approach, which is more homological than ring-theoretic, clarifies the subject and its relations to other important areas of mathematics, including *K*-theory, homological algebra, and representation theory. Problems throughout the book provide concrete examples, applications and amplifications of the text, while a set of supplementary problems explores further topics and can serve as starting points for student projects.

Richard Durrett, *Probability: Theory and Examples, Second edition,* Duxbury Press/ International Thomson Publishing Inc., 1995.

This is the second edition of *Probability: Theory and Examples*. In this edition, more than 500 typographical errors have been corrected. More details have also been added to many proofs to make them easier to understand. For example, Chapter 1 is now 78 pages instead of 63, while some sections have been re-arranged and/or divided into subsections. Last and most important, all the problems have been worked and a solutions manual has been prepared.

The book is designed for a one semester probability course taught at the junior/senior level to students who know calculus. It was developed based on Durrett's experience teaching Math 471. The book has an informal style and, as the title suggests, concentrates on the most important aspects of the subject. There are several hundred examples and more than 600 problems which illustrate the many applications of probability. These include all the standard chestnuts and a number of less common examples: paternity testing using blood type information; resolving disputed elections; Joe DiMaggio's hitting streak; and how to play Blackjack.

E.B. Dynkin, *An Introduction to Branching Measure-Valued Processes,* CRM Monograph Series 6, American Mathematical Society, Providence, RI, 1994.

This is the first monograph devoted to the theory of branching measure-valued (BMV) processes. Dynkin first constructs a large class of BMV processes, called superprocesses, by passing to the limit from branching particle systems. Then he proves that, under certain conditions, a general BMV process is a superprocess. A special chapter is devoted to the connections between superprocesses and a class of nonlinear partial differential equations recently studied by Dynkin.

John Hubbard and Beverly West, *Differential Equations: A Dynamical Systems Approach*. Springer-Verlag, 1995.

Traditional courses on differential equations focus on techniques leading to solutions. Unfortunately, most differential equations do not admit solutions that can be written in elementary terms, particularly nonlinear equations in $\mathbf{R}^n$ for $n > 1$.

About 100 years ago, Poincaré, in his seminal paper on the three-body problem, changed the face of differential equations. He took the view that a differential equations defines a family of parametric curves in $\mathbf{R}^n$ the object of the theory is to understand the geometry and behavior of these curves.

The first part of our own series focuses on differential equations in dimension one, where the possible complication of the geometry is fairly limited. Here we attempt to extend those methods to higher dimensions. The problems are much more difficult than in dimension one, and some chapters of the present volume are of a more advanced nature than in Part I, although most should be accessible to undergraduates.

Recently Published Faculty Books, con't.

Poincaré's insights were so novel and deep that it took a very long time for even the professional mathematical community to catch up. Before computer graphics, no one would have suggested that this material could be the topic of an undergraduate course.

We are now able to bring Poincaré's approach to the undergraduate curriculum: the possibility of exploring the material experimentally has changed the nature of the challenge. The companion software *MacMath*, and Extensions of *MacMath*, is designed to bring these notions to life.

Anil Nerode and **Richard Shore,** *Logic for Applications.* Springer-Verlag, 1993.

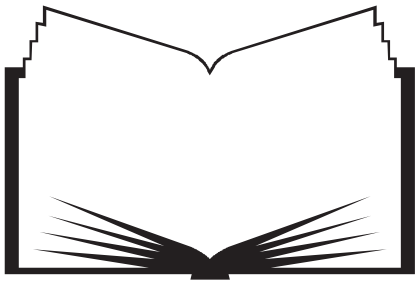
Logic for Applications presents a rigorous introduction to classical, intuitionistic, and modal logic. The book emphasizes deduction as a form of computation by examining the logical and mathematical foundations of resolution theorem proving and logic programming. These subjects are important for many areas of applications in computer science and artificial intelligence. This book presents classical and non-classical logic as well as logic programming to advanced undergraduate or beginning graduate students in computer science or mathematics.

Robert Strichartz, *A Guide to Distribution Theory and Fourier Transforms.* Studies in Advanced Mathematics, CRC Press, 1993.

This book by Professor Strichartz provides a concise exposition of the basic ideas of the theory of distribution and Fourier transforms and its applications to partial differential equations. It clearly presents the ideas, precise statements of theorems, and explanation of ideas behind the proofs without giving formal proofs. Methods in which techniques are used in applications are illustrated and many problems are included. The book also introduces several significant recent topics, including pseudo-differential operators, wave front sets, wavelets, and quasicrystals. The book is based on lecture notes that have been used in Math 422 and Math 515 for many years.

Robert Strichartz, *The Way of Analysis*, Jones and Bartlett, 1995.

This introduction to real analysis contains thorough and complete proofs with lively and generous explanation to guide the reader through the foundations and the way of analysis. Real analysis, in one and several variables, is developed from the construction of the real number system to an introduction to the Lebesque integral. There are also three chapters on applications of analysis, ordinary differential equations, Fourier series, and curves and surfaces, to show how the techniques of analysis are used on concrete settings.



Bernd Sturmfels, *Algorithms in Invariant Theory*. Springer-Verlag, 1993.

This book is both an easy-to-read text for invariant theory and a challenging research monograph that introduces a new approach to the algorithmic side of invariant theory. The Gröbner bases method is the main tool by which the central problems in invariant theory become amenable to algorithmic solutions. Students will find the book an easy introduction to this "classical and new" area of mathematics. Researchers in mathematics, symbolic computation and computer science will get access to a wealth of research ideas, hints for applications, outlines and details of algorithms, worked out examples and research problems.

Happiest of Holiday Seasons from the Mathematics Department!

Special Project Oriented Sections of 112

For the first time last spring semester, the Cornell Mathematics department offered undergraduates two choices for a second-semester calculus course: the traditional version, and an alternative, "calculus reform" version. These "reformed" calculus classes incorporated in-class cooperative learning, long-term group projects, and student group presentations at the blackboard.

There had been a consensus in the department that the second-semester calculus class needed reform. However, the initiative for offering alternative, projects-based sections of the course came from a small band of graduate students. These students drafted the proposal, selected course materials, and eventually designed the course.

Materials and ideas have been incorporated from calculus reform initiatives at New Mexico State University as well as Ithaca College. Some of these materials have been adapted or modified, while other new course materials were introduced by **Harel Barzilai** and **Lisa Orlandi**, the two graduate students who taught the course last spring. Orlandi was named a Hutchinson Fellow for the fall 1995, in part because of her work with these sections of 112.

Student feedback and evaluations were enthusiastically positive, and two sections are again being taught this fall: one by Barzilai, and one by a Cornell faculty member, **David Henderson**. Professor Henderson will be putting forward a recommendation to the Department Curriculum Committee to allow for expanding the projects-based sections.

For further information on these sections, see the November 1994 issue of *The Undergraduate Newsletter*.

Harel Barzilai is a graduate student in the department of Mathematics. He is currently teaching lecture 04 of Math 112.

Math 111: New Offerings

Starting this spring, there will be a new course offering for students taking Math 111: Calculus. Two sections of the course will include the use of graphing calculators.

Visiting Associate Professor **Carolyn DeSilva** will teach sections six and seven of the course, while Professor **David Henderson** will teach section two.

DeSilva is currently teaching sections of 111 this semester. Henderson is currently involved in the special project-oriented sections of Math 112.

LATE BREAKING NEWS!

Congratulations to John Guckenheimer!

Professor Guckenheimer was elected president of SIAM.

Summer 1995 REU Program

The summer of 1995 was the second year the Cornell Mathematics Department hosted a research program for undergraduates under a grant from the National Science Foundation. A total of twelve students (five from Cornell) participated under the direction of Professors **Bezdek**, **Connelly** and **Strichartz**. The students worked on a variety of research projects and gave reports in the Undergraduate Research Forum. Some of the students also gave presentations on their work at the summer meeting of the Mathematical Association of America in Burlington, VT.

In addition, there was a lecture series, the Smorgasbord Seminar, in which the students were given a taste of a variety of mathematical research areas (including a juggling demonstration by Professor **Richard Ehrenborg**, who first prepared the way by explaining how the study of juggling patterns can be used to prove mathematical theorems). A group of five undergraduates worked on different problems of geometric convexity under the supervision of **Karoly Bezdek**, including **David de la Nuez** of Cornell.

The four-week research part of the convexity summer project was strongly supported by the additional four-week reading part, which meant a five day per week seminar on the very recent book of

Research Experience for Undergraduates Program, con't.

R. Webster on convexity that was published by Oxford University Press in 1994. The competition among the students was very high but the atmosphere remained friendly throughout the eight weeks of the project. Everyone managed to come up with some interesting new results. The most outstanding result was achieved by David Nadler, whose seven page manuscript entitled "Minimal 2-fold coverings of E^d" has been accepted for publication in *Geometriae Dedicata*, a leading journal in geometry.

Professor Bob Connelly worked with **Alex Tsow** of Cornell and Arun Nava to calculate some stable highly symmetric tensegrity structures. These structures are a collection of points symmetrically arranged in space and held fixed by another collection of symmetric struts and cables that supply compression and tension respectively. The group concentrated on those structures whose group of symmetries was A5, the alternating group on five letters (with 60 elements). This is the group of rotational symmetries of the regular dodecahedron. The calculations were done in Maple, and lists of over a hundred examples were displayed using Geomview on the Iris workstation in the Math Lab in Stimson Hall.

Five students, including **David Glickenstein**, **Mark Krosky** and **Kevin Walsh** from Cornell, worked with **Professor Strichartz** on fractal analysis, performing computer simulations to explore interesting and colorful phenomena. Glickenstein studied fractal measures generated by nonlinear equations. A surprising result was that the nonlinearity produces regularity, essentially smoothing out the fractal behavior. A typical graph of the resulting function is shown in Figure 1.

[insert figure 1]

Krosky, who worked through the SPUR program (a similar research program run by the Theory Center), studied dimensions of fractals associated to groups of Möbius transformations of the plane. A typical example is the Appolonian packing shown in figure 2.

[insert figure 2]

The dimension of this set appears to be 1.305716, but it's unclear how accurate this estimate is. Kevin Walsh worked with Wade Satterfield from Hendrix College on the open set condition, a standard hypothesis used in fractal theory. The problem was to figure out when this hypothesis holds for some simple examples. We found that even in simple cases, the problem can be very difficult!

The program will be repeated in the summer of 1996. Information will be available in January, with a March 1, 1996 deadline. For further information, contact <reu@math.cornell.edu> or send a message to the department, attn: REU.

Karoly Bezdek is a visiting professor in the Mathematics department. Bob Connelly and Bob Strichartz are professors with the department.

CONTRIBUTE!

Math Matters is always looking for interesting articles for future editions. If you have puzzles, stories, information, or questions relevant to the Cornell mathematics community, we want to hear from you!

Direct submissions to *Karen L. Finch*, editor, 129 White Hall, Mathematics, Cornell University, Ithaca, NY 14853-7901 or < klf4@cornell.edu>.

Yes, I would like to help support the Mathematics Department endowments with my donation of $_____ for:

Δ ***The Mathematics Faculty Book Fund*** Provides the Cornell Community with immediate access to one of the world's finest assortments of mathematics books and publications by enriching the collection of the Mathematics Library.

Δ ***The Mathematics Colloquium Endowment Fund*** Instituted to invite distinguished scientists to speak at Cornell. Major contributions come from faculty who teach extra courses and donate their earnings to the fund.

Δ ***The Eleanor Norton York Award in Astronomy and Mathematics*** Established in honor of Eleanor Norton York, a valued Astronomy Department employee who worked closely with graduate students. Recognizes outstanding graduate students in Astronomy and Mathematics with an annual prize.

Δ ***The Israel Berstein Memorial Fund*** Honors the memory of a former Mathematics Department professor with an initial donation from his sister, Gita Fonarov. Funds annual awards for deserving graduate students in the fields of topology and/or geometry.

Δ ***The Logic Endowment*** Recently established by a donation from a former Cornell undergraduate. Seeks to actively support promising logic students in the areas of institutional memberships and travel expenses, for Association for Symbolic Logic meetings and events, and other activities in the field of logic.

Make checks payable to Cornell University ; a receipt may be sent to you for tax purposes if you wish. Please send to The Mathematics Department Endowments, 135 White Hall, Cornell University, Ithaca, NY 14853-7901.

Comments:_____

Name:_____

Address:_____

Spotlight on: Alice Friedenson

Alice Friedenson (BA '64, MA '71) has been busy since she left Cornell University. "Mathematics teaching has changed dramatically for me," she says. The change came about in 1989 when she participated in the Critical Skills Institute at Antioch New England Graduate School. "The philosophy gives equal importance to academic subject and skills such as communication, collaboration, critical thinking, and problem solving." She applied these standards to her own teaching, and her classroom "became alive with projects, applications, real learning."

Alice received the Model Mathematics Program Award from the New Hampshire Mathematics Coalition in 1991, and was a Christa McAuliffe Sabbatical Finalist in 1992. She has also been involved with the New Hampshire Coastal Cleanup Project; her students have compiled a statistical analysis of beach and ocean debris which was twice published as part of the National Coastal Cleanup Results in 1992 and 1993. She has continued in this area, receiving the Gulf of Maine/Bay of Fundy Visionary Award in 1993.

Alice currently works at Salem High School in New Hampshire and is exploring new projects in her calculus class. She states she would "very much enjoy sharing my ideas with current Cornell students entering mathematics education."

Changes in the Faculty for 1995-1996

Departures:
Lawrence Brown,
Paul Thurston
Xuesung Wang

Promotions:
Karin Johnsgard

Leaves:
Keith Dennis, academic year
Clifford Earle, academic year
Roger Farrell, spring
Leonard Gross, spring
John Guckenheimer, academic year
Sa'ar Hersonsky, spring
John Hubbard, academic year
G. Roger Livesay, spring
Anil Nerode, spring
Alfred Schatz, fall
Shankar Sen, spring
Birgit Speh, spring
Michael Stillman, spring
Robert Strichartz, spring
Bernd Sturmfels, academic year

New H.C. Wang Assistant Professors:

Jeffrey Diller received his Ph.D. in Mathematics from the University of Michigan in 1993. Dr. Diller is a former assistant professor at Indiana University. He will receive an NSF Postdoc and will work with Professors Hubbard and Smillie. Diller's research involves contracting properties of the Poincaré theta-operator and dynamics in several complex variables. He will not be teaching during the 1995-96 academic year.

Richard Ehrenborg received his Ph.D. in Mathematics from Massachusetts Institute of Technology in 1993. Prior to his appointment here, Ehrenborg was a postdoc at LACIM, Université du Québec á Montréal. His research interests include algebraic combinatorics, invariant theory, and stochastic processes. Professor Ehrenborg will teach two sections of Math 191—Calculus for Engineers in the fall and two sections of Math 222—Calculus in the spring.

Bakhadyr Khoussainov received his Kandidate of Science in Mathematics from Novosibirsk University, Uzbekistan in 1988. Dr. Khoussainov was an assistant professor at Tashkent University from 1988-91. A visiting scientist at Cornell since 1992, he conducts research in logic and computer science, including recursive model theory, automata, games and monadic theories, and algebraic specifications and abstract data types. Professor Khoussainov has over 20 scientific publications. He will teach two sections Math 112—Calculus in the fall and Math 486—Applied Logic and Math 682—Seminar in Logic in the spring.

Nikola Lakic received his Ph.D. in Mathematics from the City University of New York in 1995. His area of research is complex analysis and dynamical systems. Professor Lakic has taught at the University of Belgrade and at Brooklyn College. He will teach two sections of Math 111—Calculus in the fall and Math 112—Calculus in the spring.

Kevin Pilgrim received his Ph.D. in Mathematics from the University of California at Berkeley in 1994. Professor Pilgrim took a year's deferment to accept a position as Research Fellow at MSRI. His research interests include conformal dynamics, complex analysis, three-dimensional topology, Teichmüller theory and hyperbolic geometry. Professor Pilgrim will teach two sections of Math 122—Calculus in the fall and Math 293—Engineering Mathematics and Math 522—Applied Functional Analysis in the spring.

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